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INVESTIGATION INTO THE STRUCTURE OF REASONING IN ECONOMICS

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Two approaches to economics reasoning

Two main approaches to economic reasoning are discussed in professional literature the Euclidean-Cartesian (EC) and the Babylonian (BB). Their relations, properties and constructions are not often discussed. Attention to this question was recently attracted to this by Dow (1996,) This paper will argue that it is important to discuss structure of economic thinking in relation to these two paradigms, as it has significant implications for economic methodology, as well for economic education.

This paper goals to offer a possible framework for economic reasoning and it's relation to Babylonian reasoning in economics and the place of Euclidean-Cartesian reasoning within it.

Before going further, let's take an example. BB statement could look like this: How do financial intermediators supply liquidity to a market? Informal answer to this question will base on multiplicity and interactions of economic mechanisms - credits, open market operations, co-operation among several financial intermediators and so on... From an another side EC question on the same topic could sound like this: "How financial intermediators provide liquidity in comparison with a government?".[1] The answer to this question is constraint to the unique mechanism, which works within a rigid axiomatic frame. The answer does not reject other approaches to the topic, but very often hold them ceteris paribus, as that will require constructing another model.

There is another example, borrowed from Gertler (1988). "Shortly after Gurley and Shaw (GS) (1955) emphasized the importance of the financial system. Modigliani and Miller (MM) (1958) derived the formal proposition that real economic decisions were independent of financial structure. The proposition held for a setting of perfect markets. While GS had in mind a different economic environment than the Arrow-Debrew world underlying the MM theorem, they, and others at the time, did not have a formal counterpart to offer. They accordingly could not provide arguments at the same level of rigor as those suggesting the unimportance of financial structure" GS emphasized importance of financial intermediators for macroeconomics with BB approach. MM provided EC arguments with formal explanation, which turned to be more persuasive.

This difference is only the top of the huge topic – what is economic reasoning, and does it differ from one in other humanities and sciences.

The Euclidean-Cartesian approach[2]

In this paper EC approach will be considered not as one of the forms of economic reasoning, but a mean for constructing correct conclusions from given set of axioms[3]. It

[1] This refers to the paper Holmstom, Tirole (2004).
[2] Despite of the title the idea of the method goes back to Aristotle.
[3] This narrow understanding differs from one of Dow.

is based on deriving arguments from a set of axioms using "if then" rules or their mathematical equivalents. The common notion is that EC reasoning is used in economics only for operation of models. Structure of economic model relevant for the current discussion will be described further.

Every axiom in EC describes some desired property. In this sense axioms are exogenous for any particular EC mode of reasoning. This idea will be used later. The attractiveness and efficiency of EC reasoning is based on consistency of conclusions, and ability to derive only true conclusions. If the chosen set of axioms is not contradictory, application of logical inference (mathematical formalism) generates all the possible outcomes about economic behavior.[4]

Mechanism of logical inference predetermines the set of the model's outcomes. The outcome becomes a computational[5] (algorithmic) procedure – the correct set of model assumptions generates reasonable conclusions. In most cases only computational difficulties can prevent complete investigation of the model.

We claim that, EC reasoning exists in economic thinking not only in forms of economic models. We can enumerate them as they will be used further.

EC1. EC analysis inside an economic model. This is the most famous and obvious case. Largest part of economic education and publications is concentrated here, and this is what Dow understands under EC reasoning. The rest of applications of EC go beyond this understanding.

EC2. Model identification or model recognition. This is very specific and individual part of economic reasoning. Standardized mathematical economic training may erase this personification of thinking. In the simplest case it operates like a selection input. The more developed is economic thinking, the more a person can identify from the same observation. See an example from Feynman later.

EC 3. Model construction. There are many methods of economic analysis – just a few for an example – general equilibrium, partial equilibrium and so on. Each type of model has its own goals and constraints, as well as methods of construction. This means that EC3 is a set of metarules, different type of model demand different toolkit. Special training requires understanding details of construction of specific type of a model.

EC 4. Comparison of models. This is again rather individual and vague area for economic reasoning. Basic models are constructed on *ceteris paribus* principle, what allows isolating only one reason for specific economic behavior. Empirical research demand combinations of mechanisms. Serious conceptual and methodological problems may appear, when different mechanisms start interaction.

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[4] If method dominates over subject, we can generate mathematical results with poor economic content.
[5] In this paper we do not distinguish between symbolic and numeric calculations.

EC 5. Conflict resolution. This is the very special feature of any reasoning; also it is crucial for developing logical apparatus. This will be discussed further in more details.

One can easily see that every described operation can be presented in the axiomatic-reasoning way. This does not mean that axiomatic reasoning is the only way for realization of these tasks. Although their algorithmization (as a synonyms to axiom-based reasoning) has very nice properties.

1. Mode of thinking. We can take an algorithm as a whole construction, as a building block. Once established, it becomes a standardized mode of thinking within the area of applicability. Areas of applicability are described above – within a model, constructing a model, comparing models and conflict resolution between models. Mode of thinking means that it should be included into the common professional reasoning list.

2. Reproduction. Easy reproduction and usage, no need to generate conclusions ad hoc. This allows achieve intertemporal consistency in conclusions, if we have ceteris paribus in application environment. This is also important, when resources to construct argument are limited. To make a long story short, we can claim that EC reasoning (any EC1,…, EC5) allows us to exploit reasoning as an algorithm. Whenever using an EC reasoning we are in the position, described by Hilbert, presented in Gries and Schneider:[6]

"Hilbert fell that mathematics should be complete (all truth should be proved), consistent (nothing false should be proved), and decidable (there should be a mechanical procedure for deciding whether any assertion is true or false)". Almost every model has few different expositions, at least formal, verbal and graphical.

Both features imply that instead of constructing a model for every case of analysis we can just refer to it. This operation is very chip and very often creates an illusion that economics is just a "bla-bla" subject.

There are also limitations for usage EC reasoning types.

1/ Possible high costs of derivation. This means that it may be very costly or even impossible to make conclusion in some cases, especially if a model does not exist. It is very important, as it restricts consistent empirical analysis. From another side, it restricts application of Aristotle "identity" axiom: "any notion or thing referred to in one constituent statement of the argument must be identical to that notion or thing when referred to in any other constituent statement of the argument"[7]. This assertion claims that we can easily identify the same concept in any other reasoning context. This is undoubtedly true in the world of free inference or zero-cost world. The example, when high costs prevent the conclusion can be found in the same book (p.32):

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[6] Greis D., Shneider F. A logical approach to discrete mathematics. 1993

[7] Handbook of Economic Methodology, ed. Davis. J., Wade Hands D., Maki U., Edward Elgar, 1998, P. 87

"If the predicate P(…) is "Smith does not know whether … is greater than 800 000", and the number 7^7 and 823 543 are substituted for x and y respectfully, then (s) has the following hardly acceptable consequence. As 7^7 = 823 543 is easily verified[8], it follows that "Smith does not know whether 7^7 is greater than 800 000" implies "Smith does not know whether 823 543 is greater than 800 000".

"Limits of human computational and informational processing ability may lead to the adoption of boundedly rational heuristics."[9]

Gale D., Sabourian H (2005) [10] studied very similar effect – impact of complexity of equilibrium on behavior. They argue, that "that the complexity of noncompetitive behavior provides a justification for competitive equilibrium in the sense that if rational agents have an aversion to complexity (at the margin), then maximizing behavior will result in simple behavioral rules and hence in a competitive outcome." This means that costs may prevent reaching other equilibrium except competitive.

2/ Possible multiplicity of outcomes. Reasoning guarantees only achieving a result, not evaluating it. For example, possible multiplicity of results generates demand for comparison between equilibria. For this we need other ideas and another set of construction rules. For example, one of the problems with unpopularity of external economies of scale – lack of ideas how to compare equilibria and to choose between them.[11]

3/ Mathematical formalism does not support cause-effect link. For example, the sign of equality "=" just revalues a left-hand side variable, as it is a reflexive operation. Whatever value we put in the right-hand side, it will be assigned to the left-hand side. In some cases this is very convenient, when a model can operate in direct way (when prices are an outcome) and in the reverse way, when reasoning starts from exogenous price disturbance. This requires outside control for exogenous and endogenous variables. This can be done by EC2 toolkit.

Brackets $(\bullet)$ can mean both – dependency over a variable or order of operations. More of that functional notation is not unambiguous. If L(Y,i) is demand for money, than i can be an endogenous variable. From the mathematical side both letters are arguments, i.e. exogenous.

4/ Mathematical operations are defined on sets of exogenously independent and non-interactive items. For example, on the set of real numbers. So the instrument poses another restriction – we can hardly discuss exogenously interacted behavior. For

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[8] Rare person can perform this without calculator.

[9] McFadden D. Rationality for economists? Journal of Risk and uncertainty, Special issue on Preference elicitation, p.26

[10] Gale D., Sabourian H. Complexity and competition, Econometrica, Vol. 73, No. 3 (May, 2005), 739–769

[11] The same can be said about "offer curve" in trade theory. Professional can easily expand this list from their own field of expertise.

example, market demand is constructed in a way, which excludes possibility of a second best choice of some individuals.

The Babylonian approach

The Babylonian approach. The BB approach is widely used in law, theology, medicine and for non-formal reasoning in sciences and in economics. Introduction of this kind of thinking into modern economics is credited to Dow (1996, 2004, 2005)

"The modern use of the concept of Babylonian thought started with Feynman's (1965) account of Babylonian mathematics. Deductive axiomatic mathematics had been judged unsatisfactory for practical application. Long chains of reasoning are vulnerable to error being multiplied down the chain. They require all sorts of ancillary assumptions such that, even if the axioms were "self-evidently true," the truth-value of the conclusions is bound to be compromised. Rather, the preferred approach was to use short chains of reasoning that start (inevitably) from different points, depending on the question at hand and the methods employed. Such an approach is reminiscent of Marshall's justification for partial equilibrium reasoning. … I attempted to explain this in terms of Babylonian thought (Dow, 1996; 2003). "Cartesian/Euclidean thought concentrates on the known and knowable, i.e. information, while its dual, not-Cartesian/Euclidean thought, concentrates on the unknowable [where 'anything goes']. Babylonian thought transcends this dual by setting up a system for generating knowledge, where knowability is a matter of degree" (Dow, 1996, p. xi).

It may come as a surprise, but this way of reasoning is used in science and mathematics – The example can be found at Feynman (1965, p.46).

"*There are two kinds of ways of looking at mathematics, which for the purpose of this lecture I will call the Babylonian tradition and the Greek Tradition. In Babylonian schools in mathematics the student would learn something by doing a large number of examples until he caught on to the general rule. Also he would know a large amount of geometry, a lot of the properties of circles, the theorem of Pythagoras, formulae for the area of cubes and triangles; in addition, some degree of argument was available to go from one thing to another. Tables of numerical quantities were available so that they could solve elaborate equations. Everything was prepared for calculating things out. But Euclid discovered that there was a way in which all the theorems of geometry could be ordered from a set of axioms that were particularly simple. The Babylonian attitude – or what I call Babylonian mathematics – is that you know all the various theorems and many of the connections in between, but you have never fully realized that it could all come up from the brunch of axioms. The most modern mathematics concentrates on axioms and demonstrates within a very definite framework of conventions of what is acceptable and what is not acceptable as axioms.* (Feynman 1965, p.46)

To tell a long story short, specific feature of BB- reasoning can be described in the following ways - managing different items, without necessarily care of strict reasoning underlie behind this management.

To stress differences we can try to explain them in the following way. EC describes reasoning in the way – how to make the next operation to stay beyond prescribed rules. This system of thinking based on 1-st order logics. BB asks a question – what should be an order of formulas, are there variations in this order. This type of logical system operates (manages, assembles) formulas as a whole and is based on meta-rules of 2-nd order logics.

From here we can make another conclusion about Babylonian reasoning. It is offers a trade-off or an alternative for strict axiomatic reasoning, the trade-off between complexity of formal inference, and simple, but not-strict argumentation. "Lower" relative cost of BB comes from reduced time to construct an argument, verbality of reasoning. Potential losses come from steadiness to mistakes and reduced precision of outcome. Meanwhile low costs of this style of thinking permit easy combination of different economic mechanisms.

Feynman describes the trade-off in this way.

"If you have a structure that is only partly accurate, and something is going to fail, then if you write it with just the rigid axioms may be only one axiom fails and the rest remain, you need only change one little thing. But if you write it with another set of axioms, they may all collapse, because they all lean that one thing that fails. We can not tell ahead of time, without some intuition, which is the best way to write it so that we can find out the new situation. We must always keep all the alternative ways of looking at a thing in our heads; so physicists do Babylonian mathematics, and pay but little attention to the precise reasoning from the fixed axioms." (Feynman 1965, p.54)

The above example of this paper of Gurley J. and Shaw E. (1955) demonstrates the difference between BB and EC reasoning in contemporary economic thought. In 50-s Gurley and Shaw have failed to provide rigor support for ideas of importance of financial sector in macroeconomics, in contrast to formal and "transparent" MM approach. The demand for strict mathematical rigor put their ideas away from the agenda for decades. In some sense the work of Gurley J., Shaw E. has come too early, before the long-run MM benchmark. Modern researchers have revealed plenty of mechanisms related to the role of financial intermediators in macroeconomic context (see for example Gorton, Winton, (2002). EC has win the battle in 50-s due to seeming low costs of implementing MM ideas, without "*keep all the alternative ways of looking at a thing in our heads.*"

Professional demand for rigor analysis prevented development of this line of research as well development of economic thought.[12]

The easiest part for models –is verbal. That is why it is not a surprise that "low cost reasoning", BB reasoning, extensively exploits it. More detailed discussion will be presented below. But when any other way (mathematical of graphical) demonstrated relative simplicity, it has all chances to win.

Simplification of reasoning has two serious advantages - easy combination of different arguments. This means that we can expand scope of discussion by involving more arguments, based on different mechanisms or develop another argumentation. The latter feature is called openness.

"*So the first thing we have to accept is that even in mathematics you can start in different places. If all these various theorems are interconnected by starting there is no real way to say 'These are the most fundamental axioms', because if you were told something different instead you could also run the reasoning the other way…. The mathematical tradition of today is to start with some particular ideas which are chosen by some kind of convention to be axioms, and then to build up the structure from here.* "(Feynman, 1965, pp.46-47).[13]

Sheila Dow has described this in the other way:

"argument in the Babylonian style is thus conditioned by the problem at hand, employs a range of methods suited to the problem, and these methods cannot be combined into one formal deductive argument without drastically changing their nature" (Dow 1996:13).

"The method of always starting from the axioms is not very efficient in obtaining theorems. In working something out in geometry you are not very efficient if each time you gave to start back at the axioms". (Feynman, 1965, pp.46-47).

In this paper we concentrate on how "changing … nature" and "employment of ... methods" can be implemented.

What can be understood as a structure of an economic model

To compare ways of reasoning we need briefly to identify a structure of economic model, EC1 in the notation of this paper. In Levando (2003) was proposed a structure of knowledge of economic models. It can be used to demonstrate involvement of different parts of models into economic reasoning.

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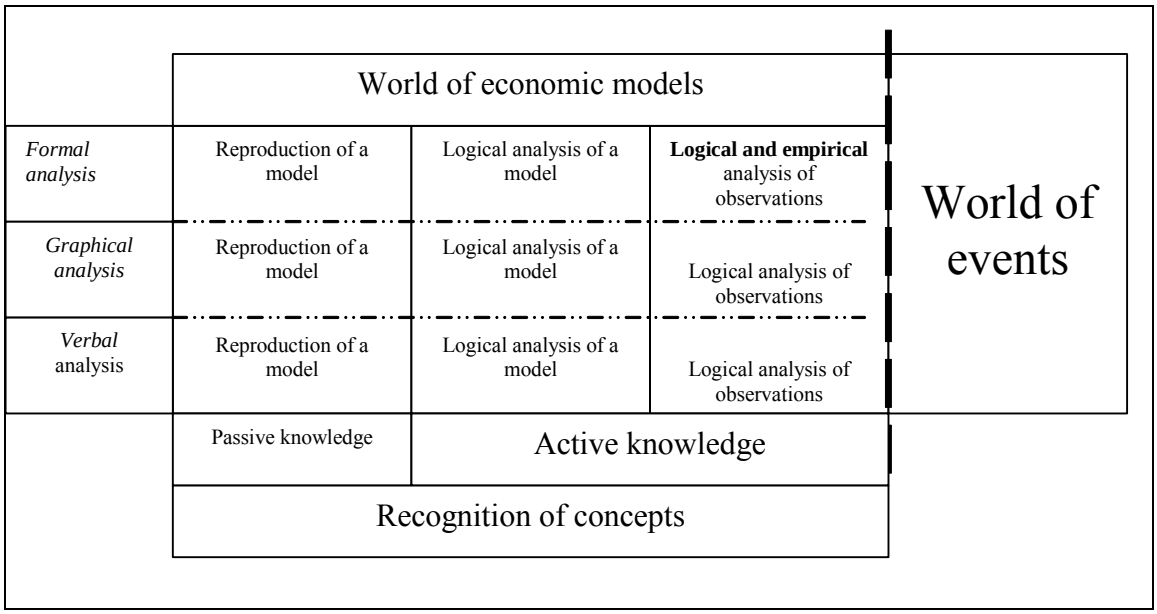
[12] "The Russian logician Manin (1977) said " A proof becomes a proof after the social act of accepting it as a proof. This is true of mathematics as it is of physics, linguistics, and biology." Cited from Sriraman (2004), p.23

[13] This passage contains one idea, important for economic analysis – which system of behavior should be chosen as a fundamental one. There are many grounds to think that that individual rationality with maximization principle is limited.

Initially the diagram was used to demonstrate different layers of economic models as well as involvement of different type of analysis. My claim is that BB reasoning is significantly based on verbal part of analysis, as it permits reduction of reasoning costs (time to construct arguments, efforts and so on). To make argument more persuasive the approach can combine different types of models, which are considered here as standardized modes of thinking.



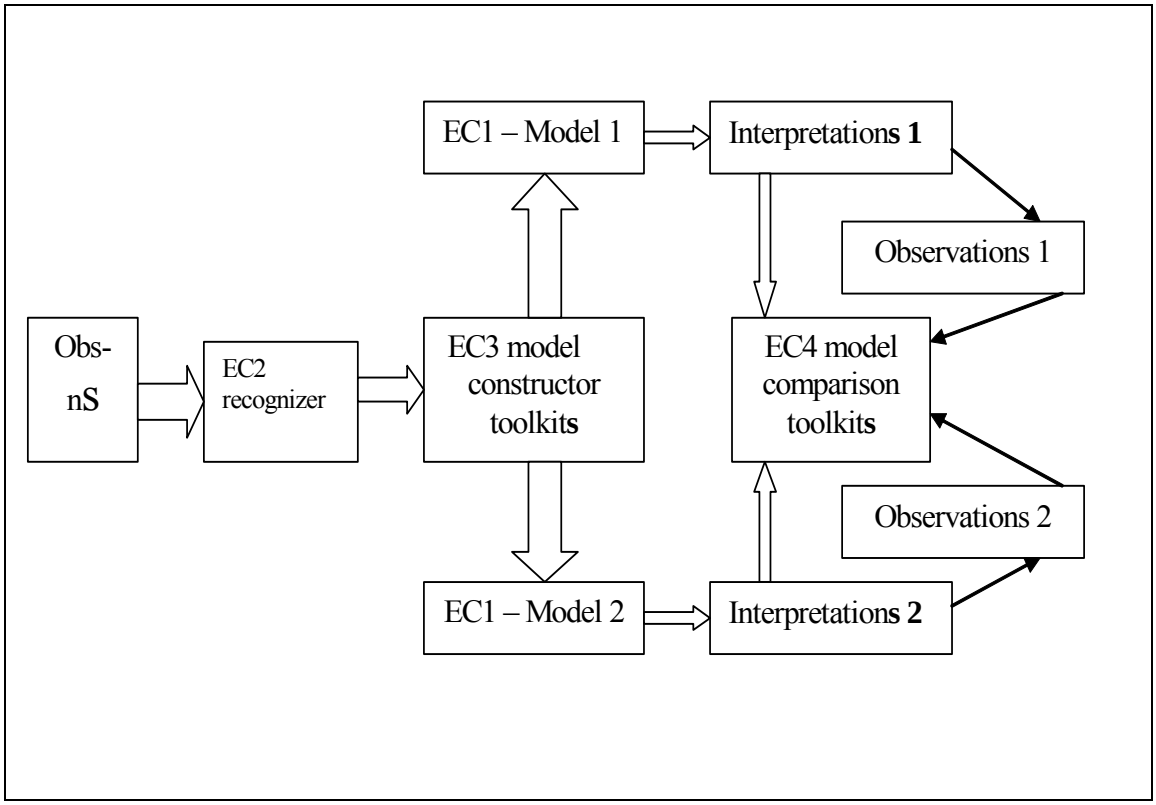
This allows speculating that EC1 reasoning is more depth-oriented way of reasoning, meanwhile BB reasoning is width oriented. Depths meant that it involves more layers of a model. Width oriented means that it goes mainly through verbal reasoning.

Proposed structure of economic reasoning

In this part of the paper we would like to present possible structure of economic reasoning. The process of reasoning is separated into several stages. Every stage operates within a specialized EC framework, serving different tasks. The BB reasoning comes when every step in reasoning is taken as verbal statement.

It is clear that knowledge of models (EC1 in current notation) is not enough to generate a sustainable economic statement. We need knowledge on choosing, constructing and application of models. These features are numerated as EC2-EC4. They are incorporated into the economic reasoning scheme presented on the next figure.

There are two different limit cases in application of economic analysis. The first assumes that application will not demand developing of reasoning, model knowledge and so on. In other worlds for simplicity we assert closeness of the economic system now or and reject openness or ability to develop.



The common understanding of EC reasoning here is entitled EC1 and is implemented in boxes with economic models. The rest of the structure usually is called the Babylonian reasoning. BB is not so obvious here when used models are expressed formally. The problem is that models are completely separated from the intellectual environment, from cases and so on. They are no more than brain images, patterns of reasoning.

This scheme appears to be very close to modern psychological conceptions of how human brain works. Very similar structure of thinking can be found in engineering disciplines and so on.

The reasoning starts from an observation of some input. At the moment we do not distinguish is it empirical or logical. We consider it just as a fact an economist is to react at.

Model recognition EC2. The first stage of analysis is model recognition. Meanwhile psychologists will immediately recognize memory here. This memory could incorporate facts from very different origins – professional training, social experience, ethnic, religious or just individual background. In psychological terms this means that economic reasoning can be exposed for influence of past and current attitudes, affects and motives. One of the examples of such influence is the model, developed by Ricardo in favor of Britain free trade.

"*Economic theory suggests that when subjects anticipate a possible connection between their response and some psychological or economic outcome in which they have interest, they may have strategic incentives to mispresent information*".[14]

Model recognizer is very specific stage not only of economic reasoning. It connects observations or facts of real world with facts of imaginary, logical, virtual world. Here the terminology of computer science is appropriate – we bind logical variables with observations. Quality of the binding is later tested by application of procedures, related to the used logical variables.

EC2 stage initiates the whole process of economic reasoning. We do not claim that this stage prescribes which single model should be applied in every case. We claim only that sets of applicable models can be different for different people in different situations. From another side a feasible set of models can be more than one for any case.

Economic education does not generally concentrate much on this stage of reasoning. There exists general understanding that this comes with experience. Selection during economic education (especially MA training) results in drop out of those, who concentrate too much on this stage or have a different vision of the subject. However recognition of the economic model is the important stage of reasoning, and it is a pity that accumulation of this skill – happens only privately and special training is rather rare[15].

Model construction EC3. After model identification we will need to construct a model. There are different styles of economic analysis. Every demands its own instruments – for example partial and general equilibrium analysis have very different methods of model construction. However every method of construction has its own internal logics. It means that once started a model, we will be able to finish it or to close it in the style of this very model. Different toolkits can be easily inconsistent with each other.

The internal structure of any such toolkit is based on the system of axiom – how does the model should look like within a given framework. Every toolkit operates according to the EC principle, but again - set of axioms and reasoning tools are exogenous for the stage...

It is important that economic reasoning is based on varieties of construction toolkits. Choice of a toolkit is very individual. Diversity of these tools demonstrates diversity of professional views and skills. This diversity together with model recognition is the reason for the disagreement between economists in analysis. Different toolkits can co-exist due to individual preferences or to training background.

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[14] McFadden, p.27

[15] We can offer an analogy with physical exercising, which contains a lot of special exercises to train different features – power, velocity, stamina and so on. It is rather strange that such diversification does not exist still in logical training.

Here words of Feynman comes again "*keep all the alternative ways of looking at a thing in our heads".*

Different people can easily have different preferences between economic mechanisms. Their disagreement is rarely revealed at this stage of analysis. However it is important to identify reasons for disagreement:

Machlup F. (1978) identifies four reasons for disagreement.

Meaning of words. Different words may mean different things for different economists. The list can be very extensive – money, money supply, demand for money, …. Differences in semantic stems from differences agents/institutions/agents involved into the concept. The immediate reason for this is diversity of background - individual, social, professional.

Differences in logics (reasoning schemes). Multiplicity of reasoning schemes naturally leads to different conclusions.

Differences in factual assumptions. Due to differences in logical system people can observe different things from the same observations.

Difference on value judgement. Different goals (interests) make people develop different arguments, which justify their interests.

Models EC1. Probably this stage of reasoning is on top of all economic thinking. Most theoretical economic models operate as a logical litmus – create an answer for the question – does this specific mechanism matter or not. As far as every model exploits ceteris paribus principle they supply us with elementary economic mechanisms. This is good for economic theory, when we know the pure effect of every single separate change. However combining even two effects may be very difficult, but this kind of combined models is the most important for practical usage.

Recent paper by Atkenson Burstein, (2004)[16] has combined many features of the traditional international trade toolkit – multiple goods, and industrial organization of product markets – perfect and imperfect (Cournot and Bertrand) competition. For years these approaches existed completely separately.

From another side different mechanism could be applicable simultaneously. This creates concurrent reasoning. Concurrent means that there are may exist simultaneous ways of reasoning (inferences), based on different economic ideas and starting from the same origin.[17,18] So we inevitably need to compare different models. The methodological difficulty comes when outcomes of models are not complementary, but substitutable, i.e. predict opposite outcomes. This generates tension and some

[16] Atkenson A. Burstein A. International relative prices in New Ricardian model of International Trade, UCLA, 2004, mimeo.

[17] In terms of EC, this implies simultaneous usage of different models for description of the same item.

[18] A multiplicity of types of reasoning implies richer considerations. Actually there can happen a trade-off between several simple ceteris paribus models or one, but complicated.

exogenous conflict resolution is required. It can be realized also in terms of different Euclidean-Cartesian systems.

Comparison EC 4.Rare economic event is based on a single economic mechanism. This is the weak point of application of ceteris paribus rule. Combination of mechanisms to produce new effect is rare. Very good example of combination of mechanisms is Suarez and Sussman (2004).[19] They describe features of the models in this way:

"*It is important to stress that our model is "clean" in the sense that it contains no unusual ingredients that drives the result. …contracts are fully endogenized. The asymmetric information structure is a simple textbook moral-hazard problem. The basic story about the relation between external finance and risk taking comes from SW (Stiglitz-Weiss, LD). The extention of project duration to more than one period is just an ordinary (and realistic) feature of capital theory. Preferences are standard and display risk neutrality in the numeraire good. … the cycle results from the financial imperfections*".

The methodological advantage of this model is that it successfully combines different economic mechanisms. The output is explanation of real cycles run by imperfections of financial markets.

Conflict resolution, learning and openness

The distinguished feature of BB reasoning is openness. This means that it open for development. This paper offers a logical structure which could support this feature. It is based on adding a logical module, to the explained above scheme. It is called conflict resolution.

The term "conflict" here can be understood in two senses.

Disagreement between conclusions of different models.

Disagreement between results of models and empirics.

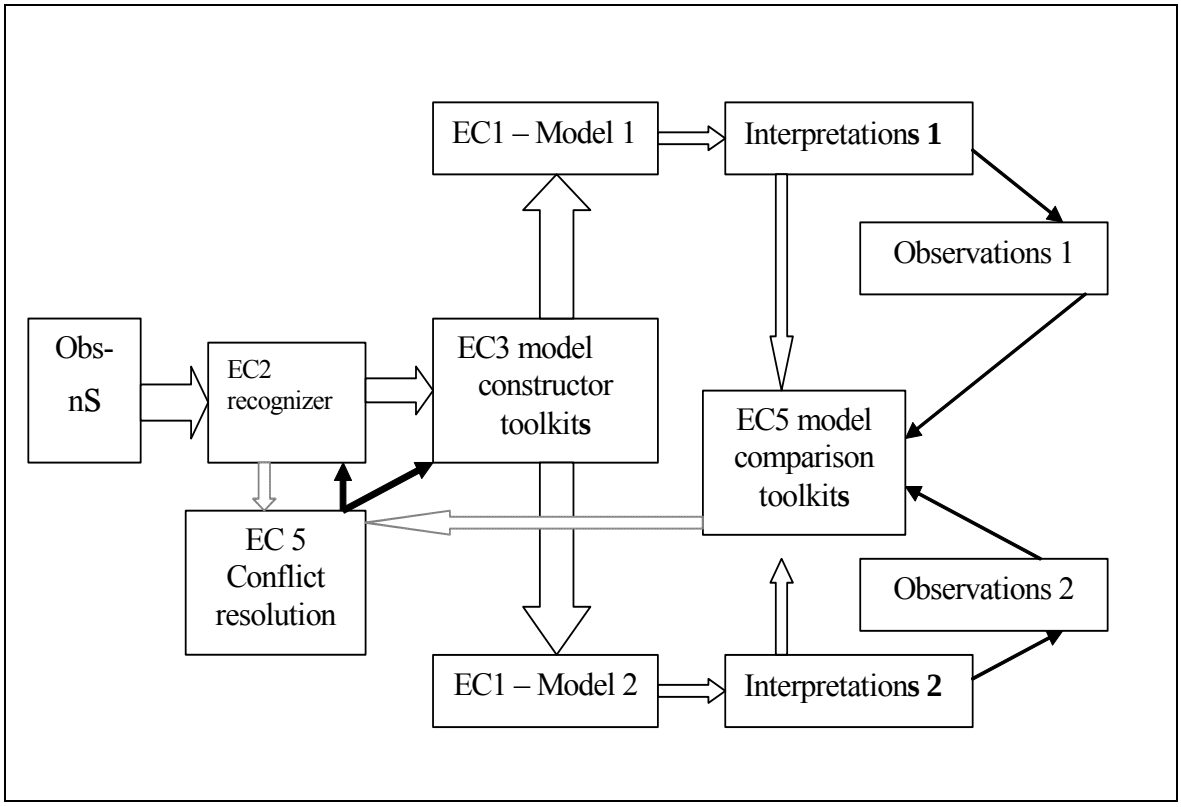
Any of them requires identification of a conflict, but at the moment we will not discriminate between them.

Conflicts are the point for development, growth points. Identification of mismatch between theories, observations and theories generates intellectual challenge. This challenge is transformed into developing a new model or a new constructor for a new class of models. In this way BB system develops, and this is what can be called "openness" of Babylonian system.

This feature allows use BB as a system of reasoning to description of the world **ex ante.** We can not assume that we know ex ante all relevant mechanisms, and finally we will come to a conflict between observations and logical conclusions.

[19] Endogenous cycles in a Stiglitz-Weiss model. In "Credits, market imperfections and macroeconomics"

The primitive scheme of conflict resolution is presented at Fig.2. The principle difference with Fig.1 is ability of blocks EC4 and EC5 to identify conflicts. Identification creates demand for other methods of economic analysis.



The first stage is model recognition, when we need to answer a question: do we have an appropriate tool for analysis? The outcome can be a set of appropriate models or demand for a new model. Some ways how to solve new problems in mathematics were described in the book by Polya (1946)[20] and can easily be interpreted in terms of the diagram.

Step 1. EC2. Understanding the problem. What is unknown? What are the data? What is the condition? The task of this step is to bind given observations (facts, variable) with those we already know. If we fail to do this, we have the conflict between knowledge and observations. In this case we need to exploit special methods of logical analysis – metaphors, analogy, heuristics and so on.

Step 2. EC 3. Devising a plan. Do you know a related problem? Look at the unknown. Using our knowledge and position of binded variables within it we can construct a model.

[20] Polya G. , How to solve it: a new aspect of mathematical method. Princeton University Library, 1946. Advices of this genius person can appear more valuable, if to know that his first degree was in Latin, Hungarian, and his major was Law.

Step 3. EC1. Carry out the plan. More or less straight forward application of the chosen models.

Step 4. EC4. Can you check the result? Examine the solution obtained. Results of the analysis are compared with empirical testing and between each other.

It is not by chance that methods of analysis of unknown in economics and mathematics turned out to be similar. This reflects construction of deep processes in human brain.

Conflicts may appear not as a competition between models but between different interpretations for the same observations. If there is no in-built mechanism to resolve conflicts between different ways of reasoning, then BB approach can be used for speculations.

Note. If we do not identify the conflict between what we know and what we observe, we loose precision of conclusions. Such conflicting conclusions can be easily used for speculations or generate a systematic mistake.

There are certain restrictions for developing of the openness of BB reasoning.

Existence of a model, appropriate for the problem. The scheme of reasoning, depicted at Fig 1, 2 describes individual reasoning. That is why it is quite possible that a model, appropriate for the problem, is not known to a person. This conflict resolution is very simple.

Costs of application of this model. This assumes an existence of the appropriate model, but impossibility of its exploitation. The outcome is potential halt of economic analysis.

Costs of identification and developing a new adequate model. The potential result is the same, with some difference. If the there is a professional consensus on the problem and the demand is large enough a new model will be created. But this does not guarantee again its applicability.

Quality of empirical research. Discussion of this question goes beyond the paper.

Interdependence of components in economic reasoning

Here we are going to discuss dependency of all stages professional economic reasoning. It is obvious that they have different roles and goals and only their interaction creates some valuable results. That is why we will try to discuss input of every stage.

EC1 – economic models (in any form – verbal, graphical and formal), very standardized reasoning. If we delete this stage from economic analysis we will unable to make precise conclusions, predictions, formulate hypothesis for empirical work.

EC2 - model recognition. Without it we will be unable to use our previous experience, and will be condemned to make systematic mistakes or to repeat the same analysis.

EC3 – model construction. Without it we will need to construct models every time from the very beginning, ignoring principles of their construction. The hypothesis if the author is that this stage of analysis requires participation of another semisphere of human brain in comparison to stage EC1. And this makes it very-very individual. Probably here is the large area for psycho-physiological research on human brain processes.

EC4 - model comparison. Without it we will be unable to verify empirics, compare outcome and so on.

EC5 – conflict resolution. Without it we will be unable to implement openness in BB.

Common base for EC and BB economic reasoning

Goedel uncertainty theorem claims that every closed logical system must contain items, which can not be derived within this theory and need be taken as exogenous. We have four pieces of closed systems, all sharing the same set of ideas, concepts, methods and so on. So we can introduce part of the economic reasoning independently from analysis.

Leibnizt wrote: "Nothing is more important, than to see the sources of invention which are, in my opinion, more interesting than the inventions themselves".[21] That is why it is very important not only to enjoy constructing economic models, but to investigate how they were built and from which elements they are constructed.

Author would like to offer his answer for this challenge – what could be model-independent items in economics. The method for such description is borrowed from linguistics and other humanities, when an item is defined according to the principle "core-vicinity". A core describes something very essential of a concept, what is always true. Always means that this feature should be true in any context the concept participates in. Vicinity describes some special features, implementations and applications. Concepts here are not considered as atoms. Vicinity generates a conceptual network and develops conceptual integrity of the subject.

Let's consider several examples of importance of this king of economic investigation.

Example 1[22]. We can define an income as a resource available to spend now. However this says nothing about nature of the resource (monetary or real), availability, size of the resource (gross or tax-free), sources (wage, rent, profit), ownership and so

[21] Polya G. p 123.

[22] This is the example, and it can miss much. And this is the problem in humanities – how to define elusive items. One of the ways how to manage this – is described above.

on. These features will be included into the vicinity of this concept. But in every case the core idea – flow variable to spend will be true.

Example 2. A contract – exchange with intertemporal binding obligations. The vicinity of this concept may include specification of sides of the contract, information asymmetry, number of parties, bargaining powers and so on.

The advantage of this kind of reasoning is that it allows immediate purification of what is context dependent and what is not and contains hints for model construction. We can also find more links between different events. For example, moral hazard problem is known long ago, although it's applications to financial markets are rather recent (since 70-80s).

The same principle "core vicinity" can be applied to economic mechanisms.

Example 3. There is famous "arbitrage-free principle" – no free lunch for non risk-lovers. It's applications to different markets have very different names – interest rate parity, purchasing power parity, market segmentation, wage equalization for free mobility of labor across industries and so on. Actually this is the same idea applied to different markets.

Example 4. Bargaining power – can we impact other side decision. There at least three possible cases for implementation of the concept. Some titles of this effect in different economic branches are presented in Table 1, and the list of examples is not exhaustive.

	Title	Bargaining power
1	Small economy principle in international trade, individual demand	No bargaining power
2	Large economy principle in international trade, monopoly, monopsony	One side bargaining power
3	Repercussion effect in open macroeconomics, oligopoly and strategic behavior	Two side bargaining power

This example deserves a little bit more discussion. Neary (2003) made the investigation to meet oligopolistic theory and general equilibrium. The origin of the mismatch was that "oligopolistic firm in general equilibrium typically have reaction functions so badly-behaved that no equilibrium exist". His analysis is based on rethinking the concept of price-maker firm. There are two possible outcomes, if a firm is price-maker. It can affect national prices or it can affect only its segment prices. In the second case the firm is large in an industry, but small for a whole economy. This was the starting point for his work, which has enormous theoretical and empirical potential.

Example 5. Pass-through is the phenomenon of transmition of one market price into another, when we do no care about pricing mechanism at both markets. Pass-through effect can for cost transmission, interest rate, exchange rate.

To the top of author's knowledge, there is a single book, which describes economic concepts in the model-independent way. It is "Economic Philosophy" by J.Robinson. The approach to develop is close to one, proposed by Tall (2004). For mathematical educational purposes he introduces the term "procept". Very similar approach to work with data is implemented in object-oriented programming. It is an object entitled "class", which can encapsulate other object with different properties.

There are also obvious disadvantage of this approach, especially for economic education – it goes away from traditional separation the field into small areas, infested with independent models with low conceptual integration.

This view on economics differs from one of Lacatos, who concentrates on the structure of particular economic theory and then deduces positive and negative heuristics of the theory. Here theories are constructed from primitives described as "a core vs. vicinity" and general model independent principles. This allows easily usage a concept for description of another market. Another advantage is the mechanism to trace conflicts between concepts.

However the advantages of this way of thinking and teaching could be quite big.

The proposed construction of the theory allows clarifying understanding of economic concepts as well as purifying problems. The core allows determine what do economists mean[23], using a concept, vicinity allows to dissolve this sharp determinacy, connect the concept to others and to use them in reasoning. Thus we can trace how does inclusion of one concept unavoidably requires/rejects another. And we can expect much insight for economic theory by refining simple concepts.

Implications for economic education

Dominance of EC approach in economic education can be summarized by "MIT-teaching"[24] method or teaching, starting from examples. Before introducing a model an example is given. Examples serve to demonstrate how the model operates. But another, concurrent message appears - is that a single model, which is relevant for interpretation of this example. Take the simplest question: "Why do people get education?" Economics gives only one message – to send a signal to employee. However, there are other reasons – tradition, curiosity to learn new, following parents' or friends' advice, enjoying education, improving general intellectual level…Some of them can be non-rational in the long-run, but in short run they seem quite plossible. Choice of the reason to get education depends on variety of reasons. In terms of this paper this selection is

[23] "Many concepts have been defined on a article-by article basis in the literature, with no consistency and little attention to euphony or usefulness. Other concepts, such as "Asymmetric information" or "incomplete information", have been considered so basic as to no need definition, and hence have been used in contradictory ways" Rasmusen E. Games and Information, Blackwell Publishing, 2001, p.5.

[24] This term was borrowed from Rasmusen E. (2003)

encapsulated into EC2 stage. From many social reasons why a person goes to school, MIT-teaching leaves only one – get an educational label (stigma).

This way of teaching impoverishes human thinking and prevents inflow of different professional thinking, with different view on the world. However there is understanding of the problem. Some international organizations seeking employees all over the world discovered that model training (EC1 training) is approximately standardized in all countries[25]. So the most valuable become people with individuality of other reasoning components (EC2-EC5). International organizations do need diversity of professional opinions.

…

BB approach enriches our reasoning about the world as it explicitly requires coordination between different mechanisms and explicitly develops critical reasoning. However modern teaching economics is EC1-oriented. That reduces the perception of the world to a single skill – choose **a** correct model. This way of teaching is more akin to engineering, than social science. What is lost from engineering by such borrowed teaching is the scope of professional (and social) vision. Engineering education is heavily based on special courses like engineering construction or running engineering projects. They develop skills to see a subject as a domain of interactive ideas. Special courses teach to disaggregate and construct objects into subsets with different bases (engineering decomposition and engineering composition). Modern economic research, encapsulated into ceteris paribus principle, does not serve these goals.

There is another side of the question. Following Arnold[26] we can hypothesis that if a person prefers one way of reasoning, this can be a result of physiological difference in brain structure. "Rigid" models (in our terminology – EC1-reasoning) is based on extensive usage of a left brain semi-sphere, "flexible" model requires harmonized activity of both brain semi-spheres. In terms of the current investigation "flexible" model are those ways of reasoning, which can exploit all stages of the proposed scheme of economic analysis.

So this means that individual preference between two ways of reasoning can be motivated by individual physiology. Economists exploit their individual comparative advantage – one people feel more comfortable with "rigid" models, others - with flexible ones. The 20-th century for economics is characterized by the triumph of rigid modeling (EC1-approach). Although discoveries are made with flexible models, what is clear from citations of Feynman.

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[25] May be this could be called international labor force QWERTY-effect.

[26] Arnold V.I., "Zhestkie" I "mjagkie" matematicheski modeli, МЦНМО 2004, in Russia. "Rigid" and "flexible" mathematical models.

The 20-th century formalism exploited advances of accumulated non-formal analysis of all the previous times. Ideas, which were accumulated for centuries, were transformed into formal systems within a little bit more than 100 years. Economic ideas, which were not easily introduced into formal analysis, were abandoned for years. For example, in 90-s contracts were rediscovered for economic theory. Although, importance of contracts can be traced back even to Bible.[27]

Conclusion

This paper offers a structure of economic reasoning, both for closed and open logical systems. The outcome of this analysis is that we can have different view on conceptual integrity of economies. "Core-vicinity" principle can improve understanding of basic economic principles, and together with the proposed scheme of analysis, develop critical thinking. Preferences over ways of reasoning among economists may depend on individual mental activities, what has gradually shifted economic reasoning in favor of formal analysis.

[27] There are multiple cases where features of human behavior are formalized only in favor of mathematical correctness.

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