J Evol Econ (2014) 24:1085–1105
DOI 10.1007/s00191-014-0382-4

REGULAR ARTICLE

The rule approach in evolutionary economics: A methodological template for empirical research

G. Blind · A. Pyka

Published online: 5 November 2014

Abstract Dopfer and Potts (2008) have proposed a new analytic foundation to evolutionary economics based on the unified rule approach. While they contend that their approach is ontologically and analytically coherent and useful, scholars sympathetic with it, e.g., Ostrom and Basurto (2011), have called for further methodological and empirical specification. In the same vein, this paper seeks to develop the Dopfer-Potts framework by proposing an analytic methodology to translate their rule-based approach into an operational method for identifying and testing hypotheses that relate to rules. It does so by defining a methodology connecting *explanandum* (response rule) and *explanantia* (factor rules) at the same level of rules. The concept of a 'savings rule' serves as a roving example that later is extended into a case study. The paper offers a methodological template for applied evolutionary analysis in economics.

Keywords Rule-based approach · Methodology · Economic change · Evolutionary economics · Empirical methodology

JEL Classification B41 · O10 · D83 · B52 · E21

1 Introduction to the rule-based approach

At the core of many 'evolutionary' approaches to economic analysis lies a focus on 'economic genes' (Nelson and Winter 1982), on 'economic memes' (Dawkins 1976), or on formal and informal 'rules' (North 1990). The latter are seen as emerging from interactions between people in political, economic, social, and organizational domains (Aoki 2001), or, more generally, as 'ideas for economic operations' (Dopfer and Potts 2008; Dopfer 2001). Based on the ontology of 'evolutionary realism', Dopfer (2004)

G. Blind
University of Zurich, Zurichbergstrasse 4, CH-8032 Zurich, Switzerland

A. Pyka (✉)
Department of Economics, University of Hohenheim, Wollgrasweg 23, D-70593 Stuttgart, Germany
e-mail: a.pyka@uni-hohenheim.de

and Dopfer and Potts (2004) argue that the evolutionary economic agent - *homo sapiens oeconomicus* – is a rule maker and rule user, and that the core domain of evolutionary economic analysis is 'meso' (Dopfer 2005, 2012).

This paper is generally concerned with the Dopfer-Potts conception of 'rules' and the micro-meso-macro framework as a new analytic foundation for evolutionary economics. In its specific aim, it attempts to provide the essential principles of an applied methodology for the 'rule-based approach' (RBA).

At its very core, a rule represents knowledge that enables its carrier to perform economic operations, i.e., production, consumption and transactions. The distinction between generic rules and operations based on these rules is essential for the RBA.[1] Significantly, it is rules, not operations, which evolve. As an analytical framework, the Dopfer-Potts approach allows for exploring the great many empirical phenomena that do not fit a rational choice explanation. The heterogeneous agents of the RBA differ from *homo oeconomicus* by making their own rule choices. On top of this, the approach allows for reassessing theoretical concepts of heterodox strands, such as institutions and technology, on the basis of a unified analytical concept.

It has been variously acknowledged that the Dopfer and Potts RBA is 'ontologically and analytically consistent and complete' (e.g., Strohmaier 2010; Beinhocker 2011; Ostrom and Basurto 2011:333–334). However, the approach has also been criticized on grounds that the concept of rules should be applied to social rules only (Runde 2009), or that it is operationally difficult or too abstract to apply to concrete empirical cases. While there are good reasons to reject the former critique (for a rejoinder compare Dopfer and Potts 2010), the concerns with regard to the tractability is in our view highly relevant and has been argued well by Elinor Ostrom and Xavier Basurto. Outlining and honoring the merits of the Dopfer-Potts approach, they argue that the approach "does not provide us with enough details about the nature of rules and rule configurations operating at the meso domain to inform how changes might take place and how these changes could be measured" (2011:334). As a matter of fact, the RBA itself contains few clues as to how specific hypotheses might be developed or how empirical analysis might be operationalized in detail.

Yet, in important respects, this same criticism extends across all evolutionary analysis and has been giving rise to the preponderance of analytic attention to, for example, simulation modelling using variables that pertain to the operant level (e.g., Axelrod 1997; Morone and Taylor 2004; Pyka and Grebel 2006; Ohori and Takahashi 2012). Among the few endeavours to identify concrete and specific rules, Grebel's *conceptual* analysis of research networks (Grebel 2012) stands out. In the present study, we endeavor to make a contribution along the line of these works. We try to demonstrate how the RBA might be employed in the context of a comprehensive empirical analysis, which includes major aspects of both rules *and* of operations. Through the proposed methodology, we aspire to provide guidance on how to fully capitalize on the analytical potential of the RBA.

Our central contention is that the rule-based approach may be best operationalized by introducing the concepts of response variables and of independent variables, or *rule explanandum* and *rule explanantia*, when dealing with empirical research. To this end,

[1] For reasons of simplicity, we refer to ‚generic rules' as ‚rules' throughout this contribution.

the Dopfer and Potts RBA is useful as it makes a clear distinction between the 'rule level' (the *rule* as semantic content, or unit of knowledge) and the level of operations based on rules. The analytic framework provided by the RBA explains the properties and outcomes of the rule that we seek to explain in terms of systems of other rules.[2]

For illustrating how the framework can be employed to develop an empirical research design, we construct a detailed fictitious case study. We start that "construction work" by taking as example the classical problem of investigating the determinants of savings. The example helps to clarify the distinction between a rule perspective on savings and the notion of aggregate savings: While the former refers to the willingness of agents to save, the latter addresses the outcomes of saving operations conducted by agents in applying their savings rule. With this we aim at providing a model case for employing the RBA in empirical research.

2 A suggested methodological framework

Putting the RBA into practice – by way of formulating and testing hypotheses – requires a number of particular methodological considerations. Let us highlight some of the building blocks of the Dopfer and Potts rule-based approach.

In Dopfer's own words, the RBA's "essential characteristic is bimodality, meaning that one idea (the generic rule) can be physically actualised by many agents (a population)" (Dopfer 2012:133). Once actualized in an agent, a rule as a "deductive schema" (Dopfer 2004:179) then allows operations. The analytical apparatus of the RBA distinguishes micro, meso, and macro domains. On the rule level of analysis, a rule originates in one agent in the micro domain, diffuses into a population of agents that become its rule carriers in the meso domain, and eventually causes change in the rule structure of the macro domain. In contradistinction, at the operant level, extant rules are used for operations and the dynamic is not a dynamic of rules but rather one of operations based on given rules. We have an initial operation (or rule use) in the micro domain, the frequency of operations in the meso domain (e.g., production volumes), and structural change through changing patterns of operations based on a given rule structure in the macro domain. Table 1 summarizes this overview of the RBA key concepts[3].

Next, the RBA introduces a taxonomy of 4 *classes* and 3 *orders* of rules (Dopfer and Potts 2008: 8,9). In Table 1, we have provided a generalized example of a technological 1st order rule. The overall RBA taxonomy encompasses the classes of cognitive, behavioral, technical and social rules as well as orders of rules, i.e., 1st order (operant) rules, 0th order (constitutional) and 2nd order (mechanism) rules.

The *classes* of technological and social rules are seen as rules for organizing objects. Physical objects, i.e., artefacts, such as machines, consumer goods or the division of labor, etc., are organized by technical rules, and humans (as subjects) are organized by using a schema of social rules.

[2] Ostrom and Basurto refer to these systems as ‚configurations' (2010:318).

[3] For the distinction between the analytical levels of rules and of operations, compare Table 1 in Dopfer K and Potts J (2009) On the Theory of Economic Evolution. Evolutionary and Institutional Economic Review 6(1):23–44.

Table 1 RBA analytical objects: Domains and Levels

RBA domain	Level of generic rules (actualized in carriers)	Operant level (operations and commodities)
Analytical objects		
Micro	Origination of a novel rule by an agent or an agency	Initial rule use
Meso	Diffusion of rules from one to many agents, i.e., emergence of populations of rule carriers; frequency of rule adoption	Frequency of rule use
Macro	Consequences of the emergence of a new rule population on existing rule population and rule structure	Interplay between uses of different rules depending on their relative use frequencies
Example		
Micro	Invention	Prototype
Meso	Number of firms adhering to a specific technology	Production volumes as instances of rule use
Macro	New technology as a complement or substitute to existing technologies	Industrial change

In turn, cognitive and behavioral rules relate to humans, i.e., to the thinking and the behavior of economic agents; Dopfer and Potts conceive agents as carriers of subject rules. Sociology, evolutionary psychology, neuroscience, etc. are traditionally seen as disciplines that are sources for studying subject rules. The distinction will become crucial when it comes to obtaining data in empirical investigations.

Orders of rules help us to understand the different ways in which rules are active in the economic system. The 1st order rules comprise all rules for operations in an economic system. Prominent examples are patents as technological rules for the operation of production. Their evolution is described on the basis of a trajectory specified by the mechanisms of origination, selective adoption and retention of a rule. Second order rules deal with rules that change the mechanisms themselves, i.e., origination or innovation mechanism rules, adoption mechanism rules and retention mechanism rules. Examples of 2nd order rules include aspects of the educational system, such as a society's tolerance of failure, which will substantially influence the propensity to adopt novel 1st order rules. The 0th order (constitutional) rules are cultural and political rule 'premises' of the overall rule system. For example, law and legislation in a Hayekian reading (Hayek 1973) represent one of the most important types of 0th order rules.[4]

Before outlining the RBA-based methodology for empirical research, let us look briefly at the major premises on which the approach is based. First, given heterogeneity of agents, rules applied by agents will differ depending on their characteristics. Second, given the openness to learning, an individual agent has the potential to change his rule base over time. Third, an individual agent may apply different rules in different

[4] It is insightful to compare the rule world of Ostrom with that of the RBA. There is a close correspondence with regard to 1st order social and behavioral rules and to 0th order rules. Ostrom's "boundary rules" and "payoff rules" closely correspond to 0th order constitutional rules, and her "choice rules" and "position rules" fit well the bracket of 1st order rules in the RBA. The 2nd order rules receive little attention in the Ostrom approach, though her first "information rule" may be conceived as a 2nd order rule (a rule pertaining to other rules).

contexts when performing a particular operation. This simply presumes a context-dependent selection of rules, i.e., that the choice of a rule for performing an identical operation may be different depending on the context. Fourth, rules have populations of carriers, and these populations also change. Even when a structure of rules remains invariant, the rule adoption frequencies of the various populations may change. So, while the macro structure of rules remains the same by qualitative measure (as rules have not changed), it changes quantitatively as the frequency of rule adoptions in populations (in at least one population) have changed.

Based on these premises, we focus on the complex relationships between the success or fitness of a rule (*explanandum*) and the structure and population dynamics of other rules (*explanantia*). Presenting our methodology, we distinguish four stages. We define and explain the nature of a response rule (*explanandum*) in the first stage, and then identify and illustrate the corresponding factor rules (*explanantia*) stated in terms of a system of factor rules (SFR) in the second stage. For identifying those rules from within the SFR that may have resulted in a change in the response rule, the third stage introduces a corresponding extraction procedure. Finally, in the fourth stage we discuss how to deal with heterogeneity of agents when establishing and testing hypotheses.

2.1 Stage 1. The explanandum: Identifying the response rule

As in any empirical study, we must first identify and select an *explanandum*. In the RBA, this *explanandum* is a 'rule'. Hence, for studies of micro and meso phenomena, researchers will have to set a 'response rule' rather than a response variable. This simple idea, as an empirical shift in focus, is one half of the proposed new methodology suggested here. (The other half is to shift the *explanantia* to rules, too.)

To illustrate this distinction, consider the response variables chosen in much of applied economic research, such as growth rates, employment levels, productivity, inflation rates, etc. Not only are these variables aggregates, but first and foremost they are the results of economic operations within a given system of rules. They do not represent, by any means, rules themselves. In some instances, underlying rules and operant variables can show relatively close links, which makes the distinction even more difficult. For instance, consider the savings rate. As an aggregate measure, it represents the average share of income put aside. The underlying rule, however, refers to the population of agents who are willing to make savings. Whether they are in a position to do so (i.e., whether their constraints allow doing so) is not part of the 'rule story', but an outcome of economic operations. A 'savings rule' is thus to be primarily explained in terms of other rules, and only secondarily in terms of relative prices and budget constraints.[5]

2.2 Stage 2. The explanantia: Identifying the system of factor rules (SFR)

After setting a response rule as *explanandum*, we identify and define the set of other rules that potentially impact on the *explanandum* in the second investigation stage. This

[5] The RBA explicitly includes the possibility of a perfect congruency between the rule level and the operant level as a special case. Yet, as becomes obvious from our example, many empirical phenomena will not come with such congruency.

explanatory set we call 'system of factor rules'. We will outline this process in five individual steps, providing practical examples for each step.

2.2.1 Empirical realism as guiding rail for identifying influencing factors

In the first step, we identify all rules that potentially influence the population of the response rule. In order to secure empirical validity, one needs to employ sources from different perspectives, e.g., references from previous research, discussions with rule adopters and rejecters, as well as with scholars from various disciplines (e.g., business studies, economics, sociology, psychology, ethnology). To recur to the example of a 'savings rule', rule adopters and rejecters are to be identified not by their actual accumulation of savings, but by their willingness to do so or not. Enquiring into the motives with respect to their stance will help us to identify supporting or conflicting rules, e.g., a hedonist rule in the case of rejecters, or an investment rule in the case of adopters. As can be seen from this small example, information is to be drawn from various sources by various methods. Ideally, the procedure will help to establish a complete list of potential influencing factors.

2.2.2 Analysis of the rule level requires clearing one's findings from prices and quantities

As our second step, we will have to clear the list of potential influencing factors from operant entities, i.e., ensure that it exclusively consists of rules. This is necessary in order to secure an unbiased analysis of the rule level. Information retrieved both from literature and primary research will likely be intermingled with operant aspects such as prices and quantities. However, as we have already pointed out, for an understanding of economic change we have to focus exclusively on the structure of rules. Naturally, if at a later stage one is to amend one's analysis of the response rule with a study of operations conducted upon it, it will be necessary to revert to omitted operant entities such as resource constraints.

In our previous example of an investment rule in the context of savings, one obviously has to consider the idea of earning interest. Given the powerful concept of adaptive expectations, one would likely be inclined to focus on real interest rates. However, doing so would not be justified from a rule-based analytic perspective, because the relevant interest rate must be derived from the perception of agents. This perception corresponds to either of two conflicting 2nd order rules: *Nominal interest* versus *Real interest*. If one imagines a slightly deflationary environment, such as in Japan (compare case study section), *Nominal interest* may well represent the rule prevalent in the majority of agents.

2.2.3 Classifying factor rules by class and order

In the third step, we categorize all factor rules according to the RBA rule taxonomy. Making this distinction is crucial for understanding the nature of factor rules and how they exert influence on the size of the response rule population. For instance, behavioral rules exert influence via mechanisms such as group pressure, customs or habits, both

leading to socially conditioned action. In contrast, cognitive rules work via rationales in the minds of agents.

Analytical consequences of the rule taxonomy are not limited to rule classes, but also arise from the distinction of rule orders. Constitutional rules typically refer to all agents in an economy; hence to the entire rule population of the response rule. In addition, second order rules often imply a substantial time lag until any consequences arise, e.g., in the case of rules bestowed through an educational system. For example, if we conceive the 'savings rule' as a cognitive rule – hence, a subject rule – we gain the epistemological insight that one cannot make inquiries concerning physical structures in this context (such as for object rules), but that one has to investigate the minds of agents.

2.2.4 Inquiring how factor rules impact on the response rule

In the fourth step, one has to determine the relationship between factor rules and the response rule. The individual relationships can either be complementary, conflicting, or neutral, thus mirroring the motivational forces proposed in Brandes and Weise (1999): the force of preference, of conformity, and of anti-conformity. The exertion of influences can either happen unilaterally, or mutually through feedback relations. Whenever feedback relations are at play, the phenomenon under scrutiny obviously is subject to a macro coordination process. Both in studies with an exclusive population focus (i.e., in perfect absence of feedback relations), and in macro coordination inquiries (i.e., in the presence of feedback relations between populations), the term "influences" always refers to the effect on the size of the response rule population.

For instance, a hedonist behavioral rule would conflict with the 'savings rule', or, in the terms of Brandes and Weise, it would be characteried by anti-conformity. Consequently, a growing population of carriers of a hedonist behavioral rule would exert a negative influence on the population size of the 'savings rule'.

2.2.5 Understanding how factor rules interact

In the fifth step, we check factor rules for interdependencies with other factor rules. Statistics offers a helpful analogy with the concept of multicollinearity. Through this precaution it is often possible to identify cases in which a factor rule exerts only a secondary effect on the response rule. If, in our 'savings rule' example, we believe that both a hedonist behavioral rule and an investment cognitive rule exert influence on the 'savings rule' as our response rule, we would need to check for mutual influences among these factor rules. While one could easily exclude a mutual influence in this case, the interest rule – expressed in terms of the perceived interest – would arguably only exert a secondary influence via the investment rule. Now, just as in regression analysis, one would obviously exclude secondary factors that are (near) covariates of other factors. However, if we are ultimately to aim at developing policy recommendations, these rules may prove to lend themselves to policy intervention. This is because the response rule population often cannot be directly influenced by economic policy, and, likely often, neither can primary factor rules. However, secondary relationships – naturally depending on their strength and the size of the respective rule population – might offer a way in.

Upon the completion of these 5 steps, we are able to establish the *explanantia* as a system of factor rules (SFR). Possible representations of the SFR range from a simple tabulated list, to graphical representations as used in network analysis. The theoretical description of the SFR is not complete in a formal sense. This is because the SFR originates essentially from the empirical estimates and efforts of the researcher. It represents a locally constrained set of hypotheses that are subject to a temporal limitation defined by the observation period. The RBA eschews formally complete and invariant theorizing in order to establish empirical hypotheses that – through testing – can be transformed into locally valid theorems. In essence, the RBA inspires inductive theory-building.

2.3 Stage 3. Origins of change: Identifying subsystems

The simple methodology proposed here connects a response rule with a set of factor rules. The presumption, and indeed goal, of the analysis is to create a set of such factors that constitutes a full explanatory system of rules, i.e., all causally relevant rules are identified. But just as one may in statistical analysis throw anything one can think of into a regression in pursuit of significance, even when we find significance, we cannot infer causality from this. An equivalent concept is applied in the methodology of rule-based analysis. Following Dopfer (2001) and Dopfer and Potts (2008), we identify the relevant rules and rule associations in order to map the subsystem effective during the investigation period. This is required to be able to provide causal explanation.

2.3.1 The nature of change on the rule level

Based on the premise that change in social systems always originates from change in associated entities, we need to understand which parts of the system of factor rules (SFR) have been subject to change during the investigation period, in order to infer the causes of economic evolution. Typically, change in the SFR will be limited to certain parts, i.e., to a number of rules that is smaller than the total number of rules in the SFR. In effectuating this helpful reduction of complexity, the third investigation stage aims at extracting those rules of the SFR that have caused change in the response rule population during the investigation period. To that end, we determine which rules in the SFR have been subject to change in the course of the observation period. These rules represent the changing sub-system, while all other rules form the meta-stable sub-system. The extraction of the changing subsystem requires an assessment of all SFR rules by two criteria. To motivate these criteria, let us consider what forms of change actually can happen on the rule level, and what consequences they imply on the level of economic operations.

First, the size of rule populations can fluctuate over time. This can potentially trigger most significant changes on the level of economic operations. To continue one of our previous examples, let us assume that the rule population of agents having adopted the ‘savings rule’ grows significantly. Depending on their constraints, we understand that the savings rate will potentially increase. In this case, we observe evolution on the rule level to cause change on the operant level. It is important to note, however, that the ensuing change in operations alone does not qualify as economic evolution.

Second, evolution on the rule level occurs with the emergence of new rules or the perishing of existing rules. Consider again the 'savings rule' in a developing economy where savings were restricted to stockpiling until a novel rule called 'trustee savings bank' emerged. While such 'mutation' clearly qualifies as evolution on the rule level, resulting change in operations might come with a time lag owing to constraints in other rules or in resources.

Third, new associations between rules can emerge in the course of time, e.g., when agents learn to recognize the significance of one rule for another. Reverting to our previous example, let agents recognize that rising life expectancy creates a need for savings in order to secure consumption during old age. Conceptually, this process of recognition can be qualified as the emergence of a new cognitive rule. It is true, therefore, that the emergence of a new association between rules equals economic evolution on the rule level. However, it will not always be possible to identify the underlying cognitive rule. Yet, for most empirical purposes, it is sufficient to identify the emerging association. In statistical analysis this can be evidenced by the emergence of a significant correlation. Naturally, this line of thought also applies to the breaking of associations between rules as a form of change. As it implies the vanishing of a cognitive rule, this corresponds to the "forgetting of a rule" as an "unconscious process of change" (Ostrom and Basurto 2011:326).

From the first form of change on the rule level - change in the size of rule populations - we conclude that change in rules does not necessarily equal economic evolution. However, all forms of change on the level of rules yield a potential for change on the operant level of the economy. Consider, for instance, how the diffusion of a superior new technology can transform entire industries. To add one further complication to this reasoning, we state that fluctuations on the operant level can also happen without a corresponding change on the rule level, e.g., through external shocks or through changes in constraints. For example, the savings rate might increase due to some positive external income shock, etc. There are, therefore, objects of analysis the significance of which is limited to the respective rule and operant levels. As the focus of this article is the rule level, it suffices to note that all forms of change on the rule level represent a potential to change on the operant level.

With the three forms of change on the rule level identified above, we can now consider how to extract that part of an SFR that has caused change in the size of the response rule population during the observation period. As already noted, this equals identifying that part of the SFR that was subject to change during the investigation period, the changing sub-system CSS. To that end, we propose to assess the rules constituting the SFR by two criteria, corresponding to the first and second step of the third investigation stage:

(a) Variation in the population sizes of factor rules,
(b) Variation in the strength of influence exerted by factor rules on the response rule population.

Criterion (a) refers not only to variation in population size as the first kind of change introduced above, but also embraces the emergence of new and the perishing of extant rules, as these phenomena can be qualified as a change in the size of a rule population from zero to positive and vice versa. Criterion (b) helps us to identify the emergence of

unspecified new rules that have led to a change in the strength of association between pre-existing rules, or to changed correlations in a statistical reading. Ideally, it will help to identify the emergence of a new rule, which has triggered the respective change in the strength of the association between pre-existing factor and response rule populations.

As an example, we can point to the research of Fehr and Gächter on "altruistic punishment". As they set up their laboratory experiments on cooperative games and free-riding, they conjectured the complete absence of punishment if it was costly and not bestowing the punisher with any reward, i.e., if agents were to apply a purely rational profit maximization rule. In their experiments, however, they witnessed a negative correlation between the free-riding rule population and the profit maximization rule. This result led them to consider the existence of a cognitive rule, which they labelled "altruistic punishment" (compare Fehr and Gächter 2002).

In order to check on criterion (a), researchers will need to rely on surveys investigating population sizes, i.e., quantifying the number of agents retaining the respective rule. In turn, when inquiring into criterion (b), researchers will ideally obtain surveys inquiring into these influences directly; e.g., the influence of mistrust in government pensions on the 'savings rule population'. Typically, however, the existence of a theoretically inferred influence will have to be evidenced through an analysis of correlations between rule population sizes.

Rule populations of factor rules for which one or both criteria have seen sizeable variation have evidently been subject to change. Thus, the procedure helps to split the SFR into a changing sub-system (CSS) and a meta-stable sub-system (MSSS). Rules attributed to the MSSS do not contribute to the change in the response rule population during the investigation period. The methodology thus directs attention to the CSS. It goes without saying that demographic change is one important factor to control for when scrutinizing changes in the size of rule populations over time.

To assess the factor rules using the two criteria, researchers will need to gather respective information. While retrieving suitable information is a common problem in any empirical study, these problems are even more pronounced when doing research within an evolutionary analytical framework such as the RBA, since the collection of economic data largely focuses on operations. As a consequence, often only data on 1st order operational rules, i.e., directly pertaining to resources, can easily be obtained. From our example of the 'savings rule' we can imagine that central bank statistics on the savings rate will be available, possibly even a micro-census displaying income and savings. Yet, if we are to determine the size of the savings rule population, i.e., the number of agents willing to save, we may have to turn to other branches of science or to the media to retrieve suitable information. As a matter of fact, economic and societal issues have never been as closely covered by surveys and polls as they have been in recent years; hence, a promising development from the perspective of the RBA.

2.4 Stage 4. Testing hypotheses on the level of rules and on the level of operations

The fourth stage of the proposed methodology involves developing and testing hypotheses about the changing sub-system (CSS). First, we establish the CSS on both levels of representation, i.e., for the level of rules, and for the level of economic operations. Distinguishing rules from operations is key to producing a meaningful in-

depth analysis going forward. Although the two modes are intimately dependent on each other, they reside in two entirely separate worlds. To make use of the 'savings rule' example one more time, let's assume that we have found the size of its population to depend on the size of the rule population of a 'providence rule' (the idea of securing consumption during old age). Now, on the level of operations, this will translate into the savings rate depending on life expectancy.

Second, we identify sub-groups of agents and their distinct rule sets. Depending on the composition of their individual sets of rules and on their endowments (operant realities), agents will be susceptible to different influences when considering the adoption of a new rule. This very much corresponds to the typologies developed for any model involving heterogeneous agents (Pyka and Grebel 2006). An analogy from marketing studies would be the segmentation of customer groups, such as about how 'rules' are variously adopted and retained by different demographic groups. For example, while a 'providence rule' might be predominantly found among junior generations, a 'bequeathing rule' will only be found among senior generations.

Third, having identified both (1) the representations of the changing sub-system for the two analytical levels of rules and operations, and (2) the nature of potential subgroups of agents, the researcher becomes able to formulate more detailed hypotheses. With the help of this experiential knowledge, the analyst will also be able to select the most appropriate technique for hypothesis testing from among the principal choices available, a decision to be made in the subsequent final step. As the choice of techniques will need to reflect the context, there are few general points to be offered here, because these contexts will tend to be unique. This is why the researcher should seek as explicit (and self-reflective) an account as possible at this methodological juncture.

3 The methodology in practice: The savings rule as a case study

Now, how can one effectively use the proposed methodology to create an appropriate research design for an empirical study? In which way can the methodology enrich empirical analysis, i.e., what is the epistemological *value added*?

In addressing these questions, we construct in the following a case study of the determinants of savings in Japan since 1990, or briefly a study of the 'savings rule'. For providing a showcase to our methodology, we need an analytical design that allows for exemplifying all of the steps introduced in preceding section 2. It would be ideal if we could provide an empirical example to illustrate the use of our methodology in its full scope and content. While this would mean providing what this paper actually intends to inspire, the few examples available (e.g., Blind 2012; Wäckerle 2013) hardly allow for illustrating all aspects of the methodology. Therefore, we must either accept not to offer a full illustration of the methodology, or to build a tailor-made didactical case study. In this article, we decided to present a constructed model in which the underlying case is empirically likely, but not manifest in any data. This is in the tradition of the many case studies used in management sciences that are tailored to serve illustrative and didactical purposes. Our "idealized" case study not only allows exemplifying the workings of the

proposed methodology, but may also be instructive as to how the rule-based approach may be employed for the analysis of similar cases.

As point of departure, we provide a step-by-step summary of the four investigative stages of our methodology in Table 2. Developing our case study in the following, we exemplify each individual step of the 4 stages.

In the first stage of investigation in our case study, we start by defining our *explanandum*. As we wish to study the savings in an economy from an evolutionary perspective, we need to understand that savings as an aggregate represent the outcome of saving operations. The latter originate from the group of agents that are willing to save, i.e., from the population of agents having adopted a 'savings rule'. With this in mind, we fix the 'savings rule' as response rule (i.e., the *explanandum*) in our case study.

Next, we have to decide on the time horizon and the spatial (geographical) delimitation of our fictitious investigation. The first delimitation is necessary because the RBA recognizes 'historic time', i.e., it argues that agents are open to learning, and hence depend on their experiences. Second, agents adopt different sets of rules depending on the context in which they live. Therefore, a spatial focus helps to capture some of the explanatory power that is lost in international comparisons whenever region- or country-specific dummy variables are found significant, but are not inquired further. For the purposes of our case study, we fix the spatial limitation to Japan – a country famous for being labelled a "special case" in international comparisons (e.g., De Long 1988:1151; Kaldor 1975; Cavelaars 2005); and we let the investigation period start in 1990 as the point in time at which Japan left its post-war high-growth path with the burst of its bubble economy.

In the second investigation stage we are to determine the system of factor rules (SFR) as the set of rules that are relevant to the 'savings rule population' as the

Table 2 Hypothesis Building and Testing within the RBA: Outline of procedures

1. Set response rule population, investigation period, and spatial delimitation.
2. Establish full system of factor rules (SFR).
   - 2.a) Identify potential factor rules through the use of appropriate sources.
   - 2.b) Check list of potential factor rules not to contain operant entities in order to ensure a clear-cut analysis of the rule level.
   - 2.c) Classify factor rules according to the rule taxonomy.
   - 2.d) Identify nature of relations between factor rules and response rule.
   - 2.e) Check for interdependencies among factor rules.
3. Split SFR into Changing Sub-System CSS and Meta-Stable Sub-System (MSSS).
   - 3.a) Identify factor rules with significant variation in population size during the sample period.
   - 3.b) Determine the strengths of influences exerted by factor rules on the response rule population during the sample period; consider a potential variation in time.
4. Conduct in-depth analysis of two-level CSS.
   - 4.a) Establish two-level representation of the CSS.
   - 4.b) Identify potential sub-groups of agents.
   - 4.c) Establish corresponding hypotheses.
   - 4.d) Test hypotheses upon choice of technique: hermeneutics, simulations, and statistics.

explanandum in our case study. In order to determine the SFR of the 'savings rule' we follow the steps outlined in Table 2, (2.a–2.e). First of all, we need to identify potential factor rules, i.e., rules that may have influenced the response rule population during the investigation period. In doing so, we follow a comprehensive approach: We extend our inquiry beyond the review of existing theoretical works to include insights from neighbouring disciplines (e.g., sociology), interviews with adopters and rejecters of the 'savings rule', and a review of media coverage.

From extant empirical works on Japan we infer the likely influence of tax law (a; Chen et al. 2006). Through interviews with rule rejecters we identify a hedonistic lifestyle (b) as one major motivation not to adopt the 'savings rule' particularly among younger individuals. In another interview with a leading sociologist we obtain an important insight regarding more senior generations. For them, the adoption of the 'savings rule' reportedly often stems from the wish to bequeath their offspring with significant assets (c). We triangulate this suggestion in a discussion with a scholar of Japanese studies who confirms the particular relevance of this motive in Japanese society, and obtain further supporting evidence by means of some semi-structured interviews with senior rule adopters. Finally, from the pertinent literature we include the real interest rate (e). As a result, we obtain the following list of potential factor rules:

(a) Tax law pertaining to interest income (TLI)
(b) A hedonist lifestyle rule (HLS)
(c) A bequeathing rule (BQ)
(d) A providence rule (PRO)
(e) The real interest rate (RI)

Now, what most notably distinguishes the approach taken in our fictitious case study from many received research designs is the explicit empirical orientation that we pursue already at this early stage of hypothesis building. We leave it to the judgment of the reader whether relying on extant theoretical work would have allowed for identifying all the five factors.[6]

As the second step (compare Table 2, 2b) we check our list of factor rules to determine whether they happen to contain operant entities instead of rules only. In doing so, we follow the definition of Dopfer and Potts of a rule as "a deductive procedure for operations" (2008:104). Tax law (TLI) prescribes the means to pay a tax on interest income, and paying a tax is an economic operation. Hence, TLI can be considered a rule. The hedonist lifestyle (HLS) also qualifies as a rule, as it implies a means to maximize consumption, with consumption being an economic operation. Equally, bequeathing (BQ) requires the transfer of assets from one agent to one or multiple other agents, and this transfer is to be considered an economic operation. Next, providence (PRO) aims at securing consumption during old age, and this requires the acquisition of corresponding options (insurance contracts, public pensions, or –

[6] From our view, the pertinent literature would suggest considering real interest and a precautionary motive implicit in the providence rule, as well as tax law (e.g., Cagetti 2001). However, it might be difficult to identify a hedonist lifestyle (b), as opposed to the intention to bequeath one's heirs (Hayashi and Ando 1988) exclusively on the basis of a review of extant literature.

precisely – savings). As the acquisition of a financial option equally represents an economic operation, PRO also qualifies as a rule.

However, reviewing the real interest rate (RI) reveals a concern. An interest rate cannot be conceived as a "deductive procedure". As a price, it is an operant entity, but not an operation itself. Hence, RI does not qualify as a rule. Yet, we accept that the idea of gaining interest might be influenced by interest rates. Therefore, we replace RI with a 'Financial investment rule' (FI; noted as e1). The rule refers to the idea of gaining interest from investments, which – in turn – is an economic operation. Wrongly conceiving of operant entities as rules (as in the case of real interest included in our first version of the SFR), is a common challenge to researchers not yet familiar with the approach.

In the third step, we classify the factor rules identified for our case study according to the RBA rule taxonomy (compare Table 2, 2c):

(a) Tax law pertaining to interest income (TLI): 0th order social rule.[7]
(b) Hedonistic lifestyle (HLS): 1st order behavioural rule.
(c) Bequeathing (BQ): 1st order social rule.
(d) Providence (PRO): 1st order cognitive rule.
(e1) Financial investment (FI): 1st order cognitive rule.

From this classification, we can draw a number of conclusions regarding the nature of the factor rule populations and of the potential influences they exert on the response rule. For instance, potential influences of the behavioral 'hedonist lifestyle' rule and the social 'bequeathing rule' will work via mechanisms such as group pressure, leading to socially conditioned action. In turn, the cognitive rules in the above list (d; e) become relevant through the abstract reasoning of agents.

In the fourth step of our fictitious case study (compare Table 2, 2d) we identify the nature of associations between factor rules and the 'savings rule' as our response:

(a) The larger the group of law-abiding agents grows, the smaller the rule population of the 'savings rule' will become. Hence, there is a conflicting relation.
(b) As a hedonist lifestyle maximizes consumption, there is a conflicting relation.
(c) With savings adding to bequeathing capacity, there is a complementary relation.
(d) With savings as one providential measure, there is a complementary relation, too.
(e1) With savings as a source of equity for investment, there is also a complementary relation.

Finally, in the fifth step, we assess the system of factor rules for interdependencies. In order to conduct a corresponding check, we establish the matrix given in Table 3.

For most of the combinations, we are able to exclude a systematic relationship. The conflicting relation between the hedonistic lifestyle rule HLS and the bequeathing rule BQ equals an alternative choice between one's own consumption and the bequeathing

[7] For a detailed discussion of the RBA rule taxonomy (orders and classes of rules), refer to Dopfer and Potts (2008:8,9).

Table 3 Interdependencies within the system of factor rules (case example)

	TLI	HLS	BQ	PRO	FI
TLI	–	Non-systematic	Non-systematic	Non-systematic	Conflicting
HLS	–	–	Conflicting	Non-systematic	Non-systematic
BQ	–	–	–	Non-systematic	Complementary
PRO	–	–	–	–	Complementary

of consumption opportunities to some heir. As alternatives, both factor rules exert direct influence on the response rule.

In contrast, a closer look the conflicting relation between taxes on interest income TLI and the financial investment rule FI, helps us to understand that TLI only exerts *indirect* influence on the response rule via its negative impact on FI. Hence, we are able to exclude TLI from the system of factor rules. Yet, for the development of policy recommendations, indirect influences may offer a starting point for interventions. Therefore, we make sure to keep in mind that there is an indirect link connecting TLI via FI to the 'savings rule' as the response rule of our case study.

Finally, the complementary relationship pointing from both the bequeathing, and the providence rule to the financial investment rule can be considered comparatively weak, as financial investments are but one way of securing assets for the two purposes of bequeathing and of securing future consumption. Upon the completion of the second investigation stage, we obtain an SFR comprising the four factor rules noted above as (b) through (e1).

Next, in the third stage of investigation of our fictitious case study, we aim at identifying those factor rules within the SFR that have causally contributed to change in the 'savings rule population' during the investigation period (compare Table 2, 3). This, in essence, is necessary to infer whether economic evolution has taken place during the investigation period. In two distinct steps, we check upon two possible sources of change: first, change in the size of the respective factor rule population, and second, change in the strength of the relationship between individual factor rules and the response rule.

Looking firstly at population sizes for factor rules (b) through (e1) through a comparison of annual opinion polls, we find that the populations of both the hedonistic lifestyle rule and of the providence rule (HLS and PRO) have increased significantly since the early 1990s. In contrast, the number of agents in the bequeathing and the financial interest rule populations (BQ and FI) do not show substantial variation during that period. We then investigate changes in the strength of the relationships between our factor rules and the response rule. From a series of semi-structured interviews, we learn that the strength of the relationship between FI and the 'savings rule' has significantly increased over the past two decades. This is because agents are reportedly gradually losing confidence in real estate investments. In contrast, there is no evidence of changes in the relationship between the other factor rules and the 'savings rule'. We summarize these findings in Table 4.

With these findings, we are able to extract the changing sub-system (CSS) from the system of factor rules. The CSS consists of those rules for which we can confirm either of the two forms of change during the investigation period. For our case

Table 4 From SFR to CSS: Change in size of SFR populations and in factor-response relations (case example)

Change	HLS	BQ	PRO	FI
In population size	Increased	–	Increased	–
In relationship to response rule	–	–	–	Increased
Part of Changing Sub-System?	Yes	No	Yes	Yes
Part of Meta-Stable Sub-System?	No	Yes	No	No

example, let's assume that we are able to do so for three of the four factor rules, namely, for hedonistic lifestyle, providence, and financial interest rules (HLS, PRO and FI). In contrast, the bequeathing rule BQ does not contribute to variation in the 'savings rule' during the investigation period. Therefore, we attribute it to the meta-stable sub-system (MSSS).

Finally, in the fourth stage of the investigation, we conduct an in-depth analysis of the CSS in order to understand how it has influenced the 'savings rule' during the investigation period. This requires four separate steps (compare Tables 2 and 4a–d). First, we establish the two-level representation of the CSS, i.e., its specification for the rule level, and for the operant level:

Rule level (populations):

$$\mathrm{SR} = a\mathrm{HLS} + b\mathrm{PRO} + c\,\mathrm{FI} + m \tag{1}$$

Operant level:

$$\text{Aggregate savings} = \alpha\Sigma\left(\text{income}^{\mathrm{HLS}}\right) + \beta\Sigma\left(\text{income}^{\mathrm{PRO}}\right) + \gamma\Sigma\left(\text{income}^{\mathrm{FI}}\right) + \mu \tag{2}$$

The rule level (1) describes how factor rule populations impact on the population of the 'savings rule', i.e., on the group size of economic agents that have adopted the 'savings rule' and are currently retaining it. From this representation, we understand the nature of the two criteria that we have used in the previous step for separating the CSS from the SFR: Our first criterion refers to the population sizes of factor rules (i.e., to HLS, PRO, and FI), while the second criterion corresponds with the strength of the relationship with the response rule (i.e., with a, b, and c).

As the second representation of the CSS, we formulate its operant form (2). While the unit of measurement on the rule level is population size as the number of rule adopters, the operant level refers to aggregate savings as a monetary unit. Relating the two levels, we see aggregate savings as resulting from adding up the fractions of income saved by the three rule populations included in the CSS of our case study.

The distinction of the two levels aids in understanding why we must expect parameter values to load with significantly differing values in a statistical test of Eqs (1) and (2). Introducing a rule perspective enables determining the population of agents that are willing to make savings, while the operant level incorporates the question of whether agents are in a position to do so. From the comparison of results from the two

levels, the researcher will be able to derive most valuable insights to policymakers: solid estimates of the effect of planned policy measures on marginal savings.

Second, in order further to sharpen the analysis of the rule level as the focus of our fictitious case study, we try to identify sub-groups of agents (compare Table 2–4b). To that end, we need a criterion that comes with significant discriminatory power considering the susceptibility of agents to influences from factor rules. In other words, we need to identify a characteristic of the agents in the response rule population that significantly correlates with their responsiveness to either of the factor rules. For our case example, imagine that segmentation by age cohorts allows for achieving this objective: From public opinion polls it is known that a hedonistic lifestyle is more likely to be found among younger generations, while concerns around old-age provisions typically arise within more senior age cohorts. Therefore, we distinguish a young and a senior sub-group SR^{yg} and SR^{sen}.

In the third step, we can now formulate hypotheses pertaining to the CSS of our case study; both for the 'savings rule population' as a whole, and for the two sub-groups identified within the 'savings rule population' (compare Table 2–4c):

1. There is a negative influence of the HL population on the SR population; i.e., $a < 0$.
1.a The relationship is stronger for younger age groups; i.e., $/a^{yg}/ - /a^{sen}/ > 0$.
2. There is a positive influence of the PRO population on the SR population; i.e., $b > 0$.
2.a The relationship is stronger for older age groups; i.e., $b^{sen} - b^{yg} > 0$.
3. There is a positive influence of the FI population on the SR population; i.e., $c > 0$.
3.a The relationship is not different for SR^{sen} and SR^{yg} sub-groups; i.e., $c^{sen} = c^{yg}$.
3.b The relationship has become stronger over time; i.e. $\delta c/\delta t > 0$ for $t \in [1990; 2014]$.

As one can see from this list, the RBA methodology allows for the formulation of a rich set of hypotheses. For instance, we do not only suggest a generally negative influence of a hedonistic lifestyle on the propensity to adopt and to retain the 'savings rule' (Hypothesis 1), but we also specify that this influence should be more pronounced among the sub-group of younger agents compared to more senior agents (Hypothesis 1.a). Correspondingly, the suggested positive influence of the providence rule population on the response rule population is stronger for senior agents than for junior agents (Hypotheses 2 and 2.a). At the same rate, the suggested positive influence of the financial investment rule (FI) is arguably not different for the sub-groups distinguished in our case study (Hypotheses 3 and 3.a). However, we suppose that the strength of the relationship has increased over time (Hypothesis 3.b).

As the fourth and last step in this final stage of our case study investigation (compare Table 2–4d), we test our hypotheses, using standard regression statistics. To that end, we need to obtain appropriate micro data. Using data from annual government opinion polls not only allows for inferring the population sizes of the rules included in our model, but also for conducting separate analyses by age group. In order to minimize bias in our analysis, we have to correct our data for demographic change during the investigation period. This is particularly important for understanding what proportion of change on the rule level, i.e., the composition of the response rule population, was merely due to population ageing. As a result, we are able to attribute the remaining share of change to an evolutionary process in the economic system.

Let's imagine how one would proceed for extending this case study to the operant level. Obviously, investigating the operant level of aggregate savings requires an analysis of disposable income earned by the agents within the factor rule populations. Thanks to the socio-economic profiles of rule populations that can be drawn from the available micro data, we should be able to obtain a calibrated estimation of aggregated disposable income for the factor rule populations analyzed. In order to estimate population-specific savings rates α, β, and γ, we may construct samples on the district level in Japan embracing 20 years of observations. Let's assume that parameter estimates of the savings rates γ_i for the FI population show a significant increase over time. This could then be interpreted as evidence supporting Hypothesis 3.b.

In terms of policy recommendations, we might formulate a threefold rule-level strategy based on the – albeit fictitious – findings in this case study. By our recommendations, we aim at helping the government to foster aggregate savings, which is necessary to secure Japan's still solid sovereign debt rating that is increasingly put at risk through its enormous public debt. First, we suggest lowering taxes levied on interest income (TLI) in order to reduce its negative impact on the financial investment (FI) rule population. Second, we encourage the continuation of monetary policy aimed at ending deflationary tendencies, as further research points to FI depending strongly on the *perception* of interest rates – which, in turn, seems almost entirely guided by nominal interest rates (Blind 2012). Third, we briefly sketch a communication campaign aiming at instigating provisional savings among adopters of the hedonistic lifestyles rule "to secure a leisurely retirement age". With this sketch of the potential nature of policy recommendations, we conclude our case study.

4 Conclusion

The rule-based approach to economic analysis is promising since it allows for an analysis of the phenomenon of economic evolution as a process of change in the content and structure of rules, i.e., the knowledge that enables operations in an economic system. Specifically, the new methodological approach proposed goes hand in hand with three claims: First, theoretical work pertaining to the rule level of the economy helps to increase explanatory power in empirical studies. Second, theoretical work is guided by "instrumental realism" (Dopfer 2004) and enables the construction of more coherent models. Third, given the comprehensive formulation by Dopfer and Potts (2008), the theory of economic evolution allows for integrating essential theoretical components from various disciplines into a consistent whole. Echoing the quest by Ostrom and Basurto (2011) for methodological specification of the theory, this paper has proposed an outline of how the theory might be specified operationally and enriched empirically. For didactical reasons, the argument has been illustrated by employing a specifically devised case study of the 'savings rule'.

Our four-stage methodology starts with setting a response rule population, a specific investigation period (owing to historic time), as well as a spatial delimitation (owing to the susceptibility of agents to different cultural environments). In the second stage, we establish the full system of factor rules (SFR) as the ensemble of rules seen to potentially influence the size of the response rule population. We suggest doing so by connecting extant theoretical work in economics with that of other disciplines, and with

insights derived from studies of rule adopters and rejecters. The third stage deals with the extraction of the part of the SFR that was subject to change during the investigation period. This requires an assessment of all rules in the SFR regarding two criteria: (a) change in the size of the respective rule populations, and (b) change in the strength of the presumed influence on the response rule population. Rules for which either or both criteria are different from zero, qualify as part of the changing sub-system (CSS), i.e., as the causal core of the model. Finally, in the fourth stage, we develop and test corresponding hypotheses. In doing so, we suggest distinguishing sub-groups of agents, which exhibit different levels of susceptibility to changes in factor rules. With due effort, the researcher will be able to identify these sub-groups by investigating their affiliations to factor rule populations.

As a new analytical framework, the RBA naturally comes with a number of particular challenges. First, it is difficult to grasp. As it does not link in very much with received economic reasoning, it is far from self-explanatory to many researchers. For example, distinguishing rules from operations may prove an intricate task in some instances. This is particularly so for 1st order rules and corresponding operations such as the distinction of the savings rule versus the operation of accumulating savings.

A second challenge for empirical studies based on the RBA arises from the limited availability of data suitable for an analysis of rules. This is because the overwhelming share of available surveys concentrates on economic operations, but does not cover the underlying rules. In many cases, this implies either a particularly extensive search for data, or the construction of appropriate indicators where data on rules cannot be identified.

Third, conducting research according to our proposed methodology implies a significantly increased workload. This results from two requirements: From the broad interdisciplinary scope during the up-front identification of factor rules, and from the minute checks upon all SFR rules in the course of the reduction to the causal core of the model. Where the second and third challenges coincide, difficulties in obtaining suitable data compound with the enlarged scope of investigation. This will likely result in a most significant increase in required efforts. Let us try and substantiate why we believe that such effort still promises appropriate reward in a great number of cases.

First, the proposed methodology for the RBA provides a comprehensive and integrated analytical framework. Through the broad scope of the initial identification of the system of factor rules (SFR) and through the subsequent causality checks, the methodology helps us not to miss relevant explanatory variables, while making sure not accidentally to include irrelevant ones. As the methodology also explicitly acknowledges differences in the susceptibility of agents to influences from factor rules, it enables researchers to study the characteristics of relevant groups and sub-groups of agents. Analyzing sub-groups individually then naturally allows for more explanatory depth.

Second, the proposed methodology allows us to construct coherent models, both in a cross-sectional and in a longitudinal dimension. The former is so because RBA-inspired models distinguish rules from operations; the latter because the methodology explicitly inquires potential learning by agents, enabling better explanations of economic change.

Third, through its formal openness, the proposed RBA-based methodology enables integrating insights from different disciplines and schools of thought by employing the

four rule classes. It adds an enriched 'horizontal' dimension to the postulate of connecting 'vertically' the domains of theory, history, and statistics (Schumpeter 1939): While it might be standard practice to involve engineers or computational scientists when conducting research about technological rules, it certainly would seem to be equally necessary to involve evolutionary sociologists, cultural anthropologists or psychologists when further investigating theoretically and empirically into cognitive, behavioral and social rules. The RBA thus provides an analytical framework for connecting systematically the relevant areas of these disciplines, a common analytical terminology for communicating between them, and a set of theoretical economic propositions to work with.

Acknowledgements We gratefully acknowledge most helpful comments and suggestions by Jason Potts, Kurt Dopfer, Manuel Wäckerle, Thomas Grebel, Raji Steineck, and two anonymous referees.

References

Aoki M (2001) Towards a Comparative Institutional Analysis. MIT University Press, Cambridge, MA
Axelrod R (1997) The complexity of cooperation: agent-based models of competition and cooperation. Princeton University Press, Princeton
Beinhocker E (2011) Evolution as computation: integrating self-organization with generalized Darwinism. J Inst Econ 7(3):393–423
Blind GD (2012) Investigating entrepreneurial spirit with the rule approach: why self-employment is on the decline in Japan. Evol Inst Econ Rev 9(1):183–198
Brandes W, Weise P (1999) Team Performance as a Constellation of Forces: A General Model. Kyklos 52(4): 573–590
Cagetti M (2001) Interest Elasticity in a Life-Cycle Model with Precautionary Savings. Am Econ Rev 91(2): 418–421
Cavelaars P (2005) Has the Tradeoff Between Productivity Gains and Job Growth Disappeared? Kyklos 58(1): 45–64
Chen K, İmrohoroğlu A, İmrohoroğlu S (2006) The Japanese Saving Rate. Am Econ Rev 96(5):1850–1858
Dawkins R (1976) The Selfish Gene. Oxford University Press, Oxford and New York
De Long JB (1988) Productivity Growth, Convergence, and Welfare: Comment. Am Econ Rev 78(5):1138–1154
Dopfer K (2001) Evolutionary Economics - Framework for Analysis. In: Dopfer K (ed) The Evolutionary Foundations of Economics. Kluwer Academic Publishers, Boston, Dordrecht, London, pp 1–44
Dopfer K (2004) The economic agent as rule maker and rule user: Homo Sapiens Oeconomicus. J Evol Econ 14:177–195
Dopfer K (2005) Evolutionary Economics: A Theoretical Framework. In: Dopfer K (ed) The Evolutionary Foundations of Economics. Cambridge University Press, Cambridge, pp 3–55
Dopfer K (2012) The Origins of Meso Economics - Schumpeter's legacy and beyond. J Evol Econ 22:133–160
Dopfer K, Potts J (2004) Evolutionary realism: a new ontology for economics. J Econ Methodol 11(2):195–212
Dopfer K, Potts J (2008) The General Theory of Economic Evolution. Routledge, London
Dopfer K, Potts J (2010) Why evolutionary realism underpins evolutionary economic analysis and theory: A reply to Runde's critique. J Inst Econ 6(3):401–413
Fehr E, Gächter S (2002) Altruistic Punishment in Humans. Nature 415:137–140
Grebel T (2012) Network evolution in basic science. J Evol Econ 22:443–457
Hayashi F, Ando A (1988) Life cycle and bequest savings: A study of Japanese and U.S. households based on data from the (1984) NSFIE and the 1983 survey of consumer finances. J Jpn Int Econ 2(4):450–491
Hayek FA (1973) Law, legislation, and liberty: Rules and order. The University of Chicago Press, Chicago
Kaldor N (1975) Economic Growth and the Verdoorn Law - A Comment on Mr Rowthorn's Article. Econ J 85:891–896

Morone P, Taylor R (2004) Knowledge diffusion dynamics and network properties of face-to-face interactions. J Evol Econ 14:327–351

Nelson R, Winter S (1982) An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge MA

North DC (1990) Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge

Ohori K, Takahashi S (2012) Market design for standardization problems with agent-based social simulation. J Evol Econ 22:49–77

Ostrom E, Basurto X (2011) Crafting analytical tools to study institutional change. J Inst Econ 7(3):317–343

Pyka A, Grebel T (2006) Agent-based modelling : a methodology for the analysis of qualitative development processes. In: Billari F, Fent T, Prskanetz A, Scheffran J (eds) Agent-based computational modelling. Physica Verlag, Heidelberg, pp 17–37

Runde J (2009) Ontology and the foundations of evolutionary economic theory: on Dopfer and Potts' General Theory of Economic Evolution. J Inst Econ 5(3):361–378

Schumpeter JA (1939) Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process. McGraw-Hill, New York and London

Strohmaier R (2010) The General Theory of Economic Evolution. Eur J Hist Econ Thought 17(2):352–356

Wäckerle M (2013) On the bottom-up foundations of the Banking-Macro Nexus. Economics: The Open-Access, Open-Assessment E-Journal 7(2013–40):1–45