

Models: Parables v Fables

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The problem of unrealistic assumptions, Mach 1: valid arguments but false premises

The models I shall discuss here, found typically in physics and economics, offer descriptions of imaginary situations or systems using a combination of mathematics and natural language. The descriptions are thin: Not much about the situation is filled in. They are often unrealistic as well in that what is filled in is not true of many real situations. Yet in many cases we want to use the results of these models to inform our conclusions about a range of actually occurring (so-called **target**) situations.

I am also going to restrict my attention to models in which results are derived by deduction. The whole point of these formal models is rigour, which is why they are preferred by physicists and economists alike over more informal reasonings that merely make results plausible. Deduction is a key ingredient in this rigour. We are assured that the consequences drawn from the models are genuine because they follow deductively from the starting descriptions; these consequences must occur whenever these descriptions are satisfied.

The 'unrealistic' assumptions that are offered in a model's descriptions are no problem so long as they play no role in deducing the intended results of the model. But this is seldom the case. In fact quite the contrary. They are often necessary to the deductions offered in the model.² This gives rise to the canonical **problem of unrealistic assumptions**: How can a result that must occur given characteristics different from those in the target inform conclusions about what will happen in the target? The conclusion is supposed to be guaranteed because it follows deductively from the premises. How does that provide information about what conclusions to expect when the premises are different?

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² The requisite deduction will sometimes not be literally on offer in the model but rather presumed.

The plan

In tackling the problem of unrealistic assumptions this paper will weave together three different strands of enquiry:

- previous work of mine on Galilean thought experiments
- previous work of mine on models as fables
- Menno Rol's insight that abstraction can turn falsehoods into truths.

It will also wind through an increasingly narrow spiral

- from **problem, Mach 1**: the first broad *problem of unrealistic assumptions* just described
- to **solution, Mach 1** that should work for certain specific kinds of models – those that can count as *Galilean thought experiments*
- to a twist at which the problem re-emerges in narrower form, as **problem, Mach 2**: the problem of *overconstraint*
- another twist provided by Menno Rol offers **solution, Mach 3** to this new version of the problem for an even more restricted set of models – by *abstraction* of the kind seen in the moral of a fable
- finally ending in a third version, **problem, Mach 3** of the problem of unrealistic assumptions, which arises because models are far more like *parables* than fables.

This final version of the problem of unrealistic assumptions cannot be solved within the model itself nor by philosophy. The problem in the end demands that the model be located in a strong, rich scientific network that can pick out the right abstract concepts with which to formulate the model's results.

Strand one. Solution, Mach 1: Galilean thought experiments

Unrealistic assumptions do not always stand in the way of drawing lessons about real situations from models. Some models function as Galilean thought experiments and for these unrealistic assumptions are not a hindrance but a necessity. A Galilean experiment, as I use the term, isolates a single factor to observe its natural effect when it operates 'on its own' and 'without impediment'. In a real Galilean experiment the effect is produced in accord with the laws of nature. In a Galilean thought

experiment it is the principles built into the model that determine what the effect must be. So real experiments and thought experiments have complementary virtues. In the real experiment we can never be sure that we have eliminated all confounding factors but we can be sure the effect is produced in accord with nature's laws. By contrast the situation described in the thought experiment has only the factors in it that we put there. So we can be sure that confounders are absent but we cannot be sure the effect is right because that depends on the principles we provide in the model.

Typical economics models, and many in physics as well – especially those set as problems to work out in physics texts – can certainly be taken to be Galilean thought experiments, isolating a single factor to study what it does 'on its own'. This is clear not only from the practice in both cases; it is explicit in much economics discussion and in some from physics as well. For those models that do serve as Galilean thought experiments the unrealistic assumptions that suppose the factor is at work all on its own, with no confounders and no impediments, are no more of a problem than they are for real Galilean experiments. If we can learn about target situations with more 'realistic' arrangements from actual Galilean experiments despite the 'unrealistic' assumptions necessary to the experiment, the same is true for Galilean thought experiments, so long as the basic principles used in the model to drive the consequences are accurate enough.³ So at least for some models and some kinds of unrealistic assumptions, unrealistic assumptions pose no problem.

The problem of unrealistic assumptions, Mach 2: overconstraint

This is a rather too happy conclusion however. That's because a good many of the models that can be cast as Galilean thought experiments have a number of 'unrealistic' assumptions beyond those necessary for them to count as Galilean experiments – that is beyond those that eliminate confounders and impediments. This is generally for two interacting reasons.

³ In either case exporting from the Galilean experiment requires both more and stronger assumptions than those supplied in the experiment. My own view is that exporting often employs the logic of capacities, where the assumption that a factor has a capacity to study in the first place takes a great deal of highly varied independent evidence. Cf. Nancy Cartwright's *Nature's Capacities and their Measurement* (1989) and 'What is this Thing Called "Efficacy"?' (2009)

First: Causes cannot just act in a vacuum. They need a concrete setting in which to play out. Consider for example a model to study the effect of skill loss during unemployment on future employment levels. If it is to be a Galilean model there must be no further source of unemployment at work in it: no downturns in consumer spending, no shift to a war economy, and so forth; no motives that differ between when employers invest to open future jobs from when they don't other than the difference in profit they expect due to a difference in the efficiency of the workers. Still, the model needs employers in it in order to study what happens given their different expectations; and it needs to have workers who have lost skills and workers who have not to create these different expectations. How many workers, how many employers? What ratio of employed to unemployed? Etc. These factors are not properly thought of as causes or impediments to the mechanism by which skill loss might affect future employment levels. Hence the answer to what form they should take is not dictated by the demand of the Galilean experiment. Still they must take some form or other, otherwise skill loss can not be set operating.

Second is the well-rehearsed reason that matters must often be set in very particular ways if calculations and deductions are to be at all possible. So often mathematically more tractable descriptions are substituted for descriptions that are more true to the target situations that we want the model results to bear on. Indeed it is often the need for mathematical tractability that solves the first problem by settling how to fix the concrete setting in which the isolated cause will play out.

So most Galilean thought experiments have many more 'unrealistic' assumptions than those they should. Again, this would not be a problem if these assumptions did not play a role in deducing the final results. But of course generally they do – that is the point of including them in the first place. Just by inspection we can see that they are a necessary part of the deduction offered by the model.⁴

⁴ Explicit attempts to deal with this problem often involve so-called 'robustness' investigations: Vary these extra assumptions in different ways to see if the results are still more or less the same. Then, I suppose, we are supposed to do a quick induction to the conclusion that the results will be the same under the conditions that hold in the target situations. Not only is this inductive inference extremely dicey but usually the variation is not very great. Also often the interest is not so much in varying the 'extra-Galilean' assumptions but rather in adding in some further causes to see how the results are affected when a more realistic arrangement of causes occurs. This latter offers some help with the problem of whether the results are exportable from the experiment to other situations – the question 'Can an induction be done at all?' – but not with the problem of *which* results to export.

In these cases I say that the results of the model are *overconstrained*. All the conditions sufficient to ensure that the model describes a Galilean experiment are met. So (pace mistakes in the driving principles) the results must be ones we would see in a real Galilean experiment. The problem is that the Galilean experiment takes place in a very special and unusual setting. What we see is indeed the result of the cause acting on its own without impediment but it is a very special result that we cannot expect in other Galilean experiments. We know we cannot expect it because we can see by inspection that the description of the special setting plays a necessary role in the derivation offered. So unrealistic assumptions that overconstrain the results are a problem for learning lessons that apply elsewhere even if the model does function as a Galilean thought experiment.⁵

In order to explain the proposed solution to this new problem of overconstraint, I first turn to another topic altogether, that of fables and their morals. I shall spend quite a bit of time on this topic because doing so will make it easy to see Rol's proposal, which I summarize in the slogan, 'Abstraction can turn falsehoods into truths'.

Strand 2: Fables, models and morals

So far I have discussed models that are used to describe thought experiments; these are models that look to the world. Let us turn now to a different kind of model, one that faces theory: models I label as 'interpretive'. According to Positivist accounts theoretical principles come in two breeds: internal principles, which lay out relations among theoretical concepts, and bridge principles, which link theoretical concepts with ones that we already know how to apply to the world. These latter are important for the predictive power of theory: There are rules within the theory – language entry rules – for how and when to apply its concepts so that we can then make use of the links within the theory to make predictions about real situations. These matter especially with respect to abstract mathematical descriptions and physics is rife with them.

⁵ For a more detailed description of Galilean thought experiments and the problem of over constraint see Nancy Cartwright, 'The Vanity of Rigour in Economics', chapter 15 in *Hunting Causes and Using Them* (2007).

Consider:

- Two bodies of mass m_1 and m_2 separated by a distance r can be assigned a force between them of size Gm_1m_2/r^2
- Two bodies of charge q_1 and q_2 separated by a distance r can be assigned a force between them of size $\epsilon q_1q_2/r^2$
- Etc.

The left-hand-side of these bridge principles are descriptions that I label *interpretive models*. The right-hand side is a mathematical representation from classical gravitational and electromagnetic theories. So bridge principles link interpretive models with the theoretical terms that can be assigned to a situation when those interpretive models apply to it.

The interpretive model, I have argued, is like a *fable* and the theoretical description it licenses is its *moral*. I do so in order to stress that the relationship between theoretical description and the description in the model that licenses it is that of the *abstract* to the *concrete*, following the theory of the fable defended by Gotthold Ephraim Lessing, the great critic and dramatist of the German Enlightenment.⁶

Lessing argues, ‘In order to give 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.’⁷ For him this is not just a matter of *anschaulichkeit* – intuitive understanding. It is also a matter of ontology: ‘The general exists only in the particular....’⁸ This is the aspect I want to stress about theoretical terms that get applied via bridge principles.

Some theoretical terms do not have bridge principles; they apply to the world ‘directly’. For these we may have a variety of different ways to measure or to test when they apply but there is no other further description that must be met to license their application. Bridge principles then have a dual effect. On the one hand they provide more visualizable content to theoretical terms and an aid to their application; on the other they place a strong constraint on the domain of these terms. As Lessing says, the general exists only in the particular. These abstract theoretical terms apply only given the applicability of their more concrete models. These constraints,

⁶ My discussion of Lessing here is taken directly from *The Dappled World*, 1999, pp. 35-48.

⁷ Lessing 1759 [1967], sec I, p.100.

⁸ *Ibid.*, sec I, p. 73.

however, are a large part of the reason why hypothetico-deductive testing in physics has so much confirmatory power unlike in other fields where we are inclined to think of the explanations offered as 'just so' stories with little power to confirm the theory that provides them.

I illustrate the relation of the abstract to the concrete, following Lessing, with a fable of his own:

A marten eats the grouse;

A fox throttles the marten; the tooth of the wolf, the fox.

Moral: the weaker are always prey to the stronger.

As I described in *The Dappled World*, Lessing makes up this story as part of his argument to show that a fable is no allegory. Allegories say not what their words seem to say, but rather something similar. But where is the allegory in the fable of the grouse, the marten, the fox and the wolf: 'What similarity here does the grouse have with the weakest, the marten with the weak and so forth? Similarity! Does the fox merely *resemble* the strong and the wolf the strongest or *is* the former the strong, the latter the strongest. He *is* it.'⁹ For Lessing similarity is the wrong idea to focus on. The relationship between the moral and the fable is that of the general to the more specific and it is 'a kind of misuse of the word to say that the special has a similarity with the general, the individual with its type, the type with its kind.'¹⁰ Each particular *is* a case of the general under which it falls.

The point comes up again when Lessing protests against those who maintain that the moral is hiding in the fable or disguised there. Lessing argues: 'How can one disguise (*verkleiden*) the general in the particular... If one insists on a similar word here it must at least be *einkleiden* rather than *verkleiden*.' *Einkleiden* is to fit out, as when you take the children to the shops in the autumn to buy them new school clothes. So the moral is to be 'fitted out' by the fable.

The account of abstraction that I borrow from Lessing provides two necessary conditions:

⁹ *Ibid.*
¹⁰ *Ibid.*

- First, a concept that is abstract relative to another more concrete set of descriptions never applies unless one of the more concrete descriptions also applies. These are the descriptions that can be used to fit out the abstract description on any given occasion.
- Second, satisfying the associated concrete description that applies on a particular occasion is what satisfying the abstract description consists in on that occasion.

This discussion of Lessing began with the topic of interpretive models. My topic in this paper is not interpretive models, however, which are models that links to theory, but rather unrealistic models that somehow, despite their unrealistic assumptions, link to the world. What I want to take away for the current study from the earlier work on interpretive models is the idea of how the model relates to the lesson to be drawn from it. Like fables and their morals, the lesson of the model is *abstract* relative to the more concrete descriptions of the model. Like the fable, the model ‘fits out’ the more abstract lesson; and when a situation satisfies the more concrete description from the model, that is what it is for that situation to satisfy the more abstract lesson.

Strand 3. Solution, Mach 3: From falsehood to truth via abstraction

The problem of models with unrealistic assumptions is one of the standard worries both in the philosophy of economics and in economics itself. Philosopher of economics Menno Rol¹¹ has a nice account of why it need not always be a problem. One can, he argues, go from falsehood to truth by climbing up the ladder of abstraction. Rather than delving into economics, let me illustrate his point with a physics example that I think will be familiar to everyone.

Suppose we perform a careful Galilean experiment to see how bodies move *inertially*, that is, subject to no forces. We do it perfectly; we succeed in stripping (or calculating) away all forces. But we do our experiments on a Euclidean plane. From this we conclude that bodies moving inertially will follow a Euclidean straight line. This conclusion is entirely correct in the setting of the experiment. But it need not be true elsewhere. In particular this will not describe correctly inertial motion in a

¹¹ Rol, M. (2008).

spherical geometry, where the body subject to no forces will move on a great circle. To use my earlier language, we succeed in carrying out an ideal Galilean experiment but the results are overconstrained. The solution, following Rol, is to describe the results of the experiment *equally correctly* in more abstract vocabulary: The bodies in the experiment travel on *geodesics* – that is, they take the shortest distance between any two points in the relevant geometry. This conclusion is true both in the experiment we conduct and (putatively) everywhere else as well.

This account dovetails exactly with the image of models as fables. The lesson of the model is, properly, more abstract than what is seen to happen in the model and that can be described in the concepts introduced there. In the model the marten eats the grouse; the body moves along a Euclidean line. The lesson is that the weaker are prey to the stronger; that inertial bodies move on geodesics. The abstract lesson can be true of a variety of new, different situations where the more concrete behaviour will fail.

The advantage of thinking of what happens here in terms of Lessing's account of morals and fables is that it makes clear that there is *nothing wrong with the initial experiment*. What is wrong vis-à-vis applicability elsewhere is the level at which the conclusion is described. Moreover, no experiment could have done better. Experiments must be performed in some geometry or other. That is the point of invoking Lessing's theory of the relation of the abstract to the concrete. The abstract can exist *only* in the concrete. You can't get it unless it is fitted out in one way or another. What the abstract consists in given one filling out will be very different from what it consists in given another. For the marten and the grouse, the grouse's being weaker consists in being slow and not having sharp teeth, claws or a hard shell; being prey is being eaten. For a worker vis-à-vis employer, being weaker can consist in having no union, no transferrable in-demand skills and no wealth; and being prey to equals working long hours in bad conditions for little pay. Still, both are cases where the weaker are prey to the stronger. And in any case, it cannot just be true that someone is weaker and prey to another. In every case there must be something more concrete – and thus less generalizable – that this consists in.

My topic here is thought experiments not real experiments. But the same lessons apply. A thought experiment can succeed perfectly in isolating the factor under study and observing – correctly – what it does on its own, without impediment. But if the results are overconstrained they will not readily generalize. Yet, just as with the 'real'

Galilean experiment I described for inertia, there may be no alternative. The experiment must be performed in some geometry or other. Similarly, the model to study the effects of skill loss during unemployment on future unemployment rates may have only two generations of workers and one employer, where these affect the outcome though they could not properly be counted as impediments to skill loss in affecting future unemployment nor as confounding causes. But all situations have some generational structure among the workers and some number of employers. 'Real' economic experiments cannot eliminate them either and so will also be overconstrained.

Thinking of thought experiments as fables, then, points out two important methodological lessons

- Though the results of an experiment or of a thought experiment may be overconstrained, this may be inevitable since the abstract exists only in the concrete.
- To get a conclusion that is true both in the model and in a variety of other cases, it may well be necessary to follow Rol's advice and climb up the ladder of abstraction.

Strand 3. The problem of unrealistic assumptions, Mach 3: Not fables but parables

Consider the parable of the prodigal son or of the good Samaritan. Why are these parables and not fables? One reason is that they are open to interpretation. The moral is not written in but must be supplied from elsewhere. Defending a moral as the correct one requires a great deal of outside work, including much interpretation of other parts of the available text and of the world itself and how it operates.

So too with our 'unrealistic' models. Many of these may be Galilean thought experiments and so rightly have 'unrealistic' assumptions. And in many cases the correct lessons to be drawn may be more abstract than those described immediately in the concrete situation of the model. But seldom can we really cast the models as fables because the moral is not written in. They are rather like parables, where the prescription for drawing the right lesson must come from elsewhere. Theory can help

here, as can a wealth of other cases to look to, and having a good set of well-understood more abstract concepts to hand will play a big role. So the good news that one can move from falsehood in a model to truth by climbing up the ladder of abstraction is considerably dampened by the fact that the model generally does not tell us which ladder of abstraction to use and how far to climb.

I should stress that this problem is not peculiar to thought experiments. As I have mentioned, 'real' experiments can be overconstrained too. As with thought experiments this need not be a problem since, as with fables and their morals, what results in the (correctly conducted) overconstrained experiment will be what the generalizable result consists in for that situation; it will be an instance of the generalizable conclusion. But the experiment does not show what the generalizable conclusion actually is, how far up which ladder of abstraction one must climb to reach a result that will be true of new target situations as well. This is, I think, clearly recognized in physics and in much of economics as well, even though not articulated in this way. I stress it because I think that it has not been taken on board in the new drive for experiments in evidence-based policy, where practitioners are trying to draw general conclusions without the aid of theory or appeal to a set of well-understood abstract concepts whose reliability has been established elsewhere. So it is important to stress that real experiments, just like thought experiments, are far more often parables than fables.

Conclusion

If we are to use Galilean thought experiments to inform ourselves about target situations we had better recognize that these models are more like parables than they are like fables. So constructing the model and deriving its consequences are just a small step towards drawing a lesson from it. In order to know what the parable means we need to study a great deal of text, reading both the theory that imbeds the model and reading the world itself.

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