Explanatory efficiency: A framework for analyzing the dynamic properties of explanatory games

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Abstract

In this paper I will discuss the problem of evaluating dynamic properties of the procedural rules that govern science. I will propose a novel framework for evaluating dynamic properties of such rules. This framework is based upon an analogy from New Institutional Economics. I will argue that the concept of 'adaptive efficiency', as it has been developed by Douglass North, solves a problem in economics that is analogous to the problem of evaluating dynamic properties of the procedural rules that govern science. I will propose to apply the main ideas underlying this concept to Chrysostomos Mantzavinos's theory of Explanatory Games. Based on these ideas, I will develop the concept of 'explanatory efficiency'. This concept is meant to provide the means to evaluate the dynamic properties of Explanatory Games. I will argue that the proposed analogy also motivates more general applications of New Institutional Economics to traditional problems of philosophy of science.

Keywords Theory of explanation · New institutional economics · Theory of scientific change · Economics of science · Explanatory games

1 The problem of evaluating dynamic properties of procedural rules

The problem I want to discuss in this paper is evaluating the dynamic properties of the procedural rules governing science. As many authors have recognized, scientists work within a framework of rules (see Popper, 1997[1945], chap. 23). Within specific communities, there are commonly accepted rules that prescribe how to explain explananda, how to structure studies and experiments, or how to criticize theories (see Albert, 1978, 33–36). Such rules are examples for procedural rules that govern

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science. Developing descriptive and normative theories concerning procedural rules is a traditional subject of philosophy of science.

One very general goal connecting authors who developed normative theories of procedural rules is that of evaluation. Authors attempted to develop theories that demonstrate the desirability and high quality of the procedural rules governing science (Kitcher, 1993), or a theory that enables comparative judgments between competing rules within science (Lakatos, 1970; Laudan, 1984).

Some of these authors noted that the normative problem of evaluation has two distinct dimensions (see for example Lakatos, 1970; Feyerabend, 1975). The first dimension of this problem is the problem of evaluating the static properties of procedural rules. The problem here is to find an appropriate way to evaluate the consequences of procedural rules as they currently are. Examples for questions raised in the context of a static analysis are these: Is research program A good as it is now? Which program is better, A or B? The problem of static evaluation is a very important problem, and there are many reasonable solutions proposed by different authors. This problem is however not what I want to discuss in this paper. This paper is concerned with the second dimension of the problem of evaluation, that is the problem of evaluating the dynamic properties of procedural rules. Procedural rules change; they can change in the future and they have changed in the past. Changes in procedural rules can improve or diminish their quality. The problem of evaluating the dynamic properties of procedural rules can be formulated as the following questions: Are these rules capable of changing for the better? Or will they change for the worse? Can we even say anything about this? Thus, questions raised in the context of a dynamic analysis include: Will this research program change in fruitful or progressive ways in the future? Which research program has better prospects for development, A or B?

The problem of evaluating the dynamic properties of procedural rules governing science can be divided into a descriptive and a normative problem. The descriptive problem amounts to developing a correct descriptive theory of procedural rules governing science. Such a theory should provide answers to the following questions: Why do these rules exist? Why are they stable and why do they change? In how far can changes be predicted? The normative problem amounts to developing a normative theory that allows for assessing the quality of the changes that these procedural rules might undergo. Ideally, it should answer questions like these: Will these rules change for the better, or for the worse? Which set of rules will change in more fruitful ways, A or B? Thus, the solution for the descriptive problem has many implications for the solution of the normative problem. Descriptive theory informs us about the possibilities and limits of our knowledge about change. Such knowledge is necessary for solving the corresponding normative problem. I will thus devote substantial parts of this paper to the solution of the descriptive problem.

2 The proposed solution

The solution for the descriptive problem I want to propose in this paper consists in an analogy from economics. Some economists saw themselves confronted with problems very similar to the one I described above. This is so especially for authors that

are associated with 'New Institutional Economics'. These authors strongly emphasize the decisive influence that institutions have on economic development. Institutions are described as normative social rules that constrain the activities of individuals and organizations (see North, 2002, 3ff). The term 'institutions' is not limited to formal laws, but also includes shared informal rules like morality or other social rules. A very important feature of these rules is that under normal circumstances they are not evaluated, but are instead followed unconsciously (see Mantzavinos, 2001, chap. 3&5). Institutions thus limit the set of activities that will be undertaken and therefore have a strong influence on what productive efforts will take place.

Drawing from the theoretical resources of New Institutional Economics is not the most obvious choice, as followers of New Institutional Economics are as a whole in the minority position in Economics. Their approach differs in a number of ways from the majority approach, that is often labeled as 'orthodox' or 'neoclassical' economics. Content wise, New Institutional Economists heavily emphasize the presumed central importance of institutions for any kind of economic activity, while within orthodox theories institutions either play a marginal role or are not explicitly considered at all. Another important difference between the two approaches consists in their characterization of individuals as economic agents. Within orthodox theories, individuals are usually represented in a highly idealized way; they are optimizers of mathematically well-defined optimization problems. Followers of New Institutional Economics use more realistic descriptions of individuals in their theories; here individuals are ideology-laden in their perspective of the world, and are 'rational' only in a comparatively limited sense (see North, 2005, Part I)[1]. Another important difference is the stance towards methodological individualism. New Institutionalists are very strict in following through with methodological individualism, while in orthodox approaches concepts like representative agents and even aggregated concepts without 'microfoundations' are frequently used (see Hoover, 2001). Within the economics of science, Philip Kitcher's microeconomic model of science as presented in his (Kitcher, 1993, chap. 8) is a typical example of applying the approach of orthodox economics to science (see Mirowski, 2004, chap. 5 for a comprehensive criticism of Kitcher's economic theory). Mantzavinos's (2016, Mantzavinos, 2021a, b) are recent examples of applying New Institutional Economics to the study of science[2]. The following

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[1] To flesh this out a little further: They are 'rational' in the sense that they do chose in accordance to what they expect to maximize their utility in the future. However, they are limited by being fallible in all respects possible in this process: They can be ignorant of their possible options, they can err in their choice between perceived options, and they can even fail to recognize a situation in which they possibly could make a choice that would benefit them and follow routinized behavior instead. While some knowledge constraints are usually imposed upon individuals within orthodox theories, I know of no such theory that introduces all of the constrains listed above. Another 'heterodox' approach that takes these limits to human rationally very serious it the Austrian School of Economics (arguably with the exception of routinized behavior that can be followed instead of a choice process (see Lipski, 2021, Sect. 5)). The most well-known contributions of the Austrian School can indeed be interpreted as criticisms of the orthodox approach to Economics, based upon the neglect of the limits of rationality by orthodox economists (see Mises, 2015[1920]; Hayek, 1945).

[2] There are of course more differences between New Institutional Economics and 'orthodox' Economics. One very prominent difference is the use of history in theorizing, and - connected to this - ideas about path dependency and the generality of theoretical explanations.

arguments are meant to exemplify the fruitfulness of New Institutional Economics as a general framework for economics of science.

Following the approach of New Institutional Economics means to focus on institutions as objects of analysis. North defines institutions as "[…] the rules of the game in a society or, more formally, […] the humanly devised constraints that shape human interaction" (North, 2002, 3)[3]. The main idea motivating this paper is that the procedural rules that govern science, such as methodological rules, explanatory rules, rules of communication, and others, can be fruitfully described as institutions in the exact same sense as New Institutional Economists use the term. Thus, insights from the scientific field of New Institutional Economics can be transferred to philosophy of science. The concept developed below, 'explanatory efficiency', is an example for such a transfer.

An important problem that Economists need to address in the context of New Institutionalism is the problem of change. Institutions are not static; they change in complex ways. Some authors connected to New Institutional Economics interpret history as demonstrating that changes in institutions in some places were systematically conducive to economic development, while in other places changes in institutions did not have similar effects. One idea that emerged from theorizing about this is the idea of adaptive efficiency. I will explain this idea in more detail below. Very roughly, adaptive efficiency can be a property of an institutional matrix. An institutional matrix is the totality of all formal and informal institutions that are in place in a given population. If an institutional matrix is adaptively efficient, it will systematically change in ways that are conducive to economic growth. If an institutional matrix does not have this property, future changes will not be systematically conducive to economic growth.

I will argue below that this concept can be - within certain limits - transferred from New Institutional Economics into philosophy of science. This transfer provides the basis for a novel solution of the problem of evaluating the dynamic properties of procedural rules governing science. As adaptive efficiency describes a property of an institutional matrix, it has to be shown that the procedural rules of science indeed have the same or very similar properties as the institutions that Economists describe. Unfortunately, there is no general institutional theory of science available that describes all the different formal and informal institutions that influence scientific inquiries[4]. There is however a narrower application of the economic theory of institutions to science available. Mantzavinos in his Explanatory Pluralism (2016) develops a descriptive theory of explanation by using the same assumptions and principles that are applied to construct theories of institutions in the context of New Institutional Economics. He describes the process of explanation as being governed by "Explanatory Games". These games consist of informal institutions that in principle have the same structure as the informal institutions that govern economic actions. Therefore, Mantzavinos developed an institutional theory of explanation. This theory

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[3] Greif (2010) discusses different definitions. The one I chose is however best suited for the present purpose, as it has already been applied for studying science as a social process.

[4] In some recent papers Chrysostomos Mantzavinos provides arguments in favor of developing such a theory and also takes first steps into developing it (see Mantzavinos, 2021a, b).

provides the basis for transferring the ideas behind 'adaptive efficiency' into discussions within philosophy of science. The following arguments will thus be contributions to the theory of explanation; more specifically they will be an extension of Mantzavinos's descriptive theory of the process of explanation. Developing further institutional theories of science would invite for broadening this scope.

In the following I will thus expand upon the theory presented in Mantzavinos's *Explanatory Pluralism.* The distinction of higher-level and lower-level rules that I will propose in the following is not introduced in Mantzavinos's presentation of the theory. Also, while Mantzavinos does explicitly acknowledge that Explanatory Games are subject to change (see Mantzavinos, 2016, chap. 9.3 and 9.4), he does not discuss the specific dynamics of Explanatory Games or how to evaluate their dynamic properties. I will thus propose novel ideas within the framework of (Mantzavinos, 2016); but in doing so I will follow the implicit methodological strategy of this book – that is to transfer insights from New Institutional Economics to philosophy of science.

This analogy from New Institutional Economics provides valuable means to solve the descriptive problem stated above. However, 'adaptive efficiency' is a descriptive concept in Economics. The analogy can thus not be used to solve the normative problem of dynamic evaluation. But since a solution to this normative problem presupposes a solution of the descriptive problem, a successful descriptive theory will be informative to determine the limits and possibilities for a corresponding normative theory. To solve the normative problem stated above, I will propose a pluralistic theory for evaluating the dynamic properties of Explanatory Games. This pluralistic theory is meant to enable the use of the normative resources developed within more traditional theories of explanation. Such theories were meant to solve normative problems connected to explanation on the static level. I will demonstrate below how a pluralist stance on the dynamic level enables the use of monistic and pluralistic normative theories from the static level.

3 Adaptive efficiency: The main insights

I want to proceed by familiarizing the reader with some basic theoretical ideas concerning institutions and adaptive efficiency. First, I will provide some further information on institutions. Second, I will introduce the distinction between lower-level and higher-level institutions that underlies the concept of 'adaptive efficiency'. With that, I will explain what 'adaptive efficiency' means exactly. I will later argue that the procedural rules governing science can be fruitfully described as institutions; that the distinction between lower-level and higher-level institutions applies here as well; and that thus some of the ideas underlying 'adaptive efficiency' can be applied to the procedural rules governing science.

3.1 Institutions: some basic concepts

It is important to distinguish institutions from organizations. An organization is a group of individuals that cooperate with each other in order to reach a common goal;

institutions are normative social rules. Organizations and individuals can be interpreted as 'players' of a social game, the rules of which are institutions.

Institutions can usefully be categorized by reference to the enforcement mechanisms underlying them (see Mantzavinos, 2001, chap. 6). Following Mantzavinos's (2001), there are two general types of institutions: Formal institutions are enforced by the state. This means that the state (which is a kind of organization) attempts to discipline those who fail to behave in accordance with these institutions (see ibid. chap. 8.1). Examples here are formally defined laws, such as laws that prohibit using violence to coerce other citizens to obey you. If you punch your neighbor in order to force him to take out your trash, state officials will attempt to punish you if they gain knowledge about this. This is written down as a codified rule in the law, the enforcement is carried out by the state – thus this is an example for a formal institution.

Informal institutions are normative social rules that are not enforced by the state. Informal institutions can be divided into three sub-categories: Conventions, moral rules, and social norms. I will focus on moral rules and social norms here, as these two are important for my arguments below[5]. Moral rules are enforced through 'first party enforcement', which means that an individual defecting from such a rule in turn imposes costs on herself (see ibid. chap. 7.2). An example for this is the phenomenon of having a 'bad conscience'. After defection, the individual does not deliberately choose to impose costs on herself, but instead this is a consequence of her motivational system that has been shaped by a lifelong process of learning and by the evolutionary history of humanity (see Tomasello, 2016). If you get carried away in a heated argument and insult a friend, you will probably experience emotional suffering as a consequence of this. This is so because you violated an internalized moral rule, and your own motivational system is disciplining you for it.

Social norms on the other hand are enforced by other individuals that are not agents of the state (see Mantzavinos, 2001, chap. 7.3). This category thus summarizes all the normative social rules that you follow solely because others are expecting you to follow them. Consider for example a dress code for a certain event: You might not experience a bad conscience if you do not show up dressed appropriately to a fancy dinner event; but other participants will probably punish your defection from the dress code, maybe by talking poorly about you behind your back, by pointing fingers, or by other impolite interactions. They will not call the police, but they will attempt to impose costs on you in some other form so that you'll obey the norm in the future.

I will argue below that the process of producing explanations in science is governed by informal institutions. Social norms are of great importance here, but something analogous to moral rules also plays a decisive role. I will argue further that this fact allows for applying the ideas underlying 'adaptive efficiency' to the theory of

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[5] Conventions are 'self-enforcing' informal institutions, which means that the structure of the problems that they solve is such that a successful solution, once in place, does not provide a motivation for defection from the rule (see Mantzavinos, 2001, chap. 7.1). A typical example for a convention would be rhythm-following of a rowing team: If they want to go in a straight line as quick as possible, following a common rhythm is in their best interest and no individual rower would gain anything by breaking the established rhythm. Science is of course also partly governed by conventions in this sense, but I will not discuss these in this paper.

explanation. For now, having established the categories explained above, I will go on and explain the distinction between higher-level and lower-level institutions.

3.2 Higher-level and lower-level institutions

As I have already mentioned briefly above, 'adaptive efficiency' is a concept that refers to the dynamic properties of an institutional matrix[6]. Institutions change, but economists such as Douglass North came to the conclusion that some institutional matrices systematically change in ways that are conducive for economic growth. One important building block to arrive at this conclusion is the distinction between higher-level and lower-level institutions.

This distinction is well-known for formal institutions. In modern states, there are laws that are subject to constant change, such as the civil law or the criminal law. In democracies, parliaments constantly refine these bodies of laws, changing them by adding new rules or deleting others. The changes are however formally confined by a constitution. The constitution sets limits and rules for changing other laws. Also, it is much harder to change the constitution than it is to change other laws. Usually, the constitution itself defines the conditions for changing its contents, and these conditions are harder to realize for lawgivers than the conditions for changing 'normal' laws. Constitutional rules are thus higher-level institutions, while for example the civil laws or the criminal laws are lower-level institutions relative to the constitution (see Voigt, 2020 for an overview over the economic literature on this)[7].

The distinction between higher-level and lower-level institutions is less obvious for informal institutions. However, that it also applies here becomes apparent if one raises the question why social norms are enforced. As I have mentioned above, social norms are enforced by 'ordinary' individuals (that do not make use of the coercive power of the state). As every action, enforcement however produces costs for the individual that carries it out. This leads to the question why the individual that bears the costs that come with punishing the defector is willing to do so. To take up the dress-code example above: If you see someone dressed inappropriately for an occasion, why should you care? After all, confronting the person probably would lead to an unpleasant interaction for you; it also might cost you potentially fruitful ways to cooperate with the defector in the future. Other ways of punishing the defector will be bothersome too. If this question is answered by reference to another social norm, such as "If you do not punish defectors, other people will punish you", a regress problem arises, as then the costs of enforcing this other social norm would have to be carried by some individual.

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[6] An 'institutional matrix' is the complete set of institutions that exist in a given population.

[7] Voigt provides a comprehensive overview over the literature that is called "Constitutional Economics". A classical theoretical contribution to the field is (Buchanan/Tullock 1999[1962]). The distinction between higher- and lower-level institutions is also prominently discussed in contexts that are not traditionally included under the umbrella "Constitutional Economics". A discussion from the perspective of Ordo-Liberalism can be found in (Eucken, 2004[1952]); F.A. Hayek discussed the topic from the perspective of the Austrian School of Economics in his (2011[1960]) as well as in other works; Elinor Ostrom also draws an analogous distinction in her work (see Knight, 2004, 172).

Within New Institutional Economics, this problem is solved by assuming that social norms are stabilized by internalized rules. Thus, the second-party enforcement of social norms is first-party enforced at some point. This means that the potential regress described above is cancelled, as at some point an individual would suffer emotional stress from not punishing the defector. The intensity of this stress outweighs the costs of enforcement. To apply this to the example above: If you see someone ignoring the dress code of a dinner event, this might get you so annoyed that you decide to confront the person. You do this in spite of the unpleasantries that come with this, as you anticipate your feelings of annoyance to become more bothersome for you if you left the manner to itself. Using the concepts introduced above, this means that each social norm is stabilized by a moral rule. Some moral rules are thus functioning as higher-level institutions for social norms[8] (Voigt, 2009, 189; see also Kiwit/Voigt, 1998; see also Tomasello, 2016, 10ff for a discussion of the problem from the perspective of evolutionary psychology).

I want to point out two important characteristics that distinguish higher-level institutions from lower-level institutions. First, the content of higher-level institutions is more general compared to the content of lower-level institutions. Second, higher-level institutions change at a slower pace than lower-level institutions and thus function as part of the selective environment of lower-level institutions.

As for the first characteristic, the more general character of higher-level institutions, this is again an obvious trait of higher-level formal institutions. Constitutions are consistent with a large variety of different possible sets of lower-level laws; but they do have implications for these lower-level laws as they rule out some possible sets of them. The same is valid for informal institutions. Take as an example the moral rule to treat all people fairly and respect their dignity. This does rule out certain social norms, for example the possible norm to not shake hands with certain people when meeting them because of the shape of their noses. However, it does not specify the appropriate social norms directly, for example both respectful handshakes or respectful fist-bumps could be an acceptable social norm for greeting strangers if the moral rule stated above is upheld.

The second important characteristic of higher-level rules is their relative stability. While higher-level institutions are not absolutely stable, they change at a slower pace than other institutions. They thus function as part of the selective environment for other rules (see on similar ideas Buchanan, 2016[1986], 52ff). The stability of higher-level institutions is the effect of the different mechanisms of change underlying them. These mechanisms are different for formal and informal institutions. Formal higher-level institutions are more stable as the formally defined mechanism of change are more demanding compared to other formal institutions. Changing the constitution often demands a legislative majority greater than changing regular laws in democracies; non-democratic states also know laws that are formally defined to be of greater stability than other laws[9].

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[8] This does not mean that every moral rule is a higher-level institution for social norms; but it does imply that every social norm is necessarily stabilized by some moral rule.

[9] Typical examples here are constitutional rules codifying the rights of citizens in democracies; in non-democratic states a well-known example are constitutional rules that determine for example the socialist

Informal institutions do not change in accordance with any formally predefined mechanism, but instead change as the outcome of invisible hand processes. The different enforcement mechanisms influence the pace at which these institutions can change. Institutions that are stabilized through second party enforcement can change at a higher pace than institutions that are stabilized through internalization and thus first party enforcement. In both cases, change happens as a consequence of a serial process of individual learning that starts with an innovation. One or more individuals perceive a situation in which they find it in their interest to disobey social norms or moral rules. They thus defect from the rule. If they experience this defection as success, they will repeat this behavior; as others observe their behavior, they will eventually imitate it in similar situations (see Mantzavinos, 2001, chap. 7).

Moral rules do however change at a slower pace than social norms. I want to provide two reasons for this. First, the costs of defection are harder to avoid for moral rules. First party enforcement, as described above, makes certain that every conscious violation of a moral rule imposes costs upon the defector, as it is her own 'bad conscious' that causes the costs. Costs that result from a defection of social norms on the other hand might be avoided by avoiding to get caught by others, or by avoiding to interact with the witnesses of an act of defection after. Given this, there will be more opportunities for an individual to benefit from disobeying a social norm as there will be to benefit from disobeying a moral rule. This is so because in the former case defection might not lead to any costs, while in the latter case costs are certain.

The second reason is that the individual learning processes take different amounts of time. Internalizing a moral rule takes more time than learning that following a specific social rule is expected by other individuals. The process of internalization necessary for learning a moral rule requires repeated experiences of felt rewards and punishments; a social rule on the other hand might be learned by a single observation.

Summarizing this, higher-level institutions exist that have implications for lower-level institutions by ruling out some possible lower-level institutions as illegitimate. Also, higher-level institutions, while not being absolutely stable, change at a slower pace compared to lower-level institutions. Thus, they are part of the selective environment of lower-level institutions.

3.3 Adaptive efficiency

With these ideas I can now explain what is meant by 'adaptive efficiency' within New Institutional Economics. The most important idea here is that institutions adapt to changes in their selective environment. The selective environment for institutions is the perceptions and choices of individuals. An individual that is confronted with a social problem to which it does not know a solution already will attempt to solve this problem in a novel way. Thus, institutions change because of novel individual perceptions of problems. Such a novel perception can have different reasons: For example, environmental changes might be perceived as problematic; or new knowledge might lead to an individual rethinking a formerly held interpretation of the world; or a new ideology might call for a reinterpretation of perceptions. The important com-

character of the political and economic system.

mon denominator is that a problem that is subjectively perceived as new calls for a novel solution; such novel solutions in turn are the source of new institutions (see Mantzavinos, 2001, chap. 6–8).

In developing novel solutions, individuals face certain constraints. They are constrained for example by their limited knowledge and the limits of their imagination. Other constraints are the circumstances of the physical environment, that will make impossible certain solutions. For the reasons stated above, higher-level institutions will also count among these constraints in many situations. Legislators will usually try to propose laws that are consistent with the current constitution if they see the need to create a new law. Analogously, an ordinary individual will attempt to solve a novel social problem within the limits of her moral intuitions. Higher-level institutions are thus elements of the selective environment of lower-level institutions (see North et al., 2013a, b[2009], chap. 7).

The kind of adaptation that is addressed by the concept 'adaptive efficiency' is the adaption of lower-level institutions to perceived novel problems. If a novel problem is perceived, and the solutions that are provided by the current institutions are deemed unsatisfactory, innovation will take place which will lead to institutional change if the novel problem solution is taken up by other individuals. The perception of a novel problem can be caused by changes in the physical environment or by changes on the intellectual level. The changes in lower-level institutions are constrained by higher-level institutions. Take as an example for this the modern challenges that arise out of environmental problems, such as climate change: Legislators that perceive climate change as a yet unresolved problem that demands legal regulations will try to innovate some new laws that contribute to solving this problem. By doing so, they are however confined by the constitutional framework they work in: In most liberal democracies, they cannot simply expropriate all citizens to stop them from contributing to CO_2 emissions, as this would violate constitutionally protected property rights. On the informal level, many individuals and organizations try to contribute to solving the problem of climate change by innovating new social norms. But they are constraint by moral rules in doing so: While it became very common among environmentalists to reject driving SUVs for example, and to criticize people that do so (to enforce this behavior as a social norm), environmentalists do not (at least not commonly) try to dehumanize SUV drivers (for example by spitting at them, denying their humanity, chasing them through the streets, or similar measures), as they are committed to respecting human dignity[10]. These examples are demonstrating how lower-level institutions adapt to changes in their selective environment (see on this also North, 2005, chap. 3). This selective environment consists of the perceptions and choices of individuals, and these choices are constrained by higher-level institutions.

Next, I want to explain by what standard such adaptations are thought of as 'efficient'. The standard that is commonly applied is whether they contribute to economic growth or not. If they do, they are efficient; if they don't, they are not. Economic growth means that the wealth within a population increases. How 'wealth within a

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[10] This is of course only one reason for abstaining from this among many. These examples are obviously not designed to represent the complexities of the real world, but merely to exemplify the idea of lower-level institutions adapting to perceived novel problems.

population' is to be defined and operationalized is subject to a variety of opinions in economics[11]. Most commonly, statistical aggregates such as attempted measures of monetary income per capita or gross domestic product are used for this purpose (for example in Galor, 2011). There are however plausible arguments in favor of alternative concepts of 'wealth' (and thus 'economic growth'). I will not go into the details of these discussions here (see Sen, 1997, Part 3&Part 5 for elaborate discussions; see also Linsbichler, 2021 for some ideas on multidimensional assessments of wealth). I only want to point out two important features connected to wealth-assessment in economics here:

First, while details about the appropriate definition and operationalization of 'wealth' remain controversial, there is also wide agreement on some fundamental empirical facts concerning this subject. No economists for example would deny that the second half of the 19th century in Great Britain and Germany were characterized by an acceleration of growth rates and thus an increase in wealth. Also, no economists would deny that nowadays citizens of the EU are on average wealthier than citizens of Afghanistan. Thus, while important theoretical controversies remain unresolved, there are also some broadly accepted empirical standards that a theoretical definition of wealth would have to meet[12].

Second, I want to point out that 'economic growth' is a concept that has descriptive, but not normative, content. This means that it is commonly acknowledged that whether or not an individual or a population is wealthier than another one is a matter of fact; whether it is good to be wealthy, or whether economic policy should follow the goal to 'maximize wealth' is a separate, normative question. It is of course true that sometimes economists (especially in public statements) use concepts like 'wealth' or 'economic growth' in a way that portrays these concepts as something necessarily good or desirable. But in doing so they are leaving the realm of descriptive economics and are adding normative assessments to descriptive economic theory[13].

Within the concept 'adaptive efficiency', 'efficient' thus means 'does contribute to economic growth'. To assess whether or not an institution is 'efficient' in this sense, economists use different means; among them theoretical insights from fields like price theory, growth theory, or political economy (see for example North, 1981; Acemoglu/Robinson, 2019, or more 'orthodox' Galor, 2011). Empirical studies of course inform theoretical considerations (see North et al., 2013a, b; Greif, 2010). By these means economists are able to explain if and how an institution contributes to economic growth (or to economic decline, which means wealth within a population diminishes).

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[11] I want to thank Alexander Linsbichler for pointing this out to me.

[12] This is especially important for my purposes, as I believe this situation to be analogous to the situation that prevails in philosophical discussions about theories of explanation: Here, theoretical controversies about what exactly constitutes explanatory progress also remain unresolved; but very few would for example deny that the first half of the 20th century was characterized by explanatory progress in physics, or that modern biology provides us with better explanations of life than medieval scholasticism.

[13] This is also very important for my purposes, as here the analogy between New Institutional Economics and philosophy of science breaks down: Philosophers aim at normative theories, for example in the realm of theories of explanation they do not merely want to describe the process of explanation, but they also aim to develop standards for normatively evaluating explanations.

Putting these ideas together, 'adaptive efficiency' refers to the way that higher-level institutions restrict the possibilities of change in lower-level institutions. If these restrictions rule out changes that would impede economic growth, the institutional matrix in question is adaptively efficient. It is also important to mention that adaptive efficiency comes in degrees, which invites for comparative judgments. In the real world, higher-level institutions will never rule out all possibilities of change that would impede economic growth. But some higher-level institutions will rule out more of these changes than others; or some might rule out certain changes that would be more severe than others. Thus, the statement "The institutional matrix of Germany showcases a higher degree of adaptive efficiency than the institutional matrix of Afghanistan" means that the higher-level institutions of Germany rule out more lower-level institutional changes that would impede economic growth than the higher-level institutions of Afghanistan.

3.4 The problem of prediction

Before applying this to the theory of explanation, I want to address the important problem of prediction. Based on the insight that higher-level institutions limit the changes that lower-level institutions can undergo, what can we know about the future structure of an institutional matrix? I believe the only genuine answer to this question is: Nothing. Knowledge about higher-level institutions only provides us with information about the present characteristics of an institutional matrix, including its dynamic properties. It does not provide us with any knowledge about the future characteristics of that matrix.

I want to provide two reasons for this. First, higher-level institutions only limit the spectrum of possible changes in lower-level institutions, they do not positively determine them. Thus, knowledge of higher-level institutions only provides knowledge about what changes are not possible in lower-level institutions. As there will always be different alternative possibilities of change that are not ruled-out by higher-level institutions, it remains uncertain what path of change lower-level institutions will actually go.

Second, while higher-level institutions are relatively stable compared to lower-level institutions, they too are subject to change. As I explained above, institutional change is caused by individuals perceiving a novel problem. Thus, higher-level institutions might change for various reasons, such as environmental changes or a new scientific finding that is perceived as very important. In order to predict changes in higher-level institutions, one would thus have to be able to predict all kinds of changes in the world, as well as the way humans will perceive these changes and react to them. A theory that does allow for this does not exist and is probably unfeasi-

ble in principle (see Popper, 2002[1957])[14]. Thus, the future of an institutional matrix is uncertain (see Mantzavinos, 2001, 97ff)[15].

This also means that negative predictive statements, such as "This specific change will not occur" become unfeasible. Such statements can only be derived if it is assumed that the higher-level institutions are stable. They are not. In order to derive any predictive statement, one would need a theory that enables predicting the changes of higher-level institutions. As higher-level institutions are not constrained by other institutions in their changes, one would need a theory that predicts any kind of novelty in individual perceptions in order to predict how higher-level institutions will change. Novelty in perception can be a reaction to novel ideas, environmental changes, religious awakenings, mistakes, or a number of other potential causes. A theory that allows for predicting such a wide range of potential causes of change is unfeasible[16].

But does that not mean that we have learned nothing about the dynamic properties of an institutional matrix by applying the concept 'adaptive efficiency'? Concluding this might be tempting, as it is not possible to predict whether or not an actual institutional matrix will in the future contribute to economic growth. But higher-level institutions exert their influence in the present. Higher-level institutions channel the actions of individuals and organizations by ruling out certain innovations in the present. The judgment that some institutional matrix is adaptively efficient is thus a judgment about the present state of that institutional matrix. It means that currently, some changes in lower-level institutions are ruled-out that would be bad for economic development. This judgment is connected to counterfactuals, such as this: "If large scale expropriations were implemented in this country, the economy would crash. Such expropriations are ruled out by the higher-level institutions of this country. This contributes to its adaptive efficiency." This does not imply that large scale expropriations are impossible to occur in the future. They might, since higher-level institutions might change, and the economy might crash as a result. But currently, they are ruled-

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[14] This does of course not mean that such changes cannot be explained in retrospect. Looking in the past, information about what changes actually did occur and how individuals interpreted and perceived these changes is in many cases available (see North, 2005, 51ff).

[15] I want to point out that this is compatible with the assessment that higher-level institutions are more stable relative to lower-level institutions. It is not permissible to conclude from this that higher-level institutions only change 'in the long run' and thus enable predicting the 'short run'. Given certain circumstances, higher-level institutions might change quite rapidly. Consider moral rules after an outbreak of civil war. In such a situation, a quick succession of many new experiences of violence within a short amount of time might lead many individuals to internalize new lessons within a short amount of time, thus quickly inducing change in moral rules within a whole population. The case is even more obvious for formal institutions; a new revolutionary government with sufficient power might change the constitution several times over within a couple of days. Lower-level rules in these scenarios will change at an even faster pace; but still, it holds that higher-level institutions can change 'in the short run' and thus a distinction between long-runs and short-runs is not useful in this case.

[16] A reviewer suggested that this might still leave room for probability statements. I disagree. Even if weaker probability statements about changes in lower-level institutions are the goal, we would need to know the probability of the higher-level institutions remaining stable. For this, we would have to gain knowledge about the probabilities of all the events that might influence our higher-level institutions, as well as the probabilities of the different possible human reactions to these events. It seems highly unlikely to me that such knowledge can be gained.

out. The predictive component here is not based on the idea of adaptive efficiency but on price theory: It is the prediction that large scale expropriations, if implemented, will actually result in the economy crashing. This result is achieved by an analysis that takes the institutional environment as static and analyzes how markets unfold given certain institutions are in place. Such an analyses allows for counterfactual as well as ceteris-paribus type of predictions (see for example Hayek, 1980[1940]).

Knowledge about higher-level institutions thus provides us with important insights about the present state of an institutional matrix. Certain institutional changes are ruled-out presently. What the influence of the ruled-out changes would be on the economy can be explained via the means that economics provides. This can be used to judge whether an institutional matrix is adaptively efficient. For making this assessment, knowledge about the future-content of the institutional matrix in question is not necessary.

4 Explanatory efficiency

As I have already indicated, I want to apply these ideas to the procedural rules that govern scientific explanation. A close analogy can be drawn between the philosophical problem of evaluating rules that govern scientific explanation and questions about how institutions contribute to economic growth. In both cases, questions are raised about how rules change and what can be known about this. Individuals pursuing science act under the constraints of normative social rules with specific enforcement characteristics. Thus, the theory of institutions is applicable to science as well. The theory proposed above implies that the distinction between higher-level and lower-level institutions thus also has to apply to science – I will argue below that this is indeed the case. If this is so, higher-level institutions function as elements of the selective environment of lower-level institutions, and thus a kind of adaption of these lower-level institutions to the corresponding higher-level institutions takes place.

The analogy however breaks down when 'efficiency' is considered. 'Adaptive efficiency', as used by economists, is ultimately grounded in the phenomenon of economic growth. As I argued above, economic growth is a descriptive concept in economics. Explanatory progress on the other hand is clearly a normative concept. The philosopher of science is not concerned with the growth of the amount of explanations; she is instead interested in the growth of explanatory knowledge. Neither the sheer amount of explanations, nor subjective feelings of satisfaction are legitimate measures for the growth of explanatory knowledge – thus the situation here is not analogous to economic growth. I will discuss an interpretation of 'efficiency' that is appropriate to this problem below.

4.1 An institutional theory of explanation: explanatory games

In his Explanatory Pluralism, C. Mantzavinos develops an institutional theory of explanation. He describes scientific explanations (and also explanations in a more general sense) as the outcomes of a continuous process that is governed by procedural rules. A complete set of such rules is called an 'Explanatory Game' by Mant-

zavinos. The emergence of these rules can be explained by using the same principles and assumptions that underly the explanation of the kinds of institutions that economists are traditionally interested in (see Mantzavinos, 2016, chap. 8&9 as well as Mantzavinos, 2001, chap. 1&2). Thus, the rules of an Explanatory Game are special cases of the broader category 'institutions'. This warrants the application of descriptive theories that are developed in the context of New Institutional Economics to Explanatory Games.

The rules of Explanatory Games are informal institutions[17]. They govern the behavior of scientists that are aspiring to explain something. They thus are subject the same mechanisms of emergence, stability and change as other informal institutions. Mantzavinos categorizes different types of Explanatory Rules in accordance with their role in governing the process of explanation in his Explanatory Pluralism. He argues that an Explanatory Game consists of constitutive rules, rules of representation, rules of inference and rules of scope. Constitutive rules largely govern the 'background' assumptions that are taken for granted in crafting an explanation. For example, a linguist will take for granted the laws of physics in explaining language related phenomena. Rules of representation and rules of inference govern what kinds of representations of are legitimately used within an explanation and how to infer from one to another. Common examples here are natural language or mathematical models as means of representation, as well as deductive logic, analogical reasoning or mathematical inferences as means of inference[18]. Rules of scope govern to which explanatory problems the rules of the Explanatory Game in question are legitimately applied. Price theory for example has a different scope of application than quantum physics (see Mantzavinos, 2016, chap. 6 for a more detailed account of this categorization). These rules channel the activities of individuals that want to explain something. As a result, while explanations are continuously created, criticized and revised, they exhibit similar characteristics within specific Explanatory Games.

As informal institutions, these rules emerge and change as a result of individual innovation and social imitation. Some individual has a novel problem perception and beliefs innovation to be necessary, as the existing institutions are unfit to solve the problem. If the resulting innovative solution is deemed useful by others, institutional change occurs. What is left open in Mantzavinos's account on Explanatory Games is how these institutions remain stable. His categorization of Explanatory Rules follows along the lines of the kinds of problems that these rules address. It is thus meant to reflect the content of these rules, not the underlying mechanisms of stability. These mechanisms of stability are however important for my purposes, as they are decisive

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[17] There are also some examples of such rules that are formal institutions. A commitment to Marxism for example was state enforced in former socialist' countries, thus it constitutes a formal rule of corresponding Explanatory Games.

[18] The details on how these representation and inferences work – for example denotation for the case of natural language – are governed by a specific sub-category of rules of representation and inference within Mantzavinos's theory. I will not go into the details of the sub-categories here, as they are not relevant for my own argument (see Mantzavinos, 2016, chap. 6 for more details). While the sub-categories don't have overlaps in content, interdependencies exist between them. For example, ideas about how the universe is structured in general (constitutive rules) will have implications for the way in which events ought to be represented (rules of representation); also, the kinds of representation bearers used (rules of representation) limit the means of inference that can be used to link them together (rules of inference).

to determine whether it is correct to categorize some Explanatory Rules as lower-level institutions and some as higher-level institutions. I will address this in the next section.

4.2 Higher-level and lower-level explanatory rules

The theory of Explanatory Games exemplifies that the procedural rules that govern explanation can be described using the same means that are used within New Institutional Economics. In his Explanatory Pluralism, Mantzavinos however does not introduce the distinction between higher-level and lower-level rules. I will argue in this section that this distinction does apply to Explanatory Games, and that thus within Explanatory Games a process of adaption takes place that is analogous to the adaption of lower-level institutions to higher-level institutions in economic systems.

First, I want to establish that most rules of Explanatory Games are to be categorized as social norms. This means that they are normative social rules that are enforced through second party enforcement. When the actual enforcement mechanisms that function in science are considered, this is a rather plausible position. Many organized efforts towards enforcing explanatory rules exist, such as peer review. There are also ways to enforce these rules that function without formal organization, such as the credibility loss that follows if one violates established explanatory rules. These are examples for second party enforcement, and thus indicate that the rules of Explanatory Games are social norms, as they rely on second party enforcement.

The assumption that all rules of Explanatory Games are social norms however leads to the same kind of regress problem that I already described above. Why should, for example, any individual researcher bear the costs of painstakingly conducting peer reviews? The assumption that another second-party enforced social norm drives her to do so invites the same kind of question again, ultimately leading to a regress problem. Thus, internalized rules have to be assumed at some point that stabilize the corresponding social norms. Such internalized principles or rules has of course already been prominently introduced many times to philosophy of science. One of the most well-known examples are Kuhn's epistemic values (see Kuhn, 1977)[19]. These values are however of an extremely general character and are shared throughout science as a whole. I however believe explanatory rules are stabilized through more specific higher-level rules than that.

The historical development of many Explanatory Games seemingly supports this assertion. Take as an example the 'orthodox' (as opposed to 'heterodox') branch of economics: A defining feature of this Explanatory Game is that mathematical formalization plays a central role as means of representation (Mirowski, 2012). On a more specific level, the kind of formalization employed here changed substantially over the course of the historical developments in recent decades. The first formalizations of equilibrium theories do employ different means than modern theories that rely for example on formal game theory. I interpret this as evidence for a higher-level rule that includes a commitment towards mathematical formalization, while the more

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[19] Other prominent discussions of higher-level principles or values governing science can be found in (Lakatos, 1970; Laudan, 1984; Kitcher, 1993).

specific means of formalizing are addressed by lower-level rules that adapt to this higher-level commitment and perceived novel problems. I am confident that many other such examples could be found throughout the history of different sciences. While Explanatory Games change continuously, certain similarities and core features remain stable over longer periods of time: This, I propose, is the effect of higher-level rules that are specific to individual Explanatory Games and that are restraining change within these Games[20].

I propose that Mantzavinos's categorization of different types of explanatory rules can be fruitfully applied to higher-level rules as well: Each category[21] consists of lower-level rules that are stabilized by higher-level rules that are specific for the corresponding category. These higher-level rules are of more general content than the corresponding lower-level rules. Thus, they are consistent with a range of different possible lower-level rules while also ruling out some possible lower-level rules. They change at a slower pace than lower-level rules, as they are first-party enforced.

If what is written above is correct, this means that the idea of adaption, as it is used by economists employing the concept 'adaptive efficiency', also applies to Explanatory Games. The lower-level rules of Explanatory Games adapt to the higher-level rules, in the sense that these higher-level rules are elements of the selective environment of lower-level rules. To exemplify this: An 'orthodox' economist encounters a novel explanatory problem. She comes to the conclusion that the established means of representation (which are specified by lower-level rules) are unfit as means to solve this problem. She will thus attempt to innovate and create new means of representation to solve the problem at hand. In these attempts, she will however be restrained by the higher-level commitment to mathematical formalization that exists within orthodox economics; only with in these limits she will thus search for innovative solutions. The underlying higher-level commitment will only stop exerting its influence if experiences of lower-level institutions providing insufficient means become very frequent or are experienced as very severe.

It is important to point out that the whole set of higher-level rules serves as a selective environment for all lower-level rules in an Explanatory Game. This means that Explanatory Games as a whole are to be treated analogously to institutional matrices in New Institutional Economics. Nevertheless, specific rules can be usefully analyzed in isolation. A specific higher-level rule might have the potential to contribute to the adaptive efficiency of an Explanatory Game even though its effects are cancelled out by other higher-level rules. It is thus both possible and useful to analyze higher-level rules in isolation. However, only an analysis of all the higher-level rules of an Explanatory Game allows for a judgment about its explanatory efficiency[22].

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[20] What I propose here is thus very similar to Lakatos's 'hard cores'. There are however important differences in comparison to Lakatos: First, the higher-level rules are not methodologically 'justified', but a historical contingency. Second, the higher-level rules can change, they are thus not as 'hard' as a Lakatosian 'hard core'. Third, I provided an explanation for the existence of these higher-level rules that is based upon findings from the social sciences.

[21] Constitutive rules, rules of representation, rules of inference, rules of scope.

[22] This situation is once again analogous to the situation in Economics. Here, higher-level rules can also have the potential to contribute to economic growth, even if they do not realize this potential as other rules cancel them out. Take as an example a constitutional rule that grants equal rights to all genders. This rule

I conclude that the 'adaption'-part of 'adaptive efficiency' can be applied quite directly to the theory of explanation. In the next section, I will discuss in how far 'efficiency' can be applied here as well.

4.3 The normative dimension of 'explanatory efficiency'

As I described above, 'efficiency' within 'adaptive efficiency' ultimately refers to economic growth as a standard. 'Economic growth' is a contested concept that has been operationalized and defined in different ways. This is however unproblematic for 'adaptive efficiency' as a concept, as it is compatible with different ideas about what 'economic growth' is.

I propose that the situation for the concept 'explanatory efficiency' that I want to develop here is similar. Multiple ideas about how to evaluate explanations have been developed over the decades of discussion (see for example Hempel, 1965; van Fraassen, 1980; Salmon, 1984; Kitcher, 1989; Pettit/Jackson, 1992; Mantzavinos, 2016; see Psillos, 2007 for a detailed account of the history of theories of explanation). No consensus has emerged about which of these ideas is the best one[23]. This however is not necessarily a problem for 'explanatory efficiency'. As a heuristic framework it can be combined with different normative ideas; the theoretical import that it contributes is thus not the introduction of novel normative standards. The novel theoretical import is instead that it allows for the application of existing normative standards to the problem of evaluating the dynamic properties of Explanatory Games[24].

I thus propose a pluralistic normative stance on the level of dynamic properties. This comes with the advantage that the insights from the established literature on explanation can be utilized for analyzing the dynamic properties of Explanatory Games. This is valid for the 'classical' monistic literature on explanation (such as Railton, 1981; Salmon, 1984 or Kitcher, 1989) as well as for the more contemporary pluralistic approaches (such as Pettit/Jackson, 1992 or Mantzavinos, 2016). A higher-level rule can be analyzed relative to its potential to increase the degree of unification of explanations; it might also be analyzed relative to its potential to add to the details of the causal history of an explanation.

The 'efficiency' part of 'explanatory efficiency' is thus always relative to a normative standard that has to be specified. As I suggested above, the philosophical literature about explanation provides a rich source of reasonable evaluative standards that can be used for this purpose. 'Efficient' in the context proposed here thus means 'rules out changes that would inhibit the realization of this specific normative standard'. Statements about Explanatory Efficiency thus always have to involve a reference to the specific normative standard that has been used within the analyses. A

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could contribute to the adaptive efficiency of the institutional matrix; but it might be cancelled out by informal rules such as a sexist moral code that prevails in a society.

[23] Analogously to the situation in Economics, there is however agreement about the progressive character of many innovations in the history of science.

[24] It is important to point out in this context that 'Explanatory Game' is a descriptive concept that is to a large extent neutral towards normative questions. A Unificationist could for example use this concept to describe procedural rules, and then apply the normative concepts of Unificationism to these rules in order to evaluate them.

statement about the explanatory efficiency of an Explanatory Game relative to the aim of unification would thus read like this: "This Game is explanatory efficient relative to the aim of unification." A statement about the contribution of a specific higher-level rule in this context would read "This higher-level rule contributes to the explanatory efficiency of the Game relative to the aim of unification."

A pluralistic approach however comes with the disadvantage that applying different normative standards might yield contradictory results. A higher-level rule might turn out to be efficient relative to its unifying potential, but inefficient relative to its potential to add details to causal histories. This is an inevitable consequence of normative pluralism. However, this is not necessarily a problem. In such cases, the produced knowledge about the dynamic properties of the Explanatory Game in question is still valid. It can be used for comparative judgment between different Games, or to stimulate modifications of a specific Game. The appropriate reactions to such results will be highly dependent on the specific evaluative problem at hand. I believe nothing more specific can be said about them but that they ought to be solved via the means of critically comparing the importance of the contradictory results against each other relative to the problem that ought to be solved (see Albert, 1978, chap. 2).

I want to point out that the descriptive ideas laid out above could also be combined with normative monism[25]. For this, some argument would have to be made that demonstrates that every Explanatory Game should develop towards the realization of one specific normative standard. While I remain skeptical about the feasibility of such an approach, the descriptive theory laid out in this paper would also be compatible with normative monism.

I want to summarize the ideas that I have defended in the previous sections. 'Explanatory efficiency' is a concept derived from the concept 'adaptive efficiency', which is used within New Institutional Economics. An Explanatory Game is explanatory efficient, if the higher-level rules of this Game limit the changes in lower-level rules in a way that is normatively desirable. The normative standpoint that has to be assumed in order to make such a judgment ought to be derived from normative theories of explanation. This means that if an Explanatory Game is explanatory efficient, changes in lower-level rules that are progressive are more likely compared to an Explanatory Game that lacks explanatory efficiency in comparison.

5 A small case study: austrian economics and mathematization

To exemplify the ideas laid out above, I want to provide a small case study from Economics. This case study will be about what I take to be a distinct Explanatory Game: Austrian Economics. I will limit the scope of the case study to the rules of representation in Austrian Economics. The case study will thus not yield conclusions about the explanatory efficiency of Austrian Economics as a whole. Instead, I will only analyze whether one specific higher-level rule of representation contributes to explanatory efficiency or not. This rule is the commitment to natural language as the exclusive means of representation in formulating theories and arguments. The normative stan-

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[25] I want to thank the anonymous reviewer that pointed this out to me.

dard guiding the analyses will be internal consistency as well as the aim of achieving gapless deductions of theorems from axioms[26]. I will argue (following Linsbichler, 2023) that this higher-level rule inhibits changes towards means of representation that would provide better means to assure logical validity of arguments and theories, and thus that this rule is detrimental to the explanatory efficiency of Austrian Economics relative to the goals of internal consistency and gapless deduction[27].

First, I want to motivate the claim that this rule is indeed a higher-level rule. That the use of natural language is prescribed on the rule level within modern Austrian Economics is obvious. Almost all contemporary proponents of the Austrian School exclusively use natural language to express arguments and theoretical assumptions (see for example Horwitz, 2000; Boettke, 2001). This is also true for those authors who are viewed as classics within the Austrian School, such as Ludwig von Mises or F.A. Hayek. As Linsbichler points out, a crucial difference between these classical authors and contemporary Austrian Economists is their attitude towards natural language as means of representation. Mises and Hayek both demonstrated an openness in principle towards mathematization[28] (see Linsbichler, 2023, 4–5). The vast majority of contemporary proponents of the Austrian School seem to categorically rule out deviating from natural language as means of representation in theorizing as being harmful in principle (ibid. 2–3). I believe this can be interpreted as evidence for the claim that the rule level commitment towards natural language moved up the hierarchy over time, being originally a lower-level rule and now a higher-level rule within Austrian Economics[29].

I now want to analyze whether this higher-level rule is explanatory efficient relative to the aims of internal consistency and gapless deduction. As Linsbichler (using other terms) argues, this is not the case. This rule blocks possible innovations in the means of representation that involve the mathematization of explanations. Mathematization however promotes deductive validity, as it allows for using syntactic rules to verify whether the connection between different statements is deductively valid (ibid. 9f). Thus, the higher-level rule in questions blocks rules of representation that would make the production of explanations that exclusively contain deductively valid argu-

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[26] I want to thank the anonymous reviewer that pointed out the importance of gapless deductions to me in this context. This goal is especially important for researchers in the praxeological tradition of Austrian Economics, as here special importance is assigned to a fundamental axiom from which it is assumed that certain theorems can be deduced (see Linsbichler, 2017 for a critical introduction in this methodology). Whether a set of assumptions is sufficient for deducing an axiom is thus of special methodological importance for praxeological Austrians.

[27] The case study presented here is of course only a sketch to exemplify the ideas that I introduced above. It is thus not meant to settle the actual issue at hand; for this, a more historically informed treatment of the problem would be necessary.

[28] By "mathematization" I mean here the process "[…]in which statements of natural language are translated into a formal language such as mathematics, predicate logic, or some logic" (Linsbichler, 2023, 3–4).

[29] As a higher-level rule, the commitment towards natural language still allows for certain innovations in lower-level rules. A common difference within the Austrian School is for example the difference between a Mises-inspired emphasis on axiomatization in theorizing, while the institutional framework is only represented in an abstract way, omitting details. Differing from this, Hayek-inspired scholars put less emphasis on axiomatization and more on representing the details of an institutional framework. Thus, the higher-level rule still allows for competing lower-level rules to exist.

ments more likely. As deductive validity promotes the internal consistency of explanations, I conclude that the higher-level rule of representation in questions does not contribute to the explanatory efficiency of Austrian Economics relative to the aim of internal consistency. This is obviously also detrimental to the aim of achieving gapless deductions, as it blocks a valuable means of testing whether there are gaps in a deduction.

I hope that this small case study suffices to demonstrate how the concept 'explanatory efficiency' can be used to analyze the dynamic properties of Explanatory Games. A complete assessment of the explanatory efficiency of Austrian Economics towards the aims of reaching internal consistency and gapless deductions would involve an explication and analyses of all higher-level rules of this Explanatory Game. Such an analyses should also be comparative, as it is the comparison to alternatives that is relevant for actual choice-problems[30]. As stated in the section above, it would also be possible to use another normative standard for the analyses. The choice of normative standards is dependent upon the interest of the researcher in question, as well as upon the specifics of the alternatives that ought to be compared.

6 Conclusion

Above I have developed the concept of 'explanatory efficiency'. This concept provides a framework for answering questions about the dynamic property of explanatory rules. Such questions include for example questions like this: "Why has this Explanatory Game developed so well historically, while its competitors developed so poorly?" or "Is this particular higher-level rule impeding or promoting progressive innovations within this Explanatory Game?" or "Which of these Explanatory Games has more prospect towards progressive changes?". Judgments about explanatory efficiency are always judgments about the present properties of Explanatory Games: They do not allow for predictions. But they do shed light on present features that influence change.

'Explanatory efficiency' is derived via an analogy from New Institutional Economics. New Institutional Economics has produced many outstanding empirical and theoretical achievements for the social sciences over the recent decades. Since science is a social process, I believe that the introduction of theoretical concepts and results from New Institutional Economics to philosophy of science would shed new light on many problems that are traditionally discussed within philosophy of science.

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[30] In the analyses presented above, I compared the higher-level rule in question to a rule that would potentially allow for mathematization of explanations.

Declarations

Conflict of interest   As the author of this paper, I have no conflict of interest to declare.

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