

# The truth of false idealizations in modeling

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## Abstract

Modeling involves the use of false idealizations, yet there is typically a belief or hope that modeling somehow manages to deliver true information about the world. The paper discusses one possible way of reconciling truth and falsehood in modeling. The key trick is to relocate truth claims by reinterpreting an apparently false idealizing assumption in order to make clear what possibly true assertion is intended when using it. These include interpretations in terms of negligibility, applicability, tractability, early-step, and more. Elaborations are suggested about their precise formulations, mutual relationships, and truth-aptness.

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## 1. Introduction

Almost by definition, models violate the whole truth. Models also appear to involve false elements that violate nothing-but-the-truth. At the same time, good models are often expected somehow to yield true information about some real features of the world – not just true predictions, but also true representations of important dependencies and mechanisms in some target domains. I have pursued the idea of models possibly being true more directly elsewhere (e.g. Mäki 1992, 1994, 2004, 2009b,c).

This paper mainly discusses a complementary way of reconciling truth and falsehood, focusing on the apparent violations of nothing-but-the-truth by various unrealistic assumptions used in building and applying a model. Theoretical models in science characteristically involve idealizing assumptions that appear to be plain false: mass point, infinite velocity, perfect information, zero transaction costs, etc. These apparent falsehoods are in need of justification. I will offer a strategy of justification that construes many of them not only as functional for the pursuit of truth, but also as only apparently false themselves. I will also distinguish that strategy from a nearby procedure that cannot deliver as much.

My suggestions are inspired by Alan Musgrave (1981), who designed an argument as a criticism of Milton Friedman's (1953) famous defense of the false assumptions of profit maximization and perfect competition in economic models. Friedman had claimed that a model can be just fine even though its assumptions are false, provided its predictive performance is satisfactory. Musgrave explained that once the import of those assumptions is correctly understood, they can be required to be true. Musgrave's argument was a clear advancement in the ongoing debate over Friedman's claims, but it had its own flaws that had to be removed by some revisions, elaborations, and amendments (Mäki 1994, 2000, 2004). In what follows, I will reframe and elaborate the arguments further. I will also briefly discuss related proposals by Frank Hindriks (2005, 2006), Catherine Elgin (2004), and Michael Weisberg (2007).

I will frame the discussion in terms of what I call the *functional decomposition approach* to examining modeling and the issue of truth in relation to models (Mäki 2004, 2009b,c). The point of the approach is to decompose a model and the representations it is embedded in so as to determine what functions are served by the various components. Importantly for the task at hand, this strategy enables (re)locating the relevant truth bearers in modeling the world.

## 2. Models and truth: the functional decomposition perspective

Here is a succinct formulation of my present account of models as representations (it has been discussed in more detail in Mäki 2009b,c,d):

*[ModRep]*

Agent *A* uses object *M* (the model)  
as a representative of  
(actual or possible) target system *R*  
for purpose *P*;  
addressing audience *E*;  
at least potentially prompting genuine issues of resemblance between *M* and *R* to arise;  
describing *M* and drawing inferences about *M* and *R* in terms of one or more model descriptions *D*;  
and applies commentary *C* to identify the above elements and to align them with one another.

*[ModRep]* should help us to locate, characterize, and resolve the issues around idealizations in modeling. The source of the puzzlement and debate that motivates the present paper derives from certain features of these idealizations: they often appear as statements that are outrageously false if taken as claims about any real target system. Reading them as such claims creates the puzzle. How to justify such outright falsehoods?

The first step is to localize those components and to understand the functions they serve in a given act of representation. Rather than reading the idealizing assumptions as claims about real target systems, they can be taken to play an important role as part of model descriptions *D*. They contribute to the description of an imagined model world by saying that in such a world, some factor is absent, constant, or has no effect on what is the case or what happens in the model. This is the first obvious sense in which an idealizing assumption can be only apparently false: it appears false if taken as a claim about some

(or any) real world target. When viewed as contributing to model description, its perceived falsity is seen to be based on a localization failure. However, the arguments for apparent falsehood to be presented are not exhausted by this simple step; their structure is more complex.

What I call *model commentary* plays an indispensable role in rectifying the localization failure and in justifying idealizations in terms of their functions. Commentary *C* identifies the key components of an act of representation and the functions they serve, coordinating them with one another. A commentary is needed because no model is itself able to specify how it relates or is supposed to relate (or fail to relate) to its (or any) target or targets. Importantly, a model commentary can be asked to spell out the purposes, audiences, and the respective desirable epistemic and pragmatic virtues to be pursued by a given modeling exercise. An adequate commentary helps remove misunderstandings that otherwise easily arise, as has been the case in the debates around idealizing assumptions. Showing how this happens is one task of this paper.

Many models are (or should be) accompanied by a commentary that spells out *isolation* as a major purpose of the model. A model is viewed as an imagined system in which some dependences and mechanisms are isolated from the interference and involvement of things not included in the system. Idealizing assumptions are vehicles of exclusion that contribute to the inclusion of selected items and relationships in the model. (Mäki 1992, 1994, 2005) By assuming that air pressure and the influence of other forces are nil, we isolate the impact of the Earth's gravity on a falling body. By assuming that there are no exports or imports, we close a model economy from the influence of foreign trade.

Whether or not idealizing assumptions are interpreted as statements about some real targets, it is unsurprising that issues of resemblance between a model and some real systems arise. The age-old debate in economics over the various "unrealistic assumptions" exemplifies this perfectly. Much of the time, this debate is carried out in terms of truth and falsity. Some say economic models are bad models because their assumptions are false. Others say they are just like all other models, always false since

they contain false assumptions. I say false assumptions *per se* are no obstacle to a model being true.

Any component in *[ModRep]* can serve as a truth maker, so we can have truths about them all. But not all of them can naturally serve as truth bearers. The obvious truth bearers can be found in model descriptions *D* (about *M*) and model commentaries *C* (about anything else in *[ModRep]*). My controversial suggestion has been that parts of *M* itself (about target *R*) can function as truth bearers (e.g. Mäki 2009b,d) – but this is not the main subject of the present paper.

Pragmatics play a prominent role in *[ModRep]* and also in meeting the challenge of justifying apparently false assumptions as true. While I don't take *truth* itself to be pragmatic, I take *what is relevantly true* to be pragmatically conditioned. The pragmatic context of purposes and audiences plays a key role in the pursuit of truth by model representation. For each purpose & audience combination *Pi&Ej*, the pursued or intended truths about the target (or perhaps about something else) may be different. It is the task of model commentary *C* to identify the relevant *Pi&Ej* combinations and the respective truth bearers in the model. I call these relevant truth bearers the *truth nominees* of the model (Mäki 2004). The model commentary nominates some component parts of model representations as worthy of consideration for their truth value. More on this in a moment.

Suppose (parts of) the relevant audience (say, students) raises an issue with the “unrealistic assumptions” that are used for describing the model, asking for their justification. The story we tell in response may be a long one, and as part of it, we may agree to consider those assumptions as truth nominees. But whatever it is that we will highlight in our commentary depends on the pragmatic context of modeling, including the purposes served and audiences addressed.

The larger pragmatic context of modeling includes disciplinary cultures and traditions. They shape the connections between the components of *[ModRep]*. For example, parts of economics appear to be done without much systematic attention to real target systems

and issues of resemblance between model  $M$  and target  $R$ . The main attention is given to inferences among model descriptions  $D$  in the examination of the properties of imagined model worlds. Disciplinary practices of this sort tend to treat models as *substitute systems* -- studied for their own sake -- rather than as *surrogate systems* -- studied in order to indirectly learn about real systems (Mäki 2001, 2005, 2009b,c,d; cf. Sugden 2009). Yet, when pressed sufficiently hard, modelers in such cultures may sometimes articulate (or at least accept) interpretations of the kind suggested in the subsequent sections. Disciplinary cultures are not carved in stone. Nor are they completely uniform, there is space for some individual variation.

Treating a model as a substitute system with no issues of resemblance arising may also be due to the properties of the model (in relation to any possible target) rather than its cultural context. Some models just may not seem to have any targets (they have not yet found any, or have lost the ones they were thought to have), and are therefore treated as substitute systems only.

### **3. Truth re-nomination**

The notions of truth nomination and truth nominee (Mäki 2004) play a key role in the argument that false idealizations may be true. A *truth nominee* is any item that is, or is supposed to be, considered for its truth-value; it is a candidate for truth. *Truth nomination* is an act that assigns an item for the role of truth nominee. *Truth re-nomination* is the proposal to treat some  $P2$  instead of  $P1$  as the relevant truth nominee. The argument here requires that  $P2$  and  $P1$  be connected. The connection can be conveyed in two ways. One is by *reformulation or paraphrase*: a sentence is transformed into another related sentence by some alteration of contents. Another is by *meta-claim*: a claim is being made about a sentence. In both cases, the original sentence is replaced by some other sentence as the relevant truth nominee.  $P1$  is paraphrased as  $P2$  so as to nominate  $P2$  instead of  $P1$  as the relevant truth nominee. Or claim  $P2$  is made of  $P1$ , and  $P2$  is nominated for truth. In both cases, it may be the case that phrased as  $P1$ , the item is false, whereas phrase  $P2$  is true.

It is the task of model commentary to propose one or both of those two kinds of truth re-nomination so as to deal with, and perhaps resolve, the issue of apparent falsehood. The issue arises since a model description is typically put in terms of apparently false idealizing assumptions – that is, false if taken to be about the real world. But one should not be misled to thinking that this reveals their intended or proper import. Conclusions about the latter can only be based on the model commentary. Truth nomination and truth re-nomination are among the accomplishments of model commentary. Neither a model itself nor its descriptions are able to reveal the relevant truth nominees. Appearances may deceive also in modeling. The task of model commentary is to check whether they do, and so to get the facts right.

So the trick accomplished by a model commentary is to relocate truth nominees within *[ModRep]*. For truth re-nomination to be justified, one must take the re-nominee as the intended or otherwise relevant truth nominee. What may first appear to be false might not be relevantly so after all, since it is not a relevant truth nominee, and its proper paraphrase or meta-claim might be true. Re-nomination is needed for revealing what real truth nominee lies behind an apparently false idealizing assumption. Among other things, this implies that one should not criticize what appears as a false idealization without understanding what assertion is intended when using it; nor should one rush to conclude that a model is false just because it seems to involve false idealizations.

Note that this strategy is greatly facilitated by the idealizing assumptions being explicitly formulated as part of model descriptions. In an early paper, I proposed distinguishing two means for theoretical isolation, one based on *silent omission*, the other based on *explicitly formulated idealization* (Mäki 1992). They both serve to exclude some items from the model world, either by leaving them out without mentioning them, or by explicitly assuming that they are constant, absent, at normal states, etc. Omissions are not included in model descriptions, while idealizations are. The latter are natural subjects for paraphrase or meta-claim. Due to their explicitness, they are easier to recognize, and due to their apparent falsity, they invite closer scrutiny and justification. Explicit formulation of idealizing assumptions with associated commentaries about their functions delivers

information that will be easily missed if only silent omission is applied. However, this division is not fixed and permanent: what is implicit can be made explicit.

Idealizations such as *the economy is closed* (exports and imports are zero) and *transaction costs are zero* (no costs of acquiring information, enforcing contracts etc) are typically nowadays made explicit. Other exclusions, such as the *absence of fairness issues* or the *absence of hysteresis effects* in all or some markets, are more often based on just silent omission. But they, too, can be made explicit for closer examination. Consider an idealizing assumption saying that

[C]            The economy is closed.

This is a much-used assumption in describing macroeconomic models. If one considers this as a factual assertion about the real world, it turns out that it is seldom exactly true; in lots of cases, it is very far from the truth. The key move in the present strategy is to refrain from considering [C] and other such assumptions as factual assertions but rather to turn them into other sentences that are used to make factual assertions about the world; or to make claims about them and their role in inquiry. At the end, truth-values are not supposed to be ascribed to idealizations like [C] but rather to their paraphrases or meta-claims that are treated as the relevant truth bearers or truth nominees. It is the task of model commentary to point out how a sentence like [C] is to be interpreted in a given context.

Musgrave (1981) suggested that one and the same sentence such as [C] (his example was “The government has a balanced budget”) can be turned into various kinds of assumption that have a chance of being true. His typology included three such types: negligibility assumption, domain assumption, and heuristic assumption. In my revision (Mäki 2000), I renamed and redescribed these and suggested that there are many other types as well. I also suggested that there are limits to this strategy. I now suggest that there are two different procedures of re-nomination (those of paraphrase and meta-claim) and that their powers in justifying the original idealizing sentence are different.



### 3. Re-nomination by paraphrase: Negligibility and applicability

The first two kinds of assumption – negligibility and applicability assumption – are based on paraphrasing an apparently false idealizing assumption and thereby giving the truth nominee a chance of being true.

#### *Negligibility*

In general terms, a negligibility assumption is the hypothesis that some factor  $F$  that might be expected to affect the phenomenon under investigation actually has an effect upon it small enough or otherwise irrelevant to be neglected relative to a given purpose and audience (Mäki 2000, 322). This is a very important and fundamental type of paraphrase that turns an idealizing assumption into a claim about the negligibility of a factor, given the modeler's purposes and audiences. Thus, [C] could be paraphrased as:

[NC] Foreign trade has negligible effects on the phenomenon of interest - effects that are negligibly small or otherwise irrelevant, given the purposes and audiences of the modeler.

The crucial payoff of this move is that while [C], if considered as a factual assertion, would be false, paraphrased as [NC] it may well be true. So conceived, [C] would be a claim about the economy having a property (of being closed), while [NC] is a claim about the negligibility of the economy not having that property (that is, of being open). These are claims about two very different things, thus it is not surprising that their truth-values have little to do with one another: one may be utterly false while the other may be true. The same applies to other assumptions such as *no transaction costs* and *no fairness considerations*. They may be irrelevantly false, while claims about the negligibility of transaction costs and fairness may be relevantly true or false, depending on the case.

Assumptions like [C] are properly read as parts of model description. They describe an imagined system such as a simple closed economy and are not claims about any real system directly. So they are not to be taken as candidates for truth about real world economies at all, hence they cannot fail as such candidates either. Given that they are not

treated as such candidates, as worthy of truth nomination, it is not sensible to ascribe them truth-values: because they are not taken to make any claims about any real systems, they are not to be regarded as true or as false about such systems.

On the other hand, formulations such as [NC] provide the relevant truth nominees, and it is these assertions that are to be examined for their truth-value, and eventually to be ascribed truth-values (with whatever degree of assurance). Such ascriptions, to be successful, require factual inquiries into the world. One hopes that claims about negligibility such as [NC] are true.

If a claim such as [NC] is a relevant truth bearer, what is its truth maker? It is the fact of negligibility. So what is negligibility? In general, negligibility is a function of two sets of facts -- ontic facts about the world and pragmatic facts about modeling the world. Two versions can be distinguished.

In the *first version*, negligibility is a function of the modeler's wish to highlight some fragment or feature in the causal structure of the world. A theoretical model isolates some important dependence relation or causal mechanism while excluding a number of other factors using idealizing assumptions that appear to state that these other factors are absent, have zero value etc. Such idealizations are camouflaged negligibility assumptions that claim that the non-absence, non-zerosness etc of those other factors is negligible because the factors are irrelevant to the main message of the model. Only the isolated factors are viewed as relevant to the purpose of illuminating some important structural feature of the world.

The *second version* of negligibility focuses on the connection between empirical data and the implications of a model. Just as in the first version, we may be interested in a relationship between the causal efficacy of a factor and the purposes and audiences of a modeler. But here what matters is how the causal efficacy of a factor (such as foreign trade) manifests itself empirically and how this relates to the predictive output of the model. The purposes of the modeler in meeting the expectations or desires of some audience may include predicting the domestic inflation rate at a certain conventional level

of accuracy appreciated by policy makers for certain policy purposes. What is negligible on this version may be very different from what is negligible on the first version.

The first version is related to the notion of *minimal model* and Weisberg's associated notion of "minimalist idealization: "Minimalist idealization is the practice of constructing and studying theoretical models that include only the core causal factors which give rise to a phenomenon." (2006, 642) I would put the idea a bit differently, with due stress on the idea that idealizations are devices of exclusion rather than inclusion: "Minimalist idealization is the practice of constructing and studying theoretical models that exclude all but the core factors by way of idealizing assumptions ..." (see Mäki 1992).

There is another issue. Weisberg's definition only cites a causal criterion of inclusion in a model while ignoring the pragmatics of modeling. However, in actual scientific modeling practice negligibility assumptions reflect varying explanatory interests in relation to the causal structure of the world. For each different explanatory question, different facet of that causal structure – different "core factors" -- may be isolated by the model, while other factors are assumed to be negligible for the purpose of answering those specific questions. And each explanatory question is a function of the varying epistemic interests of the modeler and his audiences. Negligibility is pragmatic through and through. Therefore, I would not say, as Weisberg does, that "minimalist idealization is not at all pragmatic" (2006, 645).

So in both cases the negligibility of a factor is jointly determined by an objective real-world fact and some pragmatic characteristics of scientific practice in studying the real world. And the truth-value of a negligibility assumption is determined by nothing else but just that: negligibility.

This implies that the truth-value of a negligibility assumption may vary from situation to situation. This is particularly evident in regard to the second version. *With a fixed purpose and audience* – such as predicting the rate of inflation at a certain level of accuracy expected by central bankers in some particular situation – it is more likely that [NC] is true of the US economy than about the Finnish economy. This is because the US

economy is “more closed” and so causally less dependent on foreign trade. *With a fixed target domain* – say the US economy – [NC] is more likely to be true the less stringent the model user and consumer are about the desired predictive accuracy. So the truth or falsity of a negligibility assumption depends on both the ontology of causation and the pragmatics of inquiry.

There is another way of thinking of the contextual dependency of negligibility assumptions’ truth-values. This makes those truth-values dependent just on the contingent facts of causation. On this approach, a *particular* purpose&audience would be built into each and every negligibility assumption; in other words, for each particular purpose&audience there would be a corresponding particular negligibility assumption. Thus, [NC] would express a potentially limitless family of negligibility assumptions, each variant based on a particular purpose&audience. One implication of this way of framing things would be to make the truth-values of negligibility assumptions dependent on facts of real-world causation only.

By now it should be pretty clear how the proposal deals with truth, but some further illumination may still be useful. So let me briefly compare the notion of negligibility and Elgin’s (2004) notion of *true enough* as well as the associated strategies of tolerating falsity. The notions and the strategies are closely related but not identical. I would suggest *true enough* can be taken to mean *negligibly false*. Elgin rightly recognizes that deviation from the truth is an ever-present situation in our epistemic endeavours, and she attempts to accommodate this in terms of the notion of true enough. There is a slight difference between her and my concerns and solutions. Elgin’s concern seems to be with identifying the grounds for *accepting what is no more than true enough*. In passing, she comes close to my proposal: “to accept a claim is not to take it to be true, but to take it that the claim’s divergence from truth, if any, is negligible” (119). Then she puts forth her dominant formulation: “We accept a claim when we consider it true enough” (119). This way of looking at things implies that no truth re-nomination needs to take place for acceptance. We simply accept falsehoods because they are true enough for some purpose.

Given how I have framed my argument, my concern and the suggested strategy is a little different. For my strategy, true enough is not good enough. I am proposing that if we “accept a claim when we consider it true enough” then we can as well turn this to the idea that we *accept a claim when we consider it true about negligibility*. This is the idea of accepting as true what is apparently false. Thanks to truth re-nomination, we can accept claims about negligible falsehood as true (rather than true enough, approximately true, close to the truth etc). We don’t only “take it” but we *claim* “that the claim’s divergence from truth, if any, is negligible”, while giving the claim about divergence from truth a chance of being true. That’s how we can *replace what is just true enough by what is nothing short of true*.

### *Applicability*

An applicability assumption states that a model applies to domains in which some factor  $F$  is absent or only has negligible effects on the phenomenon of interest (Mäki 2000, 323-324). The model user may be prompted to interpret and paraphrase an idealizing assumption ( $F=0$ ) as an applicability assumption after having discovered that in some domains of application, factor  $F$  is systematically non-negligible. The model commentary then suggests that those recalcitrant domains be excluded from its proper domain of applicability and that the model only applies to cases in which  $F$  is absent or negligible.

A paraphrase of [C] as an applicability assumption amounts to turning it into a claim about a property of a model in relation to a relevant domain of phenomena. Such a claim would be a claim about the applicability of the model:

[AC]            Model  $M$  is only applicable to economies that have no foreign trade – or to economies whose actual foreign trade is negligible.

Similarly, the *no fairness* or *no hysteresis* assumptions can be turned into applicability assumptions by claiming that the model involving such assumptions only applies to domains in which fairness or hysteresis make no difference or make only a negligible difference. One obvious candidate domain to which fairness-less models do *not* apply is labor markets. This is so with respect to both minimal and predictive models.

Again, what appeared to be a false idealization – such as [C] – is not treated as making any factual claims whatsoever, hence is not nominated for truth. It is rather paraphrased as a claim about applicability, a property that is jointly determined by the properties of the model in question and the properties of some domain of phenomena (and, in case negligibility is invoked, the purposes and audiences of modeling). Considered as such a claim, [AC] is worthy of truth nomination: it may be true or it may be false. Again, ascribing a truth-value to claims such as [AC] requires factual inquiries into the real world. One hopes such claims to be true.

Applicability assumptions play a role in a research strategy in which the modeler has access to a pool of models and makes informed selections from that pool depending on the domain to which -- and the purpose for which -- the selected model is supposed to be applied. In a letter to Roy Harrod (4 July, 1938), J.M. Keynes famously said, “Economics is a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world” (296). On an obvious reading of this statement it is reasonable to suggest that in an ideal case “the art of choosing models” should be based on employing true applicability assumptions. On the other hand, in the actual practice of economic inquiry such assumptions are seldom explicitly formulated and systematically tested, while implicit judgment plays a major role.

## **5. Re-nomination by meta-claim: Early-step, tractability, and more**

Negligibility and applicability assumptions as truth re-nominees emerge as paraphrases of the original idealizing assumptions. By contrast, the following re-nominations are based on making meta-claims about the original idealizations.

### *Early-step*

A common response to the charge or discovery that some factor  $F$  is not negligible and thus should not be excluded from the model by idealization is to include the factor by relaxing the idealizing assumption. These are assumptions first made, then relaxed. To

qualify as an *early-step* assumption, it is to be replaced by a *later-step* assumption at some later (logical or temporal) stage of the modeling exercise. This requires a process of de-idealization. In many such cases, a false negligibility assumption is replaced by a presumably (more) true negligibility assumption.

Many philosophers and practicing scientists appear to hold the view that models involving such early-step idealizations are unavoidably false, and that they can be made truer by relaxing such assumptions and replacing them by more realistic assumptions. This is a way of enriching the picture given by the model about the world, making it look more like the world itself, in all its richness and complexity. I don't subscribe to this view of how to approach *the* truth in modelling. I think there are many different kinds of truth to be captured with models, and this is just one of many ways of capturing some of them. Some others can be captured with (minimal) models involving unrelaxed early-step assumptions. But this is a view I have defended elsewhere. Here the focus is on those early-step assumptions themselves.

Model commentaries often identify some idealizations as early-step assumptions, but what exactly is their identity? One option is to say that an early-step assumption is an idealization like [C] plus a comment that it is temporary only and will be relaxed. Another option is to add a reason why it will be relaxed, such as its negligibility paraphrase being false. But there are other possible reasons as well, and each such reason would give us a distinct type of early-step assumption. So let us consider the first (neutral) option and see what to make of a meta-claim about [C] that looks like this:

[ESC]            [C] is an element of an early-step version of model *M* and is relaxed in its later-step versions

We may say that while [C] is an *early-step assumption*, [ESC] is an *early-step ascription*. [ESC] ascribes an early-step status to [C], or in other words identifies [C] as an early-step assumption. The truthmaker of the early-step ascription [ESC] is the fact of [C] being made (in early-step versions of a model) and being relaxed (in later-step versions). This is a fact of a feature of scientific practice, namely a sequence of assumptions. A typical – but not the only possible - reason for the obtaining of this fact is the perception that the

factor identified and excluded by the early-step assumption is not negligible, implying the denial of [NC] and the acceptance of the claim, “foreign trade makes a non-negligible difference for the phenomenon of interest”.

How to ascertain whether there is a respective truth maker that obtains? I can think of a number of different kinds of case. The easy cases are those that refer to *the past or the present*: both the early-step and the later-step have already occurred. This divides into two kinds of situation. The diachronic situation involves the history of a research field: as a matter of historical fact, an idealizing assumption was first made, and then at some later time it was relaxed. The synchronic situation involves no similar historical time dimension. The structure of a textbook is an example: in early chapters, an assumption is made, only to be relaxed in later chapters of the book. (Of course, this often involves a temporal order of reading and learning, but this is not a matter of historical sequence in assumptions.)

Accessing and establishing instances of these sorts is relatively easy. In the diachronic case, it may require nothing but tracing the actual historical development of a model in the relevant literature. In the synchronic case, it may be a matter of checking a journal article or textbook that begins with a closed economy model and at a later step relaxes the assumption and ends up with an open economy model. That the required truth maker is in place seems to be easy to establish.

The more difficult cases are those that refer to *the future*: at the time of examining the idealizing assumption, the later step has not yet occurred. In one kind of future-oriented case, the orientation is descriptive, taking on the form of expectation, anticipation, prediction: the early-step assumption is expected or anticipated to be relaxed in some later-generation models yet to be built. Depending on whether later steps will be taken, the descriptive attitude is true or false, but one can establish whether the relevant truth maker obtains only at a later time.

In other kinds of future-oriented cases, the orientation is rather a matter of attitudes such as intention, prescription, hope, or even promise: it is intended, prescribed, hoped, or



promised that the assumption in question indeed will be just an early-step assumption and will be relaxed at a later step. The modeller herself may have such a purpose, while prescription and hope are attitudes that can also be held by the audiences of modelling, deeming it as desirable that later-step models be built such that the early-step assumption will be relaxed. Promise might be given by the modeller when confronted with a sceptical or critical audience and attempting to dispel worries about an excessively unrealistic model.

Intentions, prescriptions, promises, and hopes are things that are different from predictions or other descriptive claims in that they cannot as obviously be taken as truth-valued, thus not as straightforwardly worthy of truth nomination. We can talk about their realisticness in other senses, though, such as the ease and likelihood of their realization.

The truth of early-step ascriptions such as [ESC] does little to justify an idealizing assumption such as [C] in a model in ways that would rely on judgments of causal efficacy or difference-making. In this respect, meta-claims of this kind are different from negligibility paraphrases like [NC].

### *Tractability*

Frank Hindriks (2005, 2006) has usefully analyzed the role of tractability considerations in scientific practice. He has proposed that there is a separate class of assumptions, that of tractability assumptions. But more needs to be said about the identity and separateness of such assumptions. Consider this meta-claim about [C]:

[TractC]        The use of [C] in describing and examining model *M* makes a problem (more) tractable.

Let us say that while [C] is a *tractability assumption* (or a tractability-enhancing assumption), [TractC] is a *tractability ascription*. [TractC] ascribes the function of enhancing tractability to [C], or in other words identifies [C] as a tractability (or tractability-enhancing) assumption.

On this formulation, a tractability ascription is a claim about tractability being enhanced by an idealization. The truth makers of tractability ascriptions are facts of tractability, and facts of tractability are facts of scientific practice, relating problems and various constraints on problem solving with one another. Again, a tractability ascription may be true even though the respective tractability-enhancing idealization were false about real target systems.

Tractability considerations are very important in modeling, and many idealizations are dependent on and motivated by them. However, I am unwilling to go along with Hindriks's (2006) radical suggestion to reinterpret early-step assumptions in terms of tractability. Musgrave (1982) had characterized his category of "heuristic assumptions" in a way that stresses their early-step status but does not distinguish this from their tractability-enhancing properties. My (2000) reconstruction focused only on the former characteristic and identified the category of "early-step assumptions". Hindriks's suggestion is closer to Musgrave's in not distinguishing the two characteristics but differs from it in stressing tractability. I think early-step and tractability are two different categories that should be kept separate.

Weisberg's (2007) characterization of "Galilean idealization" is close to Hindriks's suggestion. Weisberg lumps together the two characteristics of enhancing tractability and having an early-step status. He says that the purpose of Galilean idealizations is to make theories computationally tractable and also that "advances in computational power and mathematical technique should lead the Galilean idealizer to de-idealize" (641). These are the key features of Galilean idealization.

"The practice is largely pragmatic; theorists idealize for reasons of computational tractability. The practice is also nonpermanent. Galilean idealization takes place with the expectation [sic] of future de-idealization and more accurate representation." (642)

I think lumping these two things together in one category is not advisable. As I noted above, the early-step status typically depends on negligibility considerations. The relaxation of an early-step assumption is then motivated and prompted by perceptions of non-negligibility. This must now be linked to the issue of how the early-step status and

tractability are related. There seems to be no necessary connection of the kind suggested by Hindriks and Weisberg.

Suppose an idealizing assumption is initially included in a model description for tractability reasons. There is no reason to relax the assumption – and thereby to confirm its early-step status -- just because it enhances tractability. A genuine reason for its relaxation would be the belief that the factor that the assumption removes from the model is non-negligible. But this fact of non-negligibility does not explain or define the tractability-enhancing characteristics of the assumption.

An even more directly effective argument against linking tractability and the urge to relax too tightly together is to point out that it is also possible to make the discovery that the factor initially removed from the model due to tractability considerations is negligible. In such a case there may be no reason to relax the assumption. Indeed, in such a conceivable case, the idealizing assumption would have the status as a negligibility assumption and as a tractability assumption at the same time – but not as an early-step assumption.

That an idealizing assumption initially enhanced tractability is not necessarily connected to its later relaxation: it is likely to be relaxed for reasons other than its tractability-enhancing properties. These include perceived non-negligibility and an attempt to check for negligibility (as in robustness analysis). For example, a need for greater predictive accuracy or explanatory depth may motivate relaxing an idealization regardless of what happens to tractability along the way (provided the consequences lie within some minimal boundaries of tractability). And thinking of why early-step assumptions are made in the first place, there are considerations other than those of tractability that may motivate making an idealizing assumption that is later relaxed, as we will next see.

*And more...*

We may also generalize on the idea of early-step assumption by disconnecting it from judgments of negligibility that appeal to real-world causation. We may choose to say that for something to count as an early-step assumption is neutral with respect to the reasons

for this being so. Assumptions are made and relaxed, and the reasons for both may be various. Consider this meta-claim about [C]:

[PedC]           The use of [C] serves useful pedagogical purposes.

This is a claim about *pedagogical function*. It is a product of a model commentary that aligns a model description with the audience of economics students and the purpose of learning. If considered as a truth nominee, [PedC] is a true claim as witnessed by the numerous highly praised macroeconomic textbooks and lecture courses that start with expositions of closed economy models. Students are presented the simple case that will help them learn how a selected set of variables interact undisturbed by foreign trade effects. The pedagogical advantages seem obvious. This pedagogical strategy is not based on perceptions of whether the causal effects of foreign trade are negligible in the real world.

Later chapters in those textbooks (or later classes) typically relax [C] and present students with more complex open economy models with foreign trade effects included. Thanks to the pedagogical strategy, the more complex cases are now easier for students to learn. Pedagogical goals dictate the early-step strategy. On the other hand, it is obvious that causal negligibility considerations play a role in the background: there would be no need to relax [C] in the textbooks were it not the case that in many real-world domains and for many purposes, foreign trade makes a difference. But this fact is not among the truth makers of meta-claim [PedC].

Then consider a meta-claim in terms of *academic entry conditions* as part of a model commentary that coordinates model descriptions with the purpose of fortifying one's publication record and the expectations of audiences such as journal editors and referees:

[EntryC]           The use of [C] is a prerequisite of getting one's paper accepted in journal  $J_1$ , while its relaxation is required for success in journal  $J_2$ .

It does not matter whether this particular claim is actually true (with any existing two journals), but many others of this general kind surely are: they are true in virtue of facts of academic fashions, specializations, gate-keeping practices etc. These facts may

motivate strategies that rely on building early-step and later-step versions of a model (submit a closed economy version to journal  $J_1$  and an open economy version to journal  $J_2$ ). No reference might be needed to considerations of tractability or causal negligibility.

There are many other possible meta-claims about idealizing assumptions, such as

[AesC]            The use of [C] yields aesthetically pleasing models.

Such an appeal to *aesthetic values* can be popular among economists and other scientists. Putting aside difficulties of measuring aesthetic pleasure as part of the relevant truth maker, meta-claims of this kind may be true even though idealizations such as [C] were false about real systems. In this respect they are no different from paraphrases [NC] and [AC]. But there are other differences, on which a few final words next.

## **6. Truth re-nomination and justification**

Milton Friedman (1953) had sought to justify false assumptions of a model by arguing that their falsity does not matter provided the model yields sufficiently accurate predictions. This has mostly been interpreted as an instrumentalist defense of unrealistic models (but see my deviant realist reading e.g. in Mäki 2009a). Following Musgrave's general idea, the argument outlined in the present paper suggests that one should care about the factual truth of assumptions, and that this can be seen once it is understood that the idealizing assumptions can be used for making a variety of different kinds of claim. But this argument should not overlook some important asymmetries between these kinds.

These asymmetries emerge partly in consequence of the difference between the two kinds of truth re-nomination, those of paraphrase and meta-claim. An important difference lies in the truth makers of these two classes of re-nominees as we have illustrated them. Both have a chance of being true, but do so in virtue of different kinds of fact. On the one hand, paraphrases in terms of negligibility and applicability make reference to, and may be true partly in virtue of, properties of the real target system of a model. Thanks to this, they can be used for justifying the original idealization. On the other hand, the meta-claims listed above are about the roles of idealizing assumptions in modeling practice, so

are true or false in virtue of pragmatic facts only – facts about disciplinary practices of inquiry and education such as early-step, tractability, academic entry, pedagogic value. These claims may be very informative about important facts of academic practice, so may be justified as such factual claims. But for them to be adequate for justifying the original idealizing assumptions, they have to be put in a larger context that contains a collectivity of modelers, a multiplicity of models, and their dynamic evolution in short, medium and long term – as well as the various epistemic values that guide modeling activities.

Another perspective to the asymmetry is provided by the distinction (in section 2 above) between *substitute modeling* – modeling unconstrained by, or without contact with, real targets - and *surrogate modeling* – modeling as an indirect way of accessing real targets. Re-nomination in terms of early-step status, tractability, aesthetics, pedagogy, and academic entry may support nothing but substitute modeling if left unsupported by other arguments that do appeal to real-world facts. Negligibility and applicability assumptions do make appeal to the properties of real targets and are therefore able to support surrogate modeling.

It is for such reasons that only in case of paraphrase in terms of negligibility and applicability can we say that the original idealization is only apparently false: the relevant truth value is that of the truth re-nominee. This cannot be said about the meta-claims above. Their truth-value does not replace that of the original idealization, so does not remove the worry about false idealizations.

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