A Note on the Ideological Content of Modern Economic Dynamics Models and Ideology-Reducing Meta-Modeling

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Abstract. To some extent, economic models are based on empirically unproven and metaphysical concepts and assumptions, which increases their ideology content and the risk of catastrophic misprediction of (long-run) economic dynamics. We discuss the channels along which ideology can enter economic dynamics models and the approaches for reducing the ideology content of models. The (meta-)models generated by these approaches are rather qualitative and crude in nature and require the corresponding dynamics modelling techniques (logic, set theory, geometry, and topology). Yet, they may generate predictions of an economic phenomenon that represent a theoretical or positivistic consensus and can be regarded as relatively reliable. The paper provides examples from the structural change modeling literature demonstrating the implementation of ideology-reducing modeling approaches.

Keywords: methodology, ideology, metaphysical, meta-model, qualitative, economic dynamics, macroeconomics, structural change.

JEL Codes: B41, C61, E00, O41

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1. Introduction

While empirically unproven and metaphysical concepts and assumptions can be very useful tools in economic theory and normative economics, they represent a problem in positive and predictive (long-run) modeling of economic dynamics, since they increase the ideology content of economic models and the risk of catastrophic misprediction of (long-run) economic dynamics. We discuss briefly the different channels along which ideology can enter economic dynamics models and the different approaches for creating (meta-)models that avoid some of these channels. These ideology-reducing approaches generate models that are rather qualitative and crude in nature and require the corresponding dynamics modelling techniques (logic, set theory, geometry, and topology). Yet, the predictions of such models can represent a theoretical or positivistic consensus regarding the future dynamics of an economic phenomenon and can be regarded as relatively reliable. The paper provides examples from the three-sector structural change modeling literature implementing such an ideology-reducing approach demonstrating its concepts and the range of tools and models that are applicable/generable by it.

In the next section, we start the discussion by a short recapitulation of (a) the critique of economic dynamics (macro-)modeling implying that most of the critique-points arise due to the ideological/metaphysical character of some of the assumptions and (b) the problems that arise due to such assumptions. Section 3 discusses the information structure of an economic model, the channels along which ideology may enter economic models, and the approaches for reducing the ideology content of economic models. To demonstrate that these ideology-reducing approaches are implementable in economic dynamics modeling and to discuss some of the properties of the resulting models, we provide examples from the structural change modeling literature and, in particular, discuss the contributions by Stijepic (2015, 2017, 2018) in Section 4. Concluding remarks are provided in Section 5.

2. Standard ideology-related critique of economic modeling

Many methodological contributions to economic dynamics modeling criticize the standard modeling approaches and their assumptions for reasons of ideology, restrictiveness, and disconnectedness from reality among others. The standard approach for economic *demand-side* modeling relies on the (metaphysical) concept of an infinitely lived representative rational household, which is a rather historically grown convention, not proven by evidence and, thus, ideological (cf., e.g., Conlisk, 1996). The mainstream *supply-side* modeling via production functions is subject of the Cambridge capital controversy among others (see, e.g., Cohen and Harcourt, 2003, for a critical review). Developments over the last decades have favored *quantitative, microfounded general equilibrium models* in macroeconomics, which are criticized severely (see, e.g., Caballero, 2010, King, 2012, and Solow, 2007, for a detailed exposition of the critique). In part, these models do not only rely on unproven/unprovable assumptions but also on empirically rejected assumptions for reasons of 'internal consistency' of the microfoundation (Wren-Lewis, 2009).

In general, empirically unprovable assumptions, which are mostly required to generate quantitative models and precise predictions/forecasts of economic dynamics, are problematic in *positive/predictive (long-run) modeling*: they increase the ideological content of economic predictions, reduce the generality of economic models, increase the risk of (catastrophic)

misprediction (e.g., disregard of crises), may be hard to defend in public policy debates (where a policy advice based on an economic model may be rejected on the ground that it is dependent on ideological assumptions), and yield the fact that economics as a science 'is not based on the scientific method' (McAleer, 2017). For example, Caballero (2010) emphasizes that focusing on (fine-tuning of) quantitative model predictions instead on broad exploration of different aspects of macroeconomics has yielded the inability to predict the recent financial and economic crisis. Moreover, the typical disputes between different schools of thought (e.g., Classics vs. Keynsians or neoclassical vs. endogenous growth theory; see, for example, Pasinetti, 2005, and Mankiw et al., 1992) can be attributed to the ideological nature of economic models.

3. The information structure of an economic model and ideology-reducing modeling approaches

Our discussion of the information structure of economic models is based on several terms borrowed from mathematical logic and natural sciences, which we briefly recapitulate now. In mathematical logic, *primitives* are the objects of analysis or concepts that are taken as given and to which definitions and axioms refer. Primitives are not necessarily simple analytical objects; for example, we will regard the standard empirical measures (e.g., GDP and employment) as primitives. *Definitions* are statements that define new objects or concepts on the basis of the primitives. That is, definitions can be used to simplify the discussion or the derivations significantly. *Axioms* are statements (referring to the primitives) that are regarded as given or accepted in the logical model considered.

Overall, the concept of primitives and axioms allows the model builder to abstract from the derivation or the detailed discussion of some objects of analysis or statements (i.e., primitives and axioms), while focusing on the derivation of other statements (i.e., the logical implications of the axioms referring to the primitives). While one of the reasons for this abstraction may be that some of the primitives and axioms are 'widely accepted' or 'do not need a detailed discussion' (which is hard to believe in economics, as explained in the next paragraph), a major advantage of the concept of primitives and axioms is that most problems modelled are very difficult such that it is impossible to discuss all aspects of them; thus, the list of primitives and axioms allows for a separation between the (exogenous) aspects that the model will not (or cannot) explain and the aspects that the model can derive.

Note that the definition of an axiom as a statement that is 'generally accepted' is difficult to implement in economics. Different schools of economic thought regard different concepts as accepted, and it is difficult to find statements in economics that can be regarded as accepted by 'all' economists, since most economic statements do not refer to simple atomistic primitives that are assessable by simple observation but rather to complex measures (e.g., GDP, price-level, and utility) that may be ideologically constructed. Thus, while it is easy to find the axioms that are accepted within one or more school(s) of economic thought (e.g., in Neoclassics), it seems impossible to find axioms that are ideology-free and accepted by all possible schools of economic thought. In other words, in economics, axioms must be regarded as representing the consensus of one, several, or all existing school(s) of thought, rather than being ideology-free concepts acceptable by all economists (cf. McAleer, 2017). Henceforth, we follow this insight and define axioms as (consensus) statements that are

accepted by one, several, or all school(s) of thought, depending on the type of model (meta-model representing one school of thought or several/all schools of thought).

The methodological discussion of the term 'law' in natural and, more generally, empirical sciences is very extensive (see, e.g., Jackson and Smith, 2005, and Reutlinger et al., 2015, for an overview). Economic laws, i.e., the statements of economics that correspond to the natural laws in natural sciences, can be regarded as ceteris paribus laws (Reutlinger et al., 2015). In the context of our model, we choose a definition of an economic law that is rather easily implementable in ideology-reducing meta-modeling (cf. Stijepic, 2017b): an empirical observation that is persistent across countries and time is regarded as a 'law' if the theoretical literature and, in particular, the standard models (belonging to the different schools of thought considered) imply that this observation is valid in future (and in different countries). This two-sided, i.e., empirical-theoretical, definition of an economic law seems inevitable in positive/predictive economics for two reasons: First, we would not base our predictions of future dynamics on a very robust empirical observation if economic theoretical models predict that this observation will not be valid in future. For example, assume that the developing countries in our sample are characterized by very high GDP growth rates over the past decades. This may tempt us to draw the conclusion (e.g., by extrapolating the trends in our sample) that the GDP in these countries will grow at high rates in future as well. However, economic theory (e.g., neoclassical growth theory), which implies that high growth rates in developing countries are only a transitory phenomenon, contradicts this observation. Thus, we would not formulate a law stating that the countries in our sample grow at high rates in general (and, thus, in future as well). Second, we would not base our predictions on a theory (e.g., sunspot theory of macroeconomic fluctuations; cf. Mirowski, 1984) that is clearly rejected by the empirical evidence. Overall, in the context of the following discussion, economic laws represent a theoretical and empirical consensus.

Based on these concepts and the contributions by McAleer (2017) and Stijepic (2015, 2017b), we can describe the information structure of economic models as depicted in Figure 1. As we can see, there are three major types of theoretical and empirical information that enters a *standard economic model* (via, e.g., assumptions and parameterization):

- metaphysical and empirical primitives ((A1) and (A2)),
- empirical information regarding the properties/values/behavior of the metaphysical and empirical primitives ((B2a) and (B2b)), and
- the theoretical consensus and non-consensus statements regarding the properties, values, and behavior of the metaphysical and empirical primitives ((B1ai), (B1aii), (B1bi), and (B1bii)).

In particular, a standard economic dynamics model combines all these information types via mathematical operations and generates a prediction of (future) dynamics.

Figure 1. *Information structure of an economic (dynamics) model*

- insert Figure 1 here -

As already noted, the critique and the problems in economic dynamics modeling discussed in Section 2 result from ideological assumptions for the greatest part. Thus, a reduction of the ideological content of economic (dynamics) models seems valuable. Figure 1 implies that

there are different *approaches* for generating ideology-reduced (meta-)models in the context of predictive economic dynamics modeling. We focus on the following *three*:

In a *first approach*, we could combine (a) the metaphysical and empirical primitives ((A1) and (A2)), (b) the theoretical consensus assumptions regarding the behavior of the metaphysical and empirical primitives ((B1aii) and (B1bii)), and (c) (selected) empirical findings ((B2a) and (B2b)). In general, the attempts to merge the different schools of macroeconomic thought (e.g., the 'new neoclassical synthesis'; cf., e.g., Woodford, 2009) could be assigned to this first approach or, at least, they are in the spirit of it.

In a *second approach*, we could go one step further and remove all the theoretical consensus assumptions regarding the behavior of metaphysical and empirical primitives ((B1aii) and (B1bii)) that are not consistent with the corresponding empirical information ((B2a) and (B2b)). That is, if we take a model created by the first approach as a starting point and remove all the theoretical consensus assumptions that are rejected by empirical evidence from it, then we obtain a model covered by the second approach. In this way, we would achieve maximal 'external consistency' of the assumptions (cf. Wren-Lewis, 2009). Note that, in general, the macroeconomic consensus models (e.g., the 'new neoclassical synthesis') belonging to the first approach cannot be assigned to the second approach, since they accept empirically rejected assumptions for reasons of 'internal consistency' of their microfoundation, i.e., they do not achieve maximal external consistency (see Wren-Lewis, 2009, for a discussion).

In a *third approach*, we could try to eliminate all the metaphysical concepts from a model, thus generating a sort of 'positivistic model'. Such a model is only based on the shaded components depicted in Figure 1. In particular, it combines the *empirical* primitives (A2) with the corresponding *empirical* information regarding the empirical primitives (B2b) and the corresponding *theoretical* consensus statements regarding the empirical primitives (B1bii). As already explained, in general, it does not make sense to use empirical information (B2b) that is clearly rejected by the theory (B1bii), and it does not to make sense to use theoretical consensus statements (B1bii) that are rejected by empirical evidence (B2b). Thus, in the context of our third approach, it makes sense to use only the statements that represent a consensus between the empirical information (B2b) and the theoretical information (B1bii). As noted above, we name these statements 'economic (dynamics) laws'.

Overall, the *third approach* is the most radical one among the three ideology-reducing approaches suggested here, i.e., it is the most ideology-reducing. It bases its predictions only on dynamic laws, which are statements that (a) refer to the empirical (i.e., non-metaphysical) primitives and concepts (cf. (A2)), (b) represent the theoretical consensus across different schools of thought (cf. (B1bii)), and (c) are consistent with the empirical consensus evidence (cf. (B2b)). In the next section, we provide examples of models that can be assigned to the third approach. As we will see there, such models have the following characteristics:

1.) The models generated by the third approach are not necessarily closed and, thus, cannot generate quantitative predictions. In general, they may require qualitative modeling techniques (in particular, predicate logic, set theory, and geometry/topology). Nevertheless, they may be interesting complements to the standard literature by providing less ideological and more robust predictions. That is, they could mark the outer limits of possible dynamic scenarios.

2.) In general, even such a radically ideology-reducing approach as the third approach cannot generate models that are ideology-free. Even the most basic mathematical assumptions regarding the modeling framework (i.e., the choices of primitives) have an impact on the qualitative predictions (of economic) dynamics, and it can be impossible to prove such assumptions empirically. This becomes particularly clear in two-dimensional systems, where even the decision between a discrete-time and continuous-time modeling framework can have significant impacts on the possible (qualitative) dynamic scenarios. For example, non-self-intersection constraints regarding trajectories can be used in two-dimensional continuous systems to reduce the number of feasible/predicted scenarios (see Stijepic, 2015, and Lee and Kuipers, 1988), while in corresponding discrete-time systems non-self-intersection is an obsolete restriction. Moreover, the limit-dynamics of (smooth) differential equation systems in the plane are easy to predict via the Poincaré-Bendixson theorem, while, in contrast, difference-equation systems in the plane are not that easily predictable. That is, even the most basic modeling decision (e.g., the decision for continuous time or discrete time) can have most significant impacts on model predictions in economic dynamics modeling. In general, it is not easy to make these decisions on the basis of empirical evidence, and methodological reasoning is necessary, which may lead to an increase in the ideology content of the model.

3.) Due to its effort to minimize the ideology content and, in particular, to remove metaphysical assumptions, the third approach could be labeled as positivistic. As we can see in Figure 1, the approach does not necessarily base its predictions solely on empirically proven assumptions (e.g., tautologies based on empirical primitives and methodological arguments may enter the model via the elements (A2) and (B1bii)), yet it tries to avoid metaphysical concepts.

4.) In general, the definitions/choices of empirical primitives (A2) are subjective. That is, the choice of an empirical primitive over another can be ideological. However, empirical primitives do not necessarily raise the ideological content of a study unless they are interpreted in terms of economic theory. That is, a study that simply tries to predict the dynamics of an economic primitive is not necessarily ideological, but the interpretation of this prediction in terms of a theory makes the study ideological. For example, if we simply seek to predict the GDP dynamics on the basis of past time series by using a simple econometric method (e.g., trend extrapolation), the definition of GDP does not increase the ideology content of this study, since, in this context, the definition of GDP can be regarded as given (by literature or conventions). However, if we try to interpret the results of this study in terms of the welfare of the corresponding society (e.g., by assuming that an increasing GDP means an increasing welfare of the society), then the definition of GDP *as a welfare measure* raises the ideological content of the study/interpretation, since GDP is only one welfare measure among many others; e.g., income distribution across individuals or other aspects of societal welfare could be considered in welfare studies (cf. the discussion of the ‘Human Development Index’ published by the United Nations).

5.) Even the assessment that a (theoretical) statement is empirically proven and, thus, is an ‘economic law’ may be disputable, and the set of all empirically provable statements is, anyway, not known. Therefore, in general, there is some freedom of choice regarding the set of dynamic laws (cf. Figure 1). This fact may raise the ideology content of a third-approach

model (since the major model predictions depend on the composition of the set of dynamic laws).

6.) The derivation of economic laws (as defined in this paper) seems interesting, since it would allow us to approach in a similar way as engineers and physicist approach: while theory (physics or economic theory and the third approach) seeks to determine the (natural or economic) laws, engineers are rather interested in the application of these laws in reality (and not necessarily in their identification and theoretical explanation). Thus, the third approach, which focuses on economic laws, could be of interest in economic policy design and dynamics prediction, where the policy designer can take the dynamic laws that have been elaborated by the third approach as given (and does not necessarily have to model one of their numerous theoretical explanations). This would allow the policy maker to develop policies that are valid across different theoretical doctrines and less ideologically vulnerable. An example of this idea gives Stijepic (2018a), who seeks to determine a structural policy that minimizes the structural change costs under the constraint of the structural change (meta-)laws elaborated by Stijepic (2017b).

Overall, our discussion implies that the radically ideology-reducing third approach cannot be regarded as an ideology-free construct. Rather it reflects the consensus of one, several, or all existing school(s) of economic thought. Nevertheless, even then, it serves the purpose of reducing the ideology content of economic modeling.

4. Example: Ideology-reducing modeling of three-sector structural change

By now, our discussion of ideology-reducing modeling has been purely theoretical. At this point, the question arises to what extent it is possible to apply the ideology reducing approaches developed in Section 3, since, in general, it may not be easy to derive predictions from models that simply 'omit' elementary ingredients of standard models. In this section, we focus on the third approach discussed in Section 3 and briefly discuss the contributions by Stijepic (2015, 2017, 2018), which apply this approach in modeling of structural change in the three-sector framework. In this way, we do not only demonstrate that it is possible to apply the concepts (e.g., our concept of an economic law) and create models by following the third approach discussed in Section 3, but also review some of the modeling techniques applicable in ideology-reducing economic dynamics modeling.

In general, the structural change in the three-sector framework is analyzed by referring to the long-run dynamics of the agricultural, manufacturing, and services employment shares. In this context, the sectoral employment shares can be regarded as *empirical primitives* (A2). Their definition and, in particular, the fact that there are only three sectors in the three-sector framework and their employment shares are non-negative and add up to one imply a major property of a three-sector structural change model: the structural change dynamics can be depicted by trajectories on a standard 2-simplex. The latter is simply a triangle (a bounded subset of a plane), which can have important implications for the dynamics as discussed by Stijepic (2015, 2017d); in particular, the dynamics become easier to predict (under certain additional assumptions), e.g., there is no chaotic behavior. That is, in structural change models, the sectoral definition has a very strong impact on the model results/predictions. This fact exemplifies that even the definitions of empirical primitives that are regarded as standard in the literature can contain information with weighty implications for the model results.

As discussed by Stijepic (2015, 2017c), the three-sector structural change model requires several further empirical primitives, which are difficult to determine empirically. In particular, choosing continuous time and continuous functions describing the long-run dynamics of economic variables is a convention in theoretical structural change modeling and in long-run dynamics modeling in general. However, this convention can have significant impacts on model predictions as already mentioned in the previous section; e.g., in models of non-self-intersecting trajectories, which are relevant for the three-sector structural change modeling as we will see soon, continuous trajectories are a prerequisite for generating predictions (see Stijepic, 2018b, for a detailed discussion). This exemplifies fact that a simple mathematical modeling convention (here, the continuous-time assumption) can have significant impacts on the results and, thus, may be ideological, as explained in Section 3.

Following the discussion in Section 3, if we seek to develop a third-approach model for studying structural change in the three-sector framework, we have to elaborate *dynamic laws* (of structural change), which represent the consensus between structural change theory and empirics. As discussed in detail by Stijepic (2015, 2017, 2018), the three-sector structural change literature has the following characteristics:

(I) Most structural change theories predict that an economy starts as an agricultural economy and increases (decreases) its services (agricultural) employment share over the development process such that it becomes a services economy; these theoretical predictions are also supported by strong evidence.

(II) The quantitative predictions of structural change dynamics differ significantly across models; there is no theoretical consensus regarding the quantitative aspects of structural change.

(III) In the empirical and theoretical literature, there is no quantitative or qualitative consensus regarding the dynamics of the manufacturing employment share. Depending on the countries, models, and parameterizations being chosen, the manufacturing share is decreasing, increasing, or follows non-monotonous patterns.

Thus, according to Section 3, we can only regard the statements enumerated under (I) as dynamic laws of structural change. It can be discussed whether these laws are robust enough and whether they could be replaced by more robust ones; for example, the laws listed under point (I) could be replaced by a more general law, the law of non-self-intersecting trajectories, which contains the laws (I) as a special case (see Stijepic, 2015, 2017c). This exemplifies the fact that, in general, the determination of economic laws can be controversial and can increase the ideology content of a model as stated in Section 3.

For an overview of models and predictions that can be based on the primitives and laws discussed in this section and on other primitives and laws relevant for structural change modeling, see Stijepic (2015, 2017c) and Stijepic (2017d, 2018b). Moreover, the resulting positivistic models can be used in economic theory, e.g., in the discussion of Cobb-Douglas production functions (see Stijepic, 2017a) and determination of cost-minimal structural change paths (see Stijepic, 2018a).

From the methodical point of view, the contributions discussed in this section rely on qualitative and geometrical properties of trajectories and trajectory bundles (monotonicity, continuity, non-intersection, and non-self-intersection of trajectories) and trajectory domains (dimension, boundedness, and connectedness of the standard 2-simplex) as well as on set-

theoretical concepts (e.g., partitioning of the domain and separateness of some partitions) and predicate logic for deriving implications that can be translated into predictions of future structural change dynamics. Overall, the models have a rather system-theoretical character and are applicable to many other types of structural change, as discussed by Stijepic (2015, 2017e, 2018b).

5. Concluding Remarks

Much of the standard critique on economic models and modeling approaches can be reduced to fact that these models are based on unproven, unprovable, and, thus, ideological and metaphysical assumptions. Our discussion of the channels along which ideology can enter economic models implies that the creation of ideology-free economic models seems impossible, since even the choice of the most basic mathematical assumptions and 'axioms' (i.e., the choice of primitives and of the set of empirically proven theoretical consensus assumptions) can be ideological. Nevertheless, the avoidance of unproven and unprovable assumptions in economic modeling seems a valuable since ideology-reducing and, thus, robustness-increasing directive. Therefore, we have discussed several approaches for reducing the ideology content of economic models. To demonstrate the nature of the models generated by these ideology-reducing modeling approaches, we have discussed the contributions by Stijepic (2015, 2017, 2018), which deal with structural change modeling in the three-sector framework. We have shown that the models generated by the ideology-reducing approaches discussed in our paper (a) can be regarded as system-theoretical models, (b) generate rather crude predictions, (c) can be interpreted as meta-models based on consensus statements of the literature or as positivistic meta-models (avoiding metaphysics), and (d) are particularly usable for deriving the wide range of potential dynamic scenarios based on relatively robust assumptions. For these reasons, they may be usable in policy relevant predictions seeking for a minimization of (ideology-generated) uncertainty of predictions and in (very) long-run economic dynamics predictions (e.g., in future studies) where the standard statistical procedures and ideological models can fail. Needless to say that the modeling approaches discussed here are not alternatives but rather complements to the standard modeling approaches: while the standard approaches are inevitable for developing intuitive-theoretical arguments and quantitative/precise (yet relatively 'unrobust') predictions of economic dynamics ('fine-tuning'), the ideology-reducing meta-modeling approaches developed in this paper seek to generate rather crude, qualitative, and robust predictions covering a wide range of potential scenarios. In this sense, they can be regarded as contributions to a 'broad macro exploration' (cf. Caballero, 2010).

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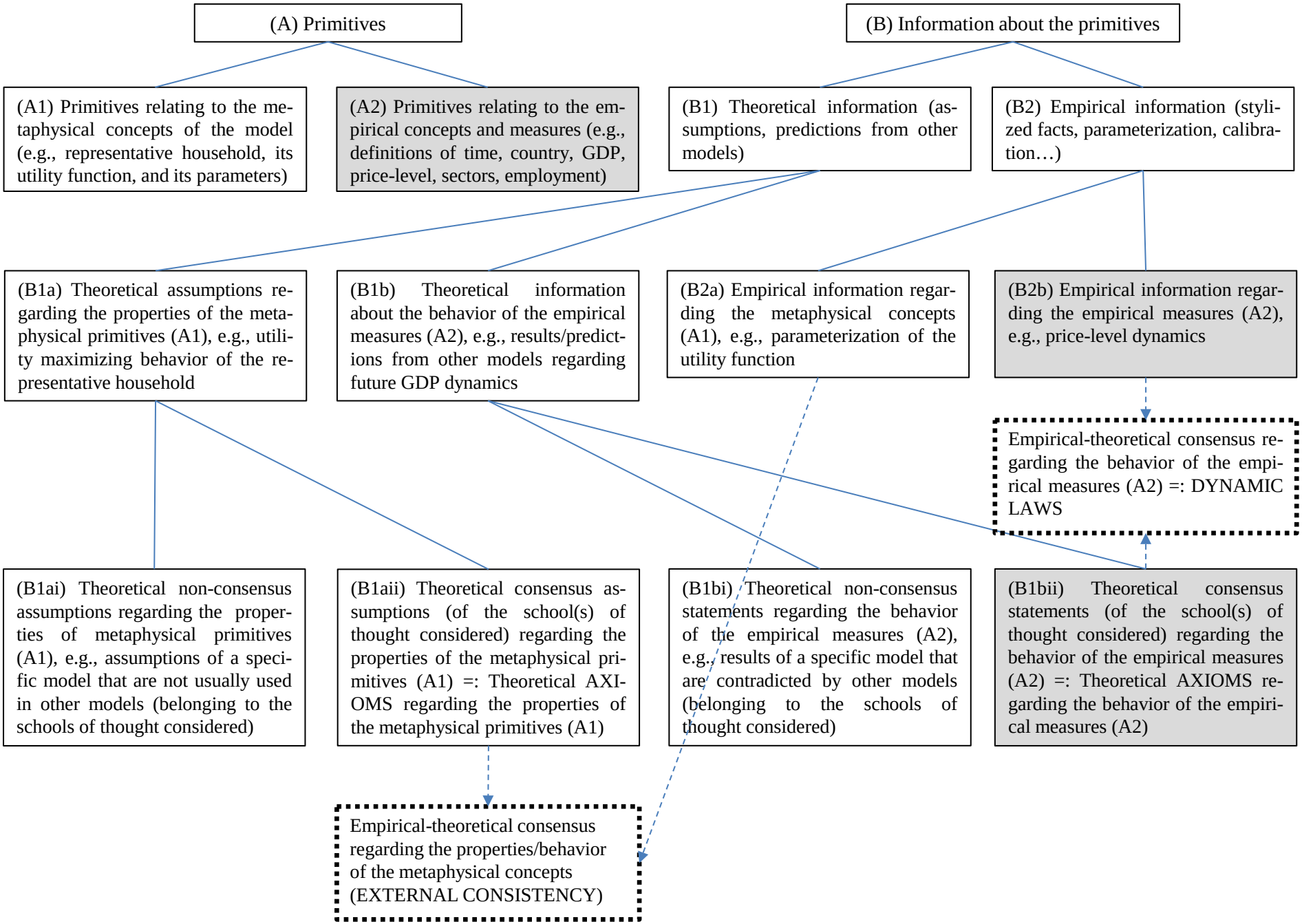
FIGURE 1


(A) Primitives
(B) Information about the primitives
(A1) Primitives relating to the metaphysical concepts of the model (e.g., representative household, its utility function, and its parameters)
(A2) Primitives relating to the empirical concepts and measures (e.g., definitions of time, country, GDP, price-level, sectors, employment)
(B1) Theoretical information (assumptions, predictions from other models)
(B2) Empirical information (stylized facts, parameterization, calibration…)
(B1a) Theoretical assumptions regarding the properties of the metaphysical primitives (A1), e.g., utility maximizing behavior of the representative household
(B1b) Theoretical information about the behavior of the empirical measures (A2), e.g., results/predictions from other models regarding future GDP dynamics
(B2a) Empirical information regarding the metaphysical concepts (A1), e.g., parameterization of the utility function
(B2b) Empirical information regarding the empirical measures (A2), e.g., price-level dynamics
Empirical-theoretical consensus regarding the behavior of the empirical measures (A2) =: DYNAMIC LAWS
(B1ai) Theoretical non-consensus assumptions regarding the properties of metaphysical primitives (A1), e.g., assumptions of a specific model that are not usually used in other models (belonging to the schools of thought considered)
(B1aii) Theoretical consensus assumptions (of the school(s) of thought considered) regarding the properties of the metaphysical primitives (A1) =: Theoretical AXIOMS regarding the properties of the metaphysical primitives (A1)
(B1bi) Theoretical non-consensus statements regarding the behavior of the empirical measures (A2), e.g., results of a specific model that are contradicted by other models (belonging to the schools of thought considered)
(B1bii) Theoretical consensus statements (of the school(s) of thought considered) regarding the behavior of the empirical measures (A2) =: Theoretical AXIOMS regarding the behavior of the empirical measures (A2)
Empirical-theoretical consensus regarding the properties/behavior of the metaphysical concepts (EXTERNAL CONSISTENCY)