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## On Similarities in Modelling and Metaphorizing Economic Phenomena

**ABSTRACT.** The focus of the paper is on investigating the nature of economic models. Although they are often fictitious descriptions of the actual world, it is shown that models can grasp the workings of economic systems. They do this by illuminating (isolating) the crucial mechanisms responsible for economic phenomena. However, the model material is distinct from the one of the target and these mechanisms are often presented as regulating the interplay between fictitious entities (described by metaphors). Therefore, models consist of metaphors, since models' ingredients are spoken *as if* constituting elements of the target system. Yet, what forms a model is not an isolated metaphor as such, but rather a network of interconnected metaphors. Thus models cannot be compared without making references to metaphors, but also, as recent studies on metaphors prove, metaphors cannot be compared without referring to models, since what matters for understanding is the network of metaphors (i.e., the model). Models and metaphors are hence similar and interconnected since the processes of modelling and metaphorizing share similar logic.

**KEY WORDS:** model, metaphor, isolation, fictionalism, representation, philosophy of economics

### 1. Introduction

Economics is to a large extent a science based on models. Consequently, many philosophers of economics ask the question: what are models? Generally speaking, a given economic model is an entity in a specific relation to its target.<sup>1</sup> Its specificity is due to the fact that models produce

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<sup>1</sup> Target is understood here in the most general sense, i.e., as *something* that is beyond the model. No special ontological assumptions about it are necessary for the present purpose. Also, I start the paper by treating models just as vehicles for learning about the target [cf. Frigg, 2006, p. 744]. That enables me not to restrict my analyse from the outset to models

theoretical insights about the real world that can be later tested empirically.<sup>2</sup> These two objects are thus joined in an entanglement state – each member of the pair (the model and the modelled) can only be described relative to one another. As models have been endemic at every level of economic inquiry, the same is true with metaphors that have become indispensable elements of economic theories [Lagueux, 1999]. Take for instance the term ‘elasticity’ which is widespread in economics and takes its roots from mechanics where it is conceived as a property of materials to recover their initial shape after having been put under pressure. It was A. Marshall who in his *Principles* introduced such a metaphor to economics in order to describe the interplay between the price of a good and its demanded quantity. So, he transferred the term in question (here: ‘elasticity’) from its original place in our verbal communication scheme to some other unaccustomed one (here: economic theory). The meaning of the metaphor cannot be understood without taking into account the original sense of the term and its new usage, so – as in the case of the model and the modelled – these two are in an entanglement state. As Black put it: “Use of theoretical models resembles the use of metaphors in requiring analogical transfer of a vocabulary. Metaphor and model-making reveal a new relationship; both are attempts to pour new content into old bottles” [1962, pp. 238–239]. The joint resurgence of models and metaphors in economic theory is thus not a random coincidence but rather it is so because of similarities in modeling and metaphorizing economic phenomena.<sup>3</sup> In this sense, models resemble metaphors, and metaphors are similar to models. The goal of the paper is to show these similarities. Therefore, answering the opening ques-

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with specific ontologies. Therefore, no special ontological claims about the models’ status are proposed in the first place.

<sup>2</sup> To be more precise, I should add that we do not test the model as such *vis-à-vis* the real world, but just “an *application* of a model, a hypothesis stating that certain elements of a model are approximately accurate or good enough representations of what goes on in a given empirical situation” [Guala, 2005, p. 219].

<sup>3</sup> For an interesting study showing the change in reasoning practices in economics, i.e., from dealing with words, to theorizing with laws, and finally with models, see Morgan, 2012. The role of metaphors in the history of economic thought is nicely described in Mirowski, 1994a, and Lagueux, 1999, provides a compelling investigation into the interplay between metaphors and economic theory.

tion – what are models? – should be supplemented by inquiring into the nature of metaphors and their role in economics. For this reason, I will try to learn about the nature of models and that of metaphors by looking at them from the perspective provided by the other (Sections 3 and 4). This will be supplemented by analysing their relationship to the real world.<sup>4</sup> Before describing models as networks of metaphors, what is needed is a deeper understanding of the modelling practices used in economics, and precisely the cognitive and creative aspects of model building (Section 2). These insights are to be later used in Section 5 to describe similarities between models and metaphors. Conclusions follow.

## 2. Creativity, imagination, and fictions in modelling

Modelling a target system requires a researcher to choose the model's ingredients, including its form, structure, content, and proprieties. Although the target can serve as a focal point in crafting the model, we can have multiple models for one target – models of completely different character and operating in distinct conceptual spaces. For instance, the workings of the economy can be represented by a real machine, e.g., the Phillips-Newlyn hydraulic analogue of U.S. money flow, which can be depicted using diagrams [e.g., Morgan, 2012, p. 35], and the diagrams as such can be explained in verbal terms as a fable.<sup>5</sup> Therefore, the model

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<sup>4</sup> My research strategy is similar to that of U. Mäki from his [2005] paper which he starts by proclaiming that models are experiments, and experiments are models. Therefore, in my investigation into the nature of economic models I am to show also that models understood as experiments (isolations) can also be viewed *as* metaphors.

<sup>5</sup> Even just this one example shows us that some models (here: the Phillips-Newlyn machine, i.e., physical model) *are not* metaphors (linguistic entities); however, one may still find many similarities in crafting such models and metaphorizing the real world. The most obvious is the one of using the method of isolation (in metaphorizing and modelling we put emphasis only on a given aspect of the world and we isolate the rest) combined with the one of making the unfamiliar familiar. Also, and still, even such mechanical (physical) models meet the definition of models as vehicles for learning about the target. However, in what follows, I am to understand models first of all as theoretical ones. The same strategy was used by

builder acts as an artist, since they both use creativity and imagination in building these artificial worlds. As Frigg [2010, p. 251] puts it clear “models share important aspects in common with literary fiction” or in Cartwright’s words “a model is a work of fiction” [1983, p. 153] and an “intellectual construction” [1983, p. 144]. I would even claim that the model understood as a fiction enables its reader to build their own mental-model of the target. Consequently, the creativity and imagination is not only on the part of the model builder but also on the side of the model reader. The model is thus a catalyst which activates our senses.<sup>6</sup> However, for the purpose of this paper, I will focus primarily on model building rather than on model comprehending.

If models consist of fictions, resulting from the cognitive processes on the side of their builders (here: economists), then the interesting question is “what is fiction”, and consequently how can the research approach denoted as fictionalism be understood? A reader unaccustomed to a recent debate on fictionalism in the philosophy of modelling may immediately treat fictionalism as it is approached in metaphysics or the philosophy of language. In these domains of philosophical reflection, fictionalism is usually contrasted with realism. So, subscribing to fictionalism means choosing an antirealist position with a strong emphasis on the claim that fictional discourse is legitimate without any particular ontology. However, as Suarez [2010, p. 2] rightly reminds us, “we should therefore not assume at the outset that [...] fictionalism is merely a derivative of the fictionalism discussed in other areas of philosophy, such as metaphysics, the philosophy of language, mathematics, or aesthetics”, and further he claims that fictionalism is not a position in metaphysics, but rather a view present in the methodology of model building. He asserts that scientific fictionalism is an indispensable element of scientific inquiry, particularly model constructing. If you take the example of economics, you have plenty of models with fictional background assumptions that do not have any direct truth value,

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Mäki [2005] who claims that only theoretical models are to be viewed as experiments. I thank prof. U. Mäki for drawing my attention to this issue.

<sup>6</sup> The interplay between a model and human senses is interestingly analyzed in the so-called pretence theory by Walton [1990].

since their primary role is to make a model work and not necessarily make it isomorphic with its target.<sup>7</sup> They can serve as tractability assumptions, e.g., you often assume that agents have continuously distributed valuations as opposed to discrete ones not because you claim they are as such in reality, but only because you need continuous functions in order to make your model mathematically tractable [Alexandrova 2006, p. 183]. Or, as it is the case, for instance, in Varian's *Model of Sales* [1980], each firm randomly chooses a price according to a given density function not because enterprises do the same in the real circumstances, but because such a mechanism of price setting is indispensable in order for Varian to have his model coherent with the neoclassical setup and because it makes it mathematically manageable, and at the same time it generates a variation in prices. Moreover, Varian's choosing of a density function as a mechanism generating prices does not result from his will to be coherent with a given data set of prices. As he explains in one of his previous articles, "Economists apply models to situations in two quite different ways, which we shall call *econometrically* and *casually*" [Varian, Gibbard, 1978, p. 672]. For sure, his 1980 model is a causal model and hence has a rationale for using tractability assumptions combined with some derivation facilitators.<sup>8</sup> Thus the role of these assumption is not to replicate the data, but rather to account for the causal structure of a given mechanism responsible for price dispersion. Whether such a model generates viable descriptions of the real market is to be checked only in the second step, namely, in econometrically informed studies on the coherence between real data and the model's insights. What is, however, important here is to control for the distortions and biases these tractability assumptions are responsible for. Or, in other words, the so-called derivational robustness analysis can be used in such

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<sup>7</sup> That they do not have any direct truth values means that at the beginning of making a model a researcher aims primarily to use them in order to make a model tractable and only later while checking the fit between model's conclusions and its target is she able to assess to what extent these assumptions correctly describe the real world.

<sup>8</sup> In his 1978 paper Varian equates his causal models with models aiming at explaining by finding causes of phenomena and thus causal models.

cases [Kuorikoski, Lehtinen, 2009].<sup>9</sup> However, one reservation is in order here, namely, that “the fact that a model turns out not to work under certain circumstances does not count as a refutation of the model but only as a failed test of its applicability in a given domain” [Guala, 2005, p. 220]. Thus one thing is the truthlikeness of models and the second is their level of *essesimilitude*, precisely the extent to which models capture all the important factors playing a role in giving rise to the outcomes we are interested in. Now, speaking a bit elliptically, in the former case the truth value of models is to be assessed within the framework of the correspondence theory of truth (the issue of whether models’ insights are consistent with the data describing the real world), and in the latter case more with reference to truth in an isolationist sense (the issue of whether models correctly identify the crucial explaining factors). But still, even models with a high level of *essesimilitude* consist of many auxiliary and tractability assumptions, combined with derivational facilitators.

Having the above in mind means that making an economic model requires creativity and imagination on the side of the modeller. However, you may have assumptions with a truth value, and in particular true ones that are also of a fictional nature, because falsehood is not a defining property of fiction in science. This is so because fictions provide inferential shortcuts in models – we use fictions for the sake of inferential expediency and we do this in order to explain [Suarez 2010]. Let me cite one of the recent papers by Bokulich on this issue:

The model explains the explanandum by showing how there is a pattern of counterfactual dependence of the relevant features of the target system (viz. the explanandum) on the structures represented in the model. [2008, p. 226]

Here the reference is made to the model with fictions, e.g., the Schelling Segregation Model employs fictions (e.g., inhabitants of the chessboard) that describe mechanisms relevant to the target system, so although described in fictional terms the relations of dependency present in the

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<sup>9</sup> Such an analysis is just a practice of deriving the same result using different modelling assumptions.

model may have truth values.<sup>10</sup> This is particularly important in economics where researchers focus on showing the interplay between various elements of the economy. So, the interplay as such is important and it can be shown using fictional representations, e.g., the law of demand can be depicted as a pattern regulating the exchange between virtual persons operating in a virtual space [see, e.g., Epstein and Axtell 1996]. Therefore, we have a structural correspondence between the model with fictions and the target. As Black put it: “[a model] shares with its original not a set of features or an identical proportionality of magnitudes but, more abstractly, the same structure or pattern of relationships” [1962, p. 223].<sup>11</sup> More importantly, it is to say that in the kind of fictions described above the researcher (model builder) at least tries to show something about the real world (*attempt*) rather than using fictions just in order to entertain the audience (*no-attempt*). Showing something means to construct models that produce insights that can be later tested empirically.

Let me now briefly comment on the interplay between the fiction and the real. Or, in other words, how fictional entities can explain the real world? Or, even more radically, how the non-existing entity (present only in the model) can explain the working of the existing one (present beyond the model)? Following Levy [2012] let me first distinguish between *whole-cloth fiction* and *worldly fiction*. The former accounts for constructions of alternative worlds with hypothetical inhabitants; the latter relates to descriptions of actual entities, albeit with creativity and imagination. The first consists of imaginary objects and the second of imaginative descriptions of actual things. Both types of fictions are not true descriptions of the real world; however, the above distinction is important for the present purpose.

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<sup>10</sup> Being true in this context means that the model’s mechanism is similar to the one operating in the real world.

<sup>11</sup> By talking about a structural correspondence, I make a reference to the semirealism which nicely combines entity and structural realism, namely, it claims that science tells us about the structure of the mind-independent reality; however, this structure is ‘encoded’ in the natures of its forming entities [Chakravarty, 2007]. Also, the elements of the structure are interrelated, i.e., changing a given component modifies the other. Thus, in this context, models are devices that enable an indirect (here: fictional) representation of such structures [cf. Hausman, 2012].

While crafting *whole-cloth fiction* models the modeller does not care in the first instance about the relation of his model to the world. However, and what is confirmed by research practice in economics, quite often he is to compare his model to the world in the second instance. Take the developments in general equilibrium theory, for instance, where such researchers as Niehans, Kurz, and Hahn, started opening the black-box of Arrow-Debreu's framework in the late 60's. What they did was first the direct comparison of the model world of exchange to the actual mechanisms of the market economy. Second, they put some proprieties of the real markets inside the model, e.g., the incorporation of transaction costs, which led them to the unexpected conclusion that the functioning of the market is costly, and hence that institutions matter [e.g., Kurz, 1974, p. 20].<sup>12</sup> So, first the Arrow-Debreu model was an entity in its own right, and only then, after having been compared to the actual economy, it gave some knowledge about the actual world. Therefore, even *whole-cloth fiction* can be knowledge creating and in accord with realism. However, the necessary condition for this is to attempt comparisons between the model and the target. In case of *whole-cloth fiction* and *no-attempt*, the knowledge creating capacities of the model are at least limited. I will return to this issue later on.

The situation differs in the case of *worldly fiction*. Here the defining feature of models with such fictions is that they are always in relation to the actual world. However, the existing relation to the outside model world does not mean that the model can be compared to the real as it was the case with *whole-cloth fiction*. Levy [2012, p. 743] explains this as follows: "because there is no invocation of fictional entities, the worldly fictionalist cannot avail herself of a notion of comparative knowledge, the key to the first package. There are no entities with which to compare target phenomena". So, although what such models say about the world is literally untrue, they can capture some true beliefs about the target system. As Mäki [2009] reminds us, we can have realistic models with unrealistic assump-

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<sup>12</sup> Modifications in GET developed by Kurz, Hahn, Niehans, and even Arrow, can hardly be treated as de-isolations, since various proprieties (assumptions) of the Arrow-Debreu model have the status of tractability assumptions [cf. Morgan, Knuutila, 2012].



tions, say here fictions. In the current context, having in mind that realism is the doctrine about knowledge, we may have knowledge creating entities (here: models), serving in producing credible beliefs about the world, being at the same time not totally true.<sup>13</sup> Or, in other words, small distortions from the truth in models are acceptable if they lead to true beliefs about the world.<sup>14</sup> How is this possible? How can one gain the truth using falsehoods? Here we come to our central idea. Fictions must somehow give knowledge about something different and from another conceptual domain. Such fictions are metaphors. They apply to something a name belonging to something else.<sup>15</sup> So, if models consist of fictions and fictions can be conceptualized as metaphors, then models are entities of a metaphorical character. However, one may now ask whether models as a whole are metaphors or whether they are just constructed from metaphors and thus they are networks of metaphors [cf. Zeidler, 2013, p. 105]? I am to focus on this question in the next section. However, two issues need to be addressed before moving further. First, what about *whole-cloth fictions*, are they also of a metaphorical character? Second, and again, what about *whole-cloth fictions* if no attempt to compare such models to the actual is undertaken? Responding briefly to the first question, it is quite clear that every part of every narration can use metaphors, even if the transposition of meaning is from something imaginary and not actual to something with the same status, e.g., if one says: *The hobbits are Middle-earth's hope*. However, and now answering the second question, if no attempt to refer to the actual is made, then such models, using *whole-cloth fictions*, are useless in scientific practice, including economics.<sup>16</sup> On the other hand, *whole-cloth fictions*

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<sup>13</sup> I refer here primarily to the epistemological realism; however, in the entire paper where references to realism are present I point also to ontological realism, at least in its minimal form, here usually as an assertion that outside the model world exists independently of both models and modellers.

<sup>14</sup> This claim has a Deweyan flavour since for Dewey the research process is finished with the creation of beliefs [Zeidler, 2013, p. 122].

<sup>15</sup> Here I make use of the classical definition of metaphor by Aristotle: "A metaphor is the application (to something) a name belonging to something else".

<sup>16</sup> They can be indirectly useful if aimed at developing computational skills, augmenting one's ability to deal with complex problems, and so on; however, focusing on such indirect

models attempting to explain the world outside the model can have fictions as metaphorical as in the case of *worldly fictions*.

### 3. Metaphors as models

In the classical sense, a metaphor accounts for talking about one thing in terms of language and attributes taken from another. Although the metaphor is a form of likening, comparing, or analogizing, it is not a simile. Aristotle's example, "Achilles is a lion", shows that the attributes of Achilles are associated with the ones of the lion. According to M. Black [1962], a metaphor is an interactive process involving the primary subject (here: Achilles) and the secondary one (here: a lion). Therefore, the deployment of language takes place *as if* these subjects were the same. So, the primary subject is spoken of *as* the secondary subject [Hills, 2011, p. 3]. Economics consists of plenty of such metaphors, including the one of 'elasticity', mentioned in the introduction, as well as 'equilibrium', 'liquidity', and so on. These were taken, for instance, from nineteenth-century physics, but nowadays the metaphors used in economics are borrowed from various conceptual domains. The metaphorical content of economics is so important because "(metaphor) extends what we can say [...] with the vocabulary we have" [Loewenberg, 1973, p. 44, cited in: Henderson, 1998, p. 291]. So, metaphors give us a new way of describing phenomena we are interested in.

In the twentieth-century philosophical reflection on metaphors, however, many important insights about their nature and role in scientific inquiry have emerged. Let me start with P. Ricœur. In his well-known *Metaphor and Reference* [1981], where he recalls Frege's distinction between sense and reference. So, we may have a given metaphor (in Frege's terms a given sign) used in various places of our vocabulary, but each time with a different sense, yet with the same reference. For instance, if one says

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usefulness of *whole-cloth fictions* with *no-attempt* is beyond the scope of this paper and is not important for the line of reasoning we are presenting here.

‘time is money’, ‘time is the alternative cost’, or ‘time is vanity’, then in these three cases we have the same reference (time), but each time a different sense.<sup>17</sup> Moreover, according to Ricœur, metaphors reflect the world and do not create it (that is why he refers to Frege’s ‘reference’). However, in mapping the world, there is always a tension between the metaphor and the actual. If not, then economics would reduce to physics, for instance. This tension is essential to metaphors, since *is* in every metaphor signifies on the one hand ‘is not’ and on the other ‘is like’. The problem we have with metaphors, including the ones in economics, is that many treat them as totally decoupled from the actual. They claim that metaphors serve in constructing the world rather than describing it. Take, for instance, the idea of ‘ornamental metaphors’ by McCloskey [1983, p. 503] where *no-attempt* to refer to the actual is made. She even claims that metaphors in economics constitute a poetics of economics [1983, p. 504] and some serve as heuristic devices [1983, p. 507]. However, and interestingly, even McCloskey, at least to my best knowledge, does not definitively decide whether all metaphors in economics are ornamental. It makes me think in terms introduced in the previous section, so ornamental metaphors recall for me *whole-cloth fictions*, and the ones without ornaments *worldly fictions*. And also, as in the case of *whole-cloth fictions* compared at the second instance to the actual, ornamental metaphors may lose their ornaments while being confronted with the economic world. I find no better way to explain the source of tensions between these two kinds of metaphors than by referring to an interesting passage by Ricœur, i.e., “rhetoric is philosophy’s oldest enemy and its oldest ally. ‘Its oldest enemy’ because it is always possible for the art of ‘saying it well’ to lay aside all concern for ‘speaking the truth’” [1981, p. 10]. The literature on rhetoric is enormous, including reflection on the rhetoric of economics, and further in-depth comments on this issue are unnecessary for the purpose of this paper.

Despite illuminating the nature of metaphors above, it is still hardly to claim that metaphors are very similar to models. For sure, for instance, ‘elasticity of demand’ or ‘prices are sticky’, although they are metaphors,

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<sup>17</sup> The sign is also the same, i.e., the word ‘time’.

are not models. In order to have an economic model, we need an entity with the structure and proprieties prepared using a given material or conceptual space. Also, such a model must have a capacity to produce insights about the real world that are empirically testable. Therefore, a given metaphor alone is not a model.<sup>18</sup> What we need is a set of connected metaphors organized in the same conceptual space. The metaphorical network (Ricoeur) fulfils this requirement. However, note that this term does not equal ‘sentence metaphor’ or ‘extended metaphor’ (for the purpose of the paper I treat the two as synonyms) [see., e.g., Hills, 2011]. Sentence metaphor can be just an extended phrase, e.g., ‘prices are sticky, rigid, and inelastic, and thus difficult to put under the pressure of monetary policy’, or even a combination of sentences. Interestingly, modern theory of metaphor focuses not on metaphor alone but on a metaphorical sentence as the fundamental unit of action [Hills, 2011, p. 5]. The defining feature of the metaphorical network is the interconnectedness of metaphors forming the network. This means that “metaphors often involve seeing in a new way not only two particular things but the domains to which they belong as well. Metaphors can thus involve whole systems of concepts” [Tourangeau, Sternberg, 1982, p. 214]. Or, as Gärdenfors [1996, p. 40] puts it: “a metaphor does not come alone – it is not only a comparison between two single concepts, but involves an identification of the structure of two quality dimensions”. So, once one uses a given metaphor the whole set of interconnected metaphors is activated in her cognitive system. This is so also because metaphors’ role in such systems can be conceptualized in terms of semantic networks [Lakoff, Johnson 1980, p. 202]. Coming back to our introductory example of the Phillips-Newlyn hydraulic analogue of

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<sup>18</sup> The fact that a model cannot be reduced to one particular metaphor does not mean that we cannot find a given domain from which all metaphors constituting a model are derived. For example, many metaphors in neoclassical economics are due to the acceptance of the so-called mechanistic world hypothesis under which the economy is a machine and thus can be described in mechanistic terms with ‘price mechanisms’, ‘elasticities’, ‘price sickness’, ‘equilibrium’, and so on. Such a fundamental metaphor (here: the economy is a machine), or the world hypothesis to use Pepper’s taxonomy, is called by Klamer and Leonard [1994, p. 41–42] a constitutive metaphor (cf. ‘root metaphor’ in: Pepper, 1942). I will come back to these issues in section 5.

U.S. money flow, we find plenty of interconnected metaphors in its description, e.g., ‘water reservoir is the stock of money’, ‘water is money’, ‘water flow is the process responsible for price changes’, and so on. They are connected since changes in ‘water flow’ influence, for instance, the content of the ‘water reservoir’. So, the single metaphor of the form ‘water is money’ links two quality dimensions, namely, the realms of water and money, and makes the formation of the whole network of metaphors possible.<sup>19</sup> We see thus that a fictional description of the actual (here: the money market in the U.S.), consisting of many different and interconnected metaphors, forms the base for the model. As Black puts it: “Every metaphor is the tip of a submerged model” [1979, p. 31], and a submerged model consists of interconnected metaphors.<sup>20</sup> Also, networks of metaphors (models) are not metaphors themselves.<sup>21</sup> Therefore, the metaphorical network is a model, but is it also a story or fable? I refer to this issue below.

Since the metaphorical network (model) consists of both metaphors and structure, it – as a concept – can shed some light on Morgan’s problem that “an economic model cannot be accurately characterized as either a metaphor or a structure” [2001, p. 365]. What she claims also is that models need stories; however, she distinguishes between two kind of stories. First, the story as an external dynamics put into a given model, i.e., a set of questions asked by the model reader, e.g., what happens if the income of an agent changes?, or, what happens to the demand, if the price is lowered by 10%?, etc. Only after being asked do the questions ignite the internal dynamics of the model. Second, following McCloskey [1990], stories may be treated as an alternative to modelling in answering ‘why’ questions. For instance, instead of modelling consumer’s behaviour in

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<sup>19</sup> The term *quality dimension* is used here as it is conceptualized in Gärdenfors [1996].

<sup>20</sup> This follows also from the cognitive theory of metaphor by Lakoff and Johnson [1980] who insist that “Describing metaphors as isolated cases, using the A IS B formula, misses the fact that no metaphor can be comprehended, or even adequately represented, independently of its experiential basis, [including other metaphors]” [2004].

<sup>21</sup> Such a view point is shared by the majority of authors; however, there is an interesting debate on how these networks of metaphors should be conceptualized (e.g., controversies between supporters of the so-called sentential paradigm by P. Churchland and the approach of conceptual spaces by P. Gärdenfors).

terms of a rationally deciding agent with income constraint, one may tell stories of how agents characterized by irrational behaviour are not to survive on the market. In the latter case, however, we do not have a structure *inside* the story, but rather a set of metaphors connected in a rather ad hoc manner by the story reader. Therefore, we do not have a model here. The former case is more interesting, since it gives rise to the following question: how stories fit within our framework with fictions as metaphors and networks of metaphors as models? As I mentioned in the previous section, models with fictions can produce true beliefs about the world. Also, the models are usually written down or told to an audience, albeit in such a form that can be understood by readers/listeners. Therefore, although the audience as such may be silent (contrary to Morgan's accounts), the modeller acts *as if* it is the model reader who ask the questions. In this sense, the metaphorical network may be treated as a fable as long as modellers are in a dialogue with the model reader. However, as I have just mentioned, the modeller usually acts also as a model reader, precisely *as if* being a part of the audience. So, such fables have epistemological purposes, just as Lessing cited by Cartwright reminds us:

In order to give to a general symbolic conclusion all the clarity of which it is capable, that is, in order to elucidate it as much as possible, we must reduce it to the particular in order to know it intuitively. [1999, p. 38]

And further Cartwright adds:

This is the job of the fable. The general moral is a purely symbolic claim; the fable gives it a specific content so that we can establish with clarity the relation that is supposed to hold between the ideas. [1999, p. 38]

But this is also the job of the model, since its moral is the belief about the world it produces. Moreover, the relation between the fable (here: metaphorical network, i.e., model) and its moral (here: the belief about the world) is not one of simple similarity, but rather an interplay between the general and the specific. Also, the moral is not hidden inside the fable, but rather it is fitted out by the story. Moreover, the fitting out of the moral is

only accomplished by letting the model work and that is done by the putting of dynamics into the model by its builders acting simultaneously as its readers and also critics. Their manipulations of a given model form a story the model is telling us, which confirms M. Morgan's theses that "The stories are neither 'merely heuristic' nor 'just rhetoric' but an essential part of the way models are labelled and used" [2001, p. 361].<sup>22</sup>

After having defined networks of metaphors as models and by making conceptual links between fables, metaphors, and models, what we did in fact was take a look at the models from the perspective provided by the metaphors. Now, it should be reversed, and we are to look at the metaphors from the models' perspective. That we do in the next section.

#### 4. Models *as* metaphors

While introducing the issue of modelling in science, many claim that models perform two distinct functions [e.g., Frigg, Hartmann, 2012]. First, we may have models of selected parts of the world. Second, we can have models of theories, in the sense that such models interpret the laws and axioms of theories.<sup>23</sup> What these two kinds of models share is that they are both imperfect representations of their targets. The defining feature of the former kind of models is that they isolate some important aspects of the target and omit others. On the other hand, models of theories usually contain a lot of auxiliary assumptions and excess content that do not form a part of a theory [Morrison, 2007, p. 203]. Models are thus used in scien-

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<sup>22</sup> A separate question is to what extent Morgan's conceptualization of models involving stories is consistent with the view on modelling as robustness analysis. Although an in-depth analysis of this issue is definitely beyond the scope of this paper, one can notice some similarities between these two practices, e.g., changing models' auxiliary assumptions while performing robustness analysis recalls the method of asking models the questions in Morgan's story telling.

<sup>23</sup> Here, formally, a model is a structure that makes all sentences of a theory true. As Frigg and Hartmann [2012] put it "any structure of which all statements of a given theory are true is a model of this theory". So, in this approach what is first is the theory and only then one constructs its model.

tific practice in different ways than the one postulated by the semantic view, e.g., that of Niiniluoto [2012, p. 71] who observes that models can approximate the real system without being identical with it at any specific point.<sup>24</sup> Also, if a given model is not a perfectly correct description of the actual world, then it cannot fully function as a representation of the theory that is supposed to correctly depict the target. So, as Morgan [2012] claims, what is needed is an investigation into the way models are constructed by practicing scientists. In this paper the focus is on models of selected aspects of the actual world.

Models in economics are often conceptualized as thought experiments [Mäki, 2005, p. 309]. They are isolated artificial worlds constructed by considering some factors absent (*ceteris absentibus*), negligible (*ceteris neglicts*), or simply unchanged (*ceteris paribus*) [Boumans, 2005]. Also, they incorporate deliberate distortions, e.g., the assumption that agents are perfectly rational. So, they are not only pure isolations, but isolations with extra content [Frigg, Hartman, 2006, p. 742]. Although the literature on idealizations in economics is rich [e.g., Mäki, 1992; 1994; 2005; 2009; Hamminga, de Marchi, 1994; Knuuttila, 2009], let me just focus on one aspect of models treated as idealizations, i.e., the one described by Mäki as follows: “an isolating theory or statement (model) is true if it correctly represents the isolated essence of the object” [1992, p. 344]. But, what is essence? Is it ‘a greater cause’ (Mill), ‘a fundamental assumption’ (Machlup), or ‘a generative assumption’ (Melitz)? Or, maybe, it is “the nature of the commodity, the nature of economy, the nature of value, of price and similar things” [Menger, 1963, cited in: Mäki, 1990, p. 320]? Writing about essence brings our attention to essentialism; however, that doctrine is nowadays untenable – “There can be no explanation which is not in need of a further explanation” [Popper, 1972, p. 195]. So, the essence captured in isolation is not an ultimate explanation (or the final cause) that does not need any further clarification, but simply the most important cause or factor that is responsible for a given phenomenon. So,

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<sup>24</sup> He follows here those supporters of the semantic view who drop the formal requirements for isomorphism between a model and its target in favour of the similarity between the two [e.g., Giere, 2004].



what matters here is an explanatory depth, and the deeper a given explanation is, the greater the generalizations it offers [Hitchcock, Woodward, 2003, p. 181].

Another important aspect of making models by using isolations is that the whole process is very sensitive to the researchers' needs – one researcher interested in a given aspect of a phenomenon will search for different causes than another one focusing on another feature of an explained object. For instance, explaining the growth of Southeast Asian economies in the latter decades of the 20<sup>th</sup> century may concentrate on the strength of local entrepreneurs with high export potential or on the other hand on the role the governments played in sustaining macroeconomic and political stability [cf. Page, 1994]. So, we have one phenomenon and two distinct areas for searching for explanations, each with a different explanatory depth. Deciding which is better is thus also subjective and depends on researchers' goals [cf. Ylikoski, Kuorikoski, 2010].

Let me now come back to the issue of metaphors. How can models understood as isolations with some deliberate distortions, serving subjective researchers' needs, be described as similar to metaphors? First, as in the case of isolating a given set of explaining items while building a model the goal is to isolate the most important ones, the same is with metaphors, since the choice of the metaphor is such as to capture the crucial characteristic of the primary subject (Achilles) by equalizing it to the secondary one (lion). As in the case of isolation, the choice of a given metaphor depends on the researcher's needs. For instance, in the Southeast Asian example, one can say 'South Korea is a tiger', if one wants to underline the dynamism, courage, and risk-loving culture of Korean entrepreneurs, or one can just proclaim that 'South Korea is a hidden dragon', if the goal is to focus on the role of a consciously built state interventionist economic policy. As in the case of isolation, where we do not have a complete isomorphism between the target and the model, the same is with metaphors, since, for instance, saying that 'South Korea is a tiger' means that it *is like* and *is not* a tiger. So, models, in this respect, have some similarities with metaphors.

Before going further in my analysis, let me comment on the possibility that modelling is closer to metonyming than to metaphorizing.<sup>25</sup> In metonyming one is calling a thing not by its own name but rather by something associated in meaning, e.g., “Hollywood” is a metonym for “the U.S. film industry”. An important difference between metaphor and metonym is that the former is connected with that for which it is substituted on the basis of similarity, whilst the latter is based on contiguity or closeness. For instance, “Seoul” might be a metonymy for “South Korea”. Contrary to metaphors, metonyms do not require transposition from one domain to another. Since the model’s material is distinct from the one of the target, then modelling shares some important characteristics with metaphorizing, where primary and secondary subjects are located in different domains (“South Korea is a tiger”). This is not the case of metonyming [Lakoff, Johnson, 1980, p. 39]. Thus one can claim that elements of a given model metaphorize particulars of the target but are not metonyming them. A concrete example will follow.

Is the above mentioned similarity between models and metaphors the only one? Definitely not, as in the case of models where achieving high explanatory depth is a virtue, also in the case of metaphors we can try to find the so-called deeper metaphors [cf. Henderson, 1994, p. 360]. The following passage from Edgeworth [1881, p. 89, cited in: Mirowski, 1994b, p. 23] can serve as an example:

The comparison between pleasure and energy may be viewed under two aspects; first (than which not more is asserted here), as not known to be more than a metaphor, yet elegant and convenient, like the hypothesis of fluids in electricity, or the “now abandoned but still interesting” [Thomson, Tait] corpuscular theory of light; secondly, as in the text [pp. 9–15] a deep and real analogy, the *maximum* of pleasure in psychics being the effect or a concomitant of a *maximum* physical energy (emphasis added).

In this second aspect what we are facing is in fact a metaphorical network, since starting by *observing* that psychical energy *is* physical energy (simple metaphor), Edgeworth constructed the whole network of meta-

<sup>25</sup> I thank an anonymous referee for drawing my attention to this issue.

phors based on the insights from physics – “The invisible energy of electricity is grasped by the marvelous methods of Lagrange; the invisible energy of pleasure may admit of a similar handling” [ibid., p. 13].<sup>26</sup> As in the case of a simple metaphor, also in the Edgeworthian model of exchange (network metaphor) we do not have a perfect similarity between the primary subject (here: the Edgeworthian model) and the secondary one (here: the way of reasoning in physics). Edgeworth was conscious of this: “The measurement of the Useful in general (including the Beautiful) [...] differs more from (physics) in this respect – that in the moral measurement there never is an objective real value” [Edgeworth, 1884, p. 141, cited in: Mirowski, 1994, p. 36]. However, the borrowing of concepts from physics and forming on that basis the model of economic exchange revealed a new conceptual space for doing economic research. The history of economics proved that it played an important role in the rise of neoclassical economics [cf. Creedy, 1986]. What is also important is that Edgeworth not only borrows concepts from physics, but he even makes reference to the Fairy Queen as a charioteer [Morgan, 2012, pp. 106–135]. So, he mixed various metaphors, which proves his great imagination and creativity. Also, his comparisons between, for instance, energy and pleasure are not metonyms, since the two are from different domains and he uses them to claim that energy is to some extent similar to pleasure (metaphor based on the resemblance between the two) but is not identical with it (metonymy based on the relation of adjacency between the two).<sup>27</sup>

As explained above, modelling and metaphorizing share some important similarities. They are both constructed by isolating some crucial aspects of the actual and the choosing is subjective to the researcher’s needs. Also, the choosing of the model’s material is similar to choosing the meta-

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<sup>26</sup> As Lakoff and Johnson explain “In the metaphor A IS B, some of the dimensions of structure for B are imposed upon the gestalt for A, forming a complex gestalt” [1980, p. 203]. Or, as Tourangeau and Sternberg [1982] put it: the two domains that a metaphor relates (here: physics and economics) “include the same skeleton of semantic relations” [420]. In our case linking metaphorically psychical to physical energy started the inflow of various concepts from physics into economics.

<sup>27</sup> A nice discussion on metonyms and metaphors with plenty of examples can be found in Chandler [2007].

phor's secondary subject (e.g., tiger or lion in the above-mentioned South-east Asian example). They both require creativity and imagination on the side of the modeller and the creator of metaphors. Therefore, we have now many arguments for claiming that the logic of modelling and metaphorizing is very similar; however, in order to have the full picture of similarities between the two, what is needed is a reflection on the ways models and metaphors are compared or tested. The next section discusses this issue.

## **5. On similarities in understanding the world through models and metaphors**

Metaphors and models are constructed in order to better understand the actual world. Or, in other words, as D. Bailer-Jones nicely put it: "Models and metaphors exploit the strategy of understanding something in terms of something else that is better understood and more familiar; they exploit the analogy relationship suggested by a metaphor or explored in a model" [2002, p. 118]. So, the quality of understanding they offer should be taken as a measure of their goodness. It is important to note that understanding means having true beliefs about the world, or, more precisely, believing truths and not believing falsehoods. So, understanding is defined in terms of belief and not in terms of universal knowledge. Let me explain. Invocations to knowledge are much absent from contemporary epistemology [David, 2001, p. 152]. What contemporary epistemologists value most is connecting justification to the non-epistemic concept of truth. As Alston famously states it:

Epistemic evaluation [justification] is undertaken from we might call 'the epistemic point of view'. That point of view is defined by the aim at maximizing truth and minimizing falsity in a large body of belief [...]. For a belief to be justified is for it, somehow, to be awarded high marks relative to that aim (emphasis added). [Alston, 1985, pp. 83–84]

The aim is usually defined in terms of searching for truth; however, with an emphasis on searching, since arriving at universal knowledge that

is free from doubts is hardly possible [cf. Lehrer, 1990, pp. 20–38]. While searching for the truth, we successively produce some often vague descriptions of the reality giving us insights into the way the world works (maximizing truth) and does not work (minimizing falsity). So, while analysing scientists' practices, including the ones in economics, it is clear that what is important is not to focus on knowledge as such, but rather on the ways the researchers do science [Cartwright 1999]. This is why contemporary philosophy of science, including epistemology, finds analysing the truth-goal (the virtue of maximizing truth and minimizing falsity) so fruitful in extracting the essence of what scientists do.

Modelling and metaphorizing fit well with the above described goal of maximizing truth and minimalizing falsity, since they are both truth-aimed practices, focusing on the crucial elements of the actual world from the researcher's standpoint, producing at the same time entities (models and metaphors respectively) with some falsehoods (no perfect isomorphism between models/metaphors and the target combined with some explaining items falsely taken as important ones).<sup>28</sup> However, in the case of models the rule of maximizing truth and minimizing falsity should be primarily understood as achieving the greater explanatory depth, i.e., identifying the essence [see, section 4 above], and at the same time minimizing the risk of falsely treating some casual factors as crucial ones. Therefore, the focus on minimizing falsification should not be understood as minimizing the number of unrealistic assumptions, but rather as a rule of not isolating the important elements of explanans. The same holds for metaphors, i.e., the primary subject should not be spoken of *as* the falsely taken secondary one. So, both in the case of models and metaphors the truth-goal is a pragmatic one – we have to believe truths that are important for us.<sup>29</sup> Therefore, the tension between the model/metaphor and the actual world is not only the

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<sup>28</sup> Such an approach can also be seen as a departure from the deductive-nomological model of scientific explanation. As M. Hesse put it: “[...] deductive model of scientific explanation should be modified and supplemented by a view of theoretical explanation as a metaphorical redescription of the domain of explanandum” [1966, p. 157].

<sup>29</sup> Foley nicely describes it in his book entitled (nomen omen) *Working without a Net: A Study of Egocentric Epistemology* [1993].

very essence of the two, as it was described in the previous sections, but also a fundamental feature of a highly justified belief (here: model/metaphor). So, insights about the world produced by both models and metaphors are subparts of the belief category, and hence are very similar in terms of the role they play in our epistemic fabric.

Let me now concentrate on some particularities of models and metaphors in forming true beliefs about the world. I will start with metaphors. Here the question is the following: why are models understood as networks of metaphors so effective in providing researchers with an understanding of the workings of the economy? Or, in other words, why does understanding of the aspects of the actual world often equal metaphorizing it? Recent works in experimental psychology greatly illuminate this issue. First, it is now clear that metaphors are crucial for the way people make sense and categorize their experience [Gibbs, 1992, p. 572]. This is so because long-term memory is to a great extent metaphorically structured [see., e.g., Lakoff and Johnson 1980 for a well-known early treatment of this issue], and hence people think *metaphorically* due to some fundamental characteristics of their cognitive systems.<sup>30</sup> So, metaphor is not only a linguistic but rather a conceptual phenomenon.<sup>31</sup> If so, then understanding the world through metaphors is deeply embedded in the way we make sense of reality. Once we subscribe to it, we have an appealing justification, resulting from cognitive linguistic, for claiming that metaphorization is more closely related to thinking than to language only [Zeidler, 2013, p. 111]. However, the intuition that networks of metaphors provide a better understanding of the universal characteristics of the actual world than historical accounts is even present in Aristotle's *Poetics*: "Poetry, therefore, is a more philosophical and a higher thing than history: for poetry tends to express the universal, history the particular" [book IX]. So, metaphors are formed by agents in

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<sup>30</sup> However, there are thinkers who claim that metaphorical mode of thinking is not an universal property of human mind, but rather a phenomenon due to cultural evolution of mankind [e.g., Oesterdiekhoff 2011]. But still, the crucial role of metaphorical thinking is not denied. I thank an anonymous referee for drawing my attention to this issue.

<sup>31</sup> This claim forms the core of the conceptual theory of metaphor [see, e.g., Grady et al., 1999].

confrontation with the real world and are used in making sense of it. This is the core claim of the cognitive view of metaphors.

But in order to make our picture complete, we need to incorporate models in our framework, i.e., how do models refer to metaphors in the process by which people comprehend the actual world? We touch upon here also another important issue – how can one compare distinct models serving the same goal? Note that models are networks of metaphors. So, the less falsehoods metaphors constituting a given model have, the better for the model. For instance, the metaphor for describing the money stock in the Phillips-Newlyn hydraulic analogue of U.S. money flow should illuminate the crucial features of the complexity of the real stock of money in the economy, i.e., its secondary subject must be properly chosen. The same goes for every metaphor in the network (model). However, since these metaphors are interconnected, they must belong to the same conceptual sphere (e.g., mechanistic, or organismic, etc.). Let me explain. If we have the metaphor of a ‘water reservoir’ for the money stock in the U.S. and we agree that it satisfies the rule of minimizing falsity, then in testing the whole model of the U.S. money market we should check how well it corresponds with other metaphors in the model (network). So, the model as a whole should contain only metaphors from one conceptual domain – if the metaphors forming the model of U.S. money flow turn out hypothetically to be rooted in the ‘chemical’ conceptual domain, then even though the mechanical metaphor of a ‘water reservoir’ nicely illuminates the characteristics of the money stock alone, it is incompatible with other metaphors, so it must be substituted with a metaphor from the ‘chemical’ domain. Therefore, metaphors forming the model cannot be compared without taking into account the goodness of the whole network. Weinrich in his somehow forgotten contribution to the theory of metaphor states the following in this respect:

Metaphors, especially if they appear in consistent image fields, must be estimated as (hypothetical) *cognitive models* (emphasis added). [Weinrich, 1964, p. 294, cited in: Jäkel, 1999, p. 19]

Therefore, a given model should be tested not only in terms of the individual metaphors it employs but also in terms of the goodness of the

whole cognitive model (the network of metaphors). So, and importantly, models cannot be compared without making references to metaphors, but also metaphors cannot be compared without referring to models, since what matters for understanding is the network of metaphors (i.e., the model). Also, if a given mode is to isolate the essence of the target (e.g., by metaphorizing well its elements), then it should produce credible insights about its empirical domain [cf. Guala, 2005].

## 6. Conclusions

Modelling and metaphorizing form a joint process of enabling a researcher to grasp the essence of the way the world works. These two cannot be separated – modelling boils down to crafting structured networks of metaphors, and metaphorizing means firstly preparing individual metaphors and secondly putting these metaphors in the context of other metaphors and thus building the whole network of metaphors (model). How does this fit with my suggestion that models are similar to metaphors? As it was shown throughout the paper, they both share some important characteristics of representations that are aimed at isolating the most important factors giving rise to various economic processes. However, one cannot equate metaphors to models and say they denote the same thing. For instance, iconic models, e.g., wooden cars or plastic planes' wings, are not metaphors. Nevertheless, many material analogical models, e.g., the hydraulic model of an economic system, although they are not metaphors as such, enable building metaphorical networks (models) by firstly forming analogues. Also, individual metaphors are not models, since a defining feature of the model is its constituting structure. Such metaphors as 'money liquidity', 'money flow', or 'elasticity of demand' alone are not models; however, once put in the context of other metaphors (e.g., 'money liquidity' *plus* 'money flow'), they become networks of metaphors, i.e., models. However, as Weinrich [1964] reminds us, such a network is not an additive sum of its ingredients (individual metaphors), but rather something genuinely new offering a novel quality in understanding. However, the issue of



the emergent nature of such metaphorical networks must be further investigated. Having in mind recent advances in cognitive linguistics, it is quite probable that even if not accompanied by other metaphors from the outside of one's cognitive apparatus, a given agent often puts metaphors in the context of the ones already present in one's epistemic fabric. The interesting question is thus whether we may have purely individual metaphors at all? To conclude, I would like to stress that in economics, models resemble networks of metaphors, since the processes responsible for forming them share the similar logic.

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