A Conceptual framework for performance modeling

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Outline

I. Motivation and Introduction
II. Modeling and nature of models
III. A Doubly Conditional Performance evaluation model
IV. Performance Measurement and Performance Management

I. Motivation and Introduction

Motivation

- Understanding the functioning of education and research: How does the production of knowledge work?
- Assessing education, research and their impacts: How can we measure productivity and efficiency of education and research and their impacts?
- What do we measure? (ontological ambiguities)
- How do we measure it? (measurement ambiguities)
- Why do we measure it? (effectiveness, equity, sustainability)
- An "intriguing" complex research problem
- A relevant policy issue

From Productivity to Efficiency

- Productivity is one of the basic economic principle since Adam Smith's pin factory and even before
- Any notion of productivity relates a vector of inputs to a vector of outputs
- In the assessment of research and education, all the three elements (inputs, outputs and the relation between the two) are affected by severe conceptual and measurement problems
- In research and teaching both inputs and outputs are not only qualitatively heterogeneous but sometimes truly incommensurable, the relation is non-deterministic, and the output is lagged but with a lag structure which is not fixed.
- If we extend the comparison and include a frontier of best practice we move to efficiency

From Efficiency to Effectiveness towards Impact

“There is nothing quite so useless, as doing with great efficiency, something that should not be done at all.”

“Efficiency is doing the thing right. Effectiveness is doing the right thing.”

— *Peter F. Drucker*

For impact, in a *broad* sense, we mean any effect, change or benefit, to the economy, society, culture, public policy or services, health, the environment or quality of life.

Moving towards effectiveness and impact, the problems increase

Methodological challenges

- D. Hendry (1979): “until the model does not adequately represent the data generation process ... it seems useless to try to test hypotheses derived from economic theory”.

“Econometricians may well tend to look too much where the light is and too little where the key might be found. Nevertheless, they are a positive help in trying to dispel the poor public image of economics (quantitative or otherwise) as a subject in which empty boxes are opened by assuming the existence of can-openers to reveal contents which any 10 economists will interpret in 11 ways...”

(**Hendry, 1980, p. 403**).

II. Modeling and nature of models

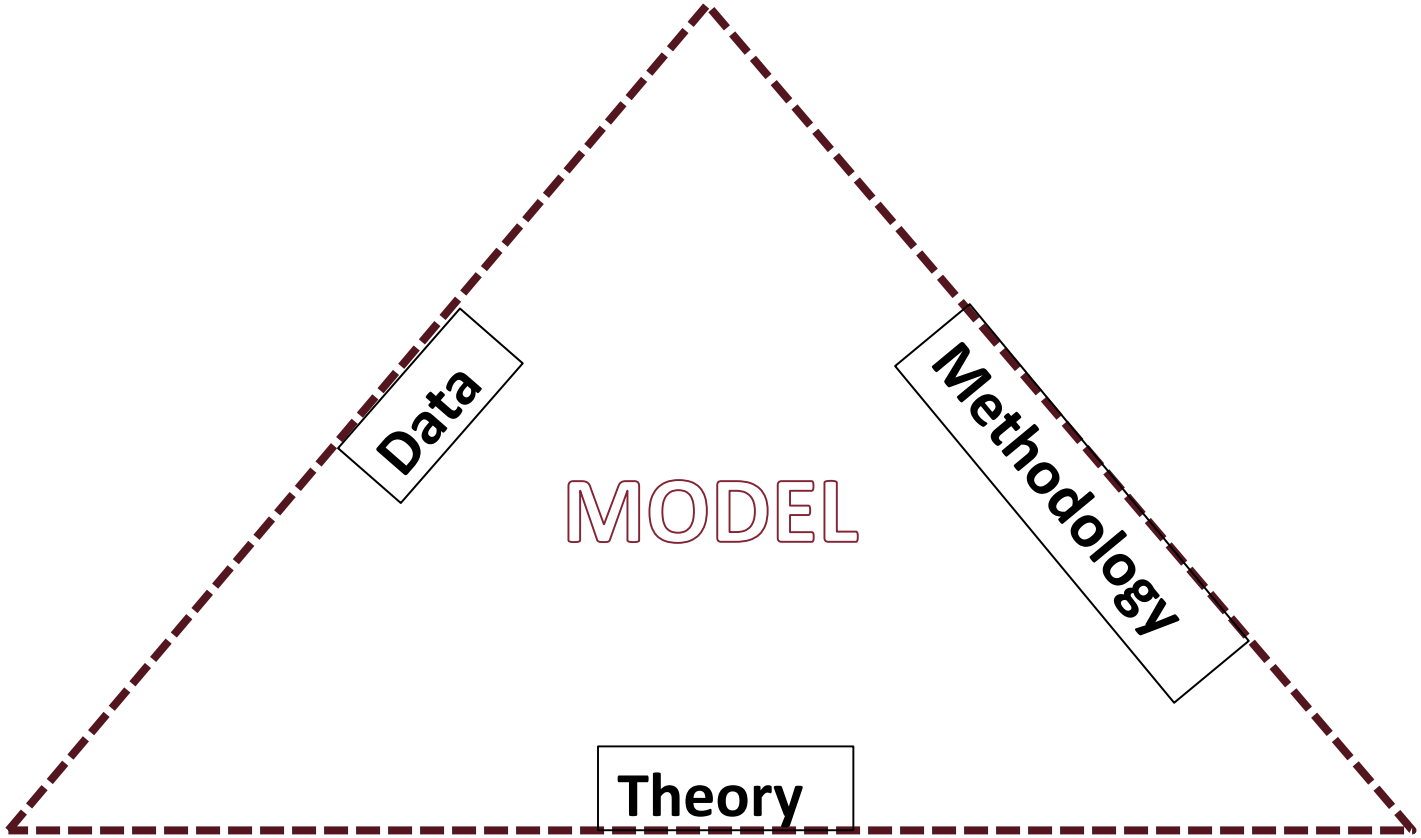
Need for an overall framework for the assessment of Performance

- Crucial importance of the issue of designing relevant models to assess the performance.
- The evaluation of performance is a complex task for many reasons.
- There are no perfect methods/estimators which fit for all purposes.
- In order to understand the appropriateness of the methods/estimators to be used, we need to frame the problem taking into account
  - the *systemic* nature of the phenomena and
  - to develop *models* of performance that are as close as possible to the reality being assessed.

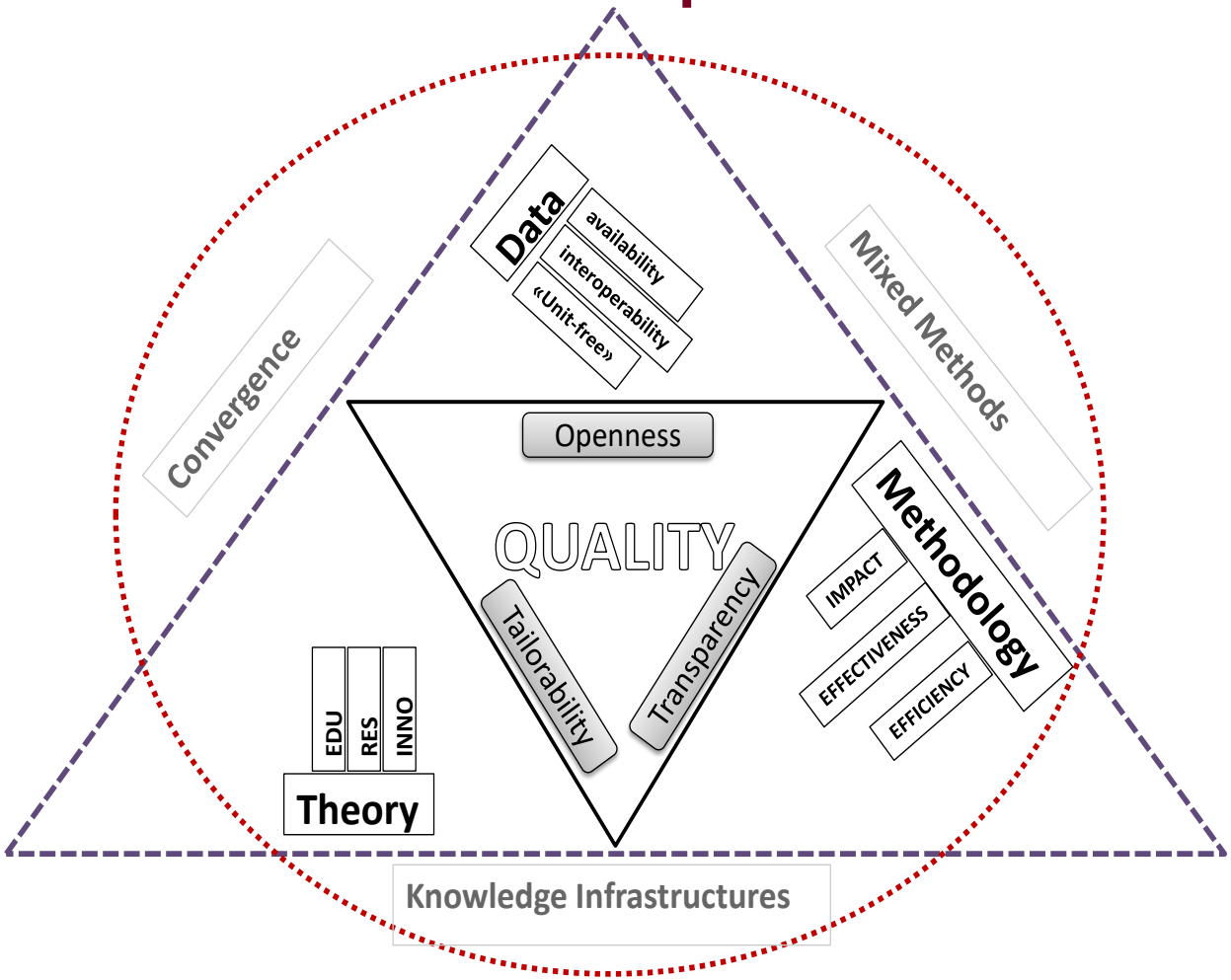
Need for an overall framework for the assessment of Performance

- each metric (quantitative evaluation based on the application of an estimator in our context) is based on a *model* that can be implicitly or explicitly defined and discussed.
- If the model underlying the metric is not described, this does not mean that the indicator is more robust to modelling choice. It simply means that you do not explicitly clarify and account for the underlying theoretical choices, methodological assumptions and data limits.
- Thus, as a consequence, if you do not specify your model of the metric, you may not check its robustness.

Developing a model



A systemic framework for the development of models of metrics



The ability to develop (and afterwards understand and use effectively) models for the assessment of research is linked and depends, among other factors, on the degree or depth of the conceptualization and formalization, in an unambiguous way, of the underlying idea of quality.

Source: Daraio (2017a)

Nature of models

- A model is an abstract representation, that from some point of view and for some end, represents an object or real phenomenon.
- The representation of reality is achieved through the analogy established between aspects of reality and aspects of the model.
- We have focused our attention on quantitative models: models in which the analogy with the real world takes place in two steps:
  - 1. *quantification* of objects, facts and phenomena in an appropriate way;
  - 2. identification of the *relationships* existing between the previously identified objects, closest to the reality (that is the object of the model).

Role of models

- The practical use of a model depends on the different roles that the model can have and from the different steps of the decisional process in which the model can be used.

- The analysis of the roles of model can start then with the main steps of a decisional process.

Role of models

- Dewey (1910) proposes (Dewey, J. (1910), How we think, Boston) to answer the following questions to take a decision:

1. *What is the problem?*
2. *What are the alternatives?*
3. *What is the best alternative?*

- Along the same line, Simon identified 4 activities necessary to take a decision:

1. *Information*
2. *Design*
3. *Choice*
4. *Verification*

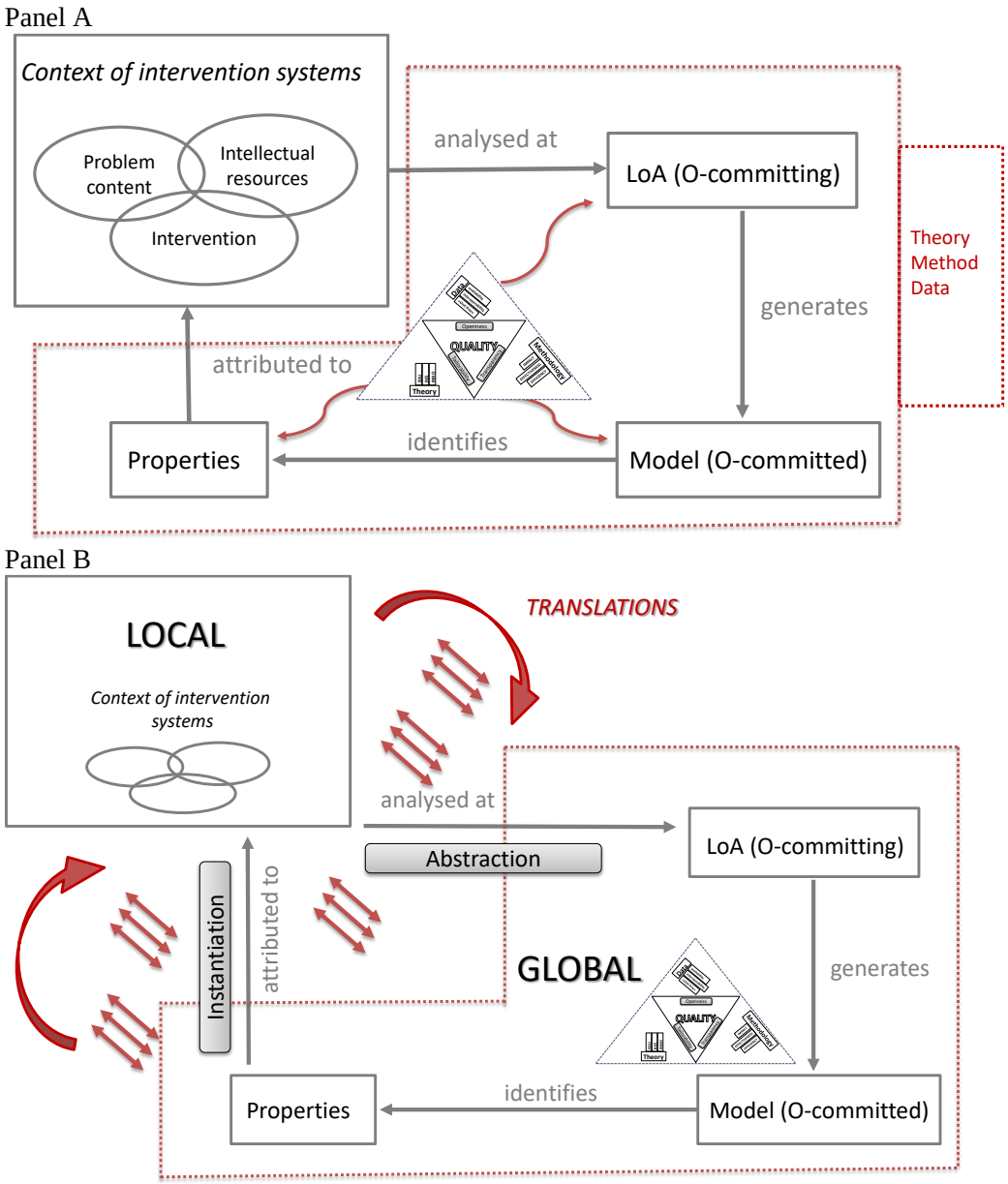
Role of models

- A practical role: the model is a tool for understanding the reality.
- *Potentiality* of models: 4 main roles:

1. Description
2. Interpretation
3. Forecasting
4. Intervention

- These 4 roles may be correlated or not, depending from the objective of the analysis and the way the model is built.
- Usually a model has one or a few roles, as it is difficult to embrace in one analysis all the 4 roles listed above!

The «generalized» implementation problem



Source: Daraio (2017b).

Useful readings: Borgonovo, E., & Plischke, E. (2016). Sensitivity analysis: a review of recent advances. *European Journal of Operational Research*, *248*(3), 869-887.

Abstract: *The solution of several operations research problems requires the creation of a quantitative model.*

- *Sensitivity analysis is a crucial step in the model building and result communication process.*
- *Through sensitivity analysis we gain essential insights on model behavior, on its structure and on its response to changes in the model inputs.*
- *Several interrogations are possible and several sensitivity analysis methods have been developed, giving rise to a vast and growing literature.*
- *We present an overview of available methods, structuring them into local and global methods.*

Useful readings: Saltelli, A., Pereira, Â. G., Van der Sluijs, J. P., & Funtowicz, S. (2012). What do I make of your latinorum? Sensitivity auditing of mathematical modelling.

Abstract: *Sensitivity analysis, mandated by existing guidelines as a good practice to use in conjunction to mathematical modelling, is as such insufficient to ensure quality in the treatment of uncertainty of science for policy.*

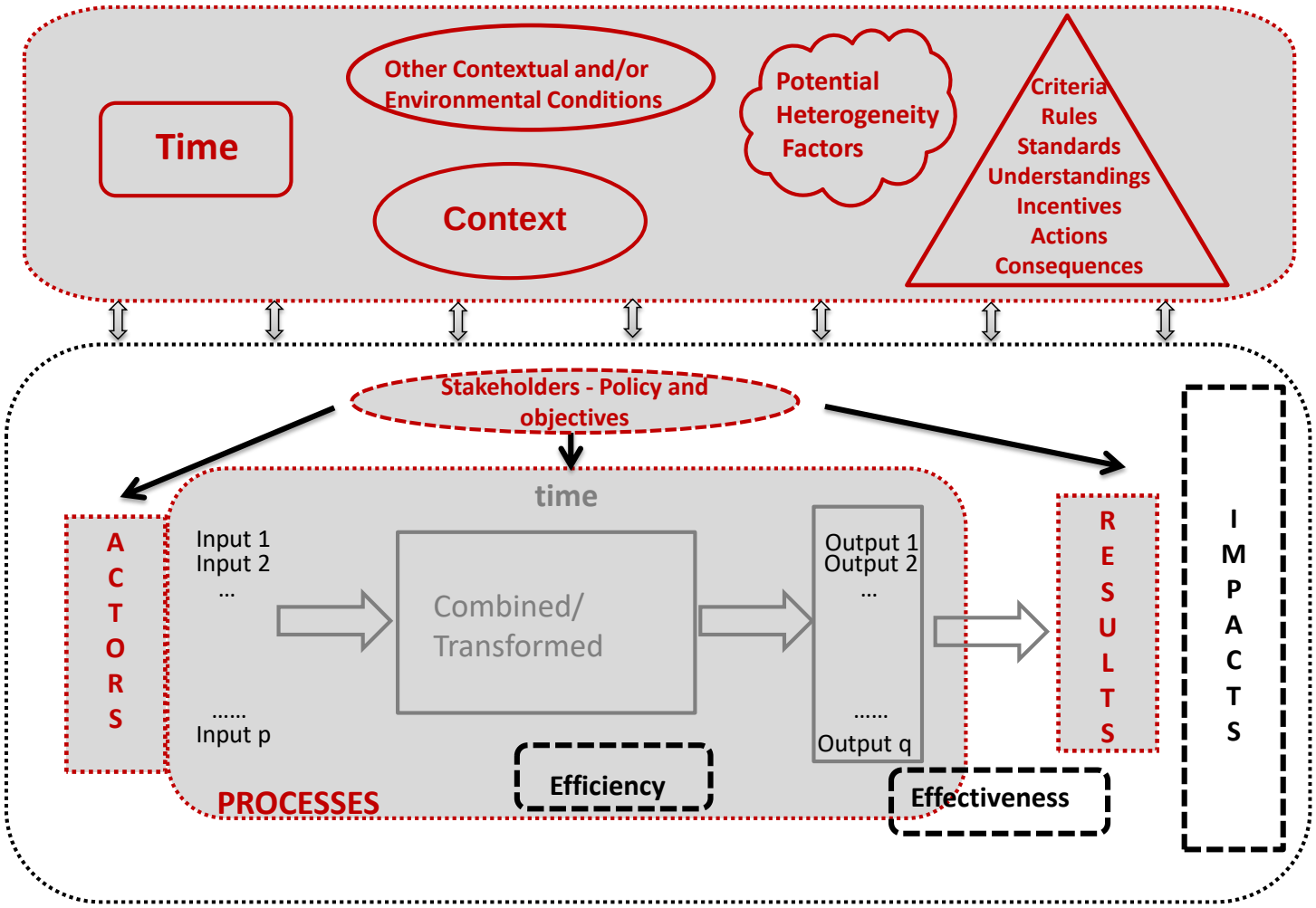
- *If one accepts that policy-related science calls for an extension of the traditional internal, peer review-based methods of quality assurance to higher levels of supervision, where extended participation and explicit value judgments are necessary, then by the same token sensitivity analysis must extend beyond the technical exploration of the space of uncertain assumptions when the inference being sought via mathematical modelling is subject to relevant uncertainties and stakes.*
- *We thus provide seven rules to extend the use of sensitivity analysis (or how to apportion uncertainty in model-based inference among input factors) in a process of sensitivity auditing of models used in a policy context.*

III. A Doubly Conditional Performance evaluation model

A Doubly-Conditional Performance evaluation model

- The next Figure illustrates the main component of a *Doubly Conditional* performance evaluation model proposed by Daraio (2017b) which is based on a combination and extension of Johnsen (2005); van den Hove (2007) and Lewis (2015).
- It is a possible model we can derive from the previous three-dimensional framework.
- It is “doubly conditional” because the evaluation is **conditioned two times**: **on the information that are available and on those which are not available.**

A Doubly-Conditional Performance evaluation model



Actors realize processes which produce outputs/results/ impacts according to their objectives/ stakeholders and policy

A Doubly-Conditional Performance evaluation model

Actors realize processes which produce outputs/results/impacts according to their objectives/ stakeholders and policy needs

We distinguish two kind of conditioning:

1. Internal conditioning or *normalization*: on actors, processes and results: compare comparable entities, setting appropriate reference sets.
2. External conditioning or *contextualization*: to account for heterogeneity factors that we call *external conditioning* or contextualization.

According to this model of performance evaluation,

it's all a matter of appropriate normalization and contextualization.

A Doubly-Conditional Performance evaluation model: concluding remarks

This model:

1. Permits the *identification* of the *components* of the analysis (in terms of theory-method-data characterization) that are excluded (what remains outside) in the specific context of the evaluation;

2. Provides an *interpretative value* of the measure (or metrics or indicators) of research assessment calculated, that has to be considered as a *residual*, what remains after the consideration of the dimensions we pursued, that is due to other factors or components not accounted for.

- It is a model in which **each one can find its own best way to contribute to the "creation of value"** of its over-hierarchical institution (for example, for individuals the department of the university, for the university the region in which it is located, and so on).

A Doubly-Conditional Performance evaluation model

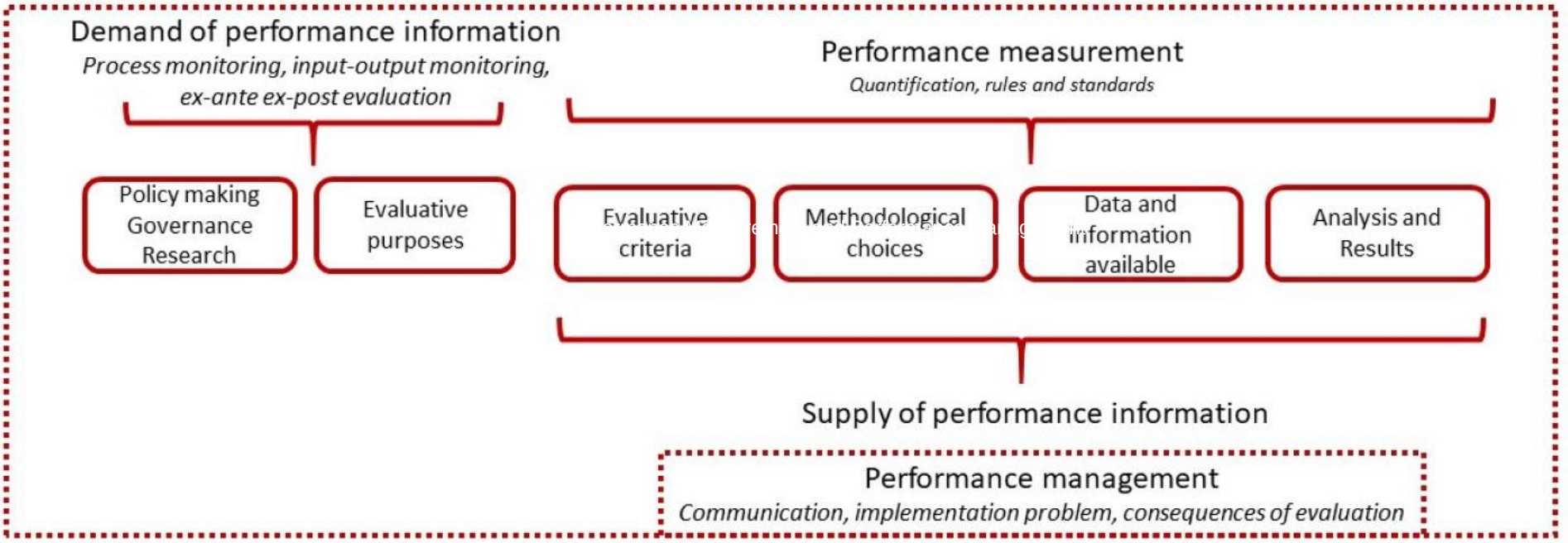
- It may be seen as a revisited version of the Ricardo's approach of *comparative advantages* but in the context of a broader framework.
- It allows to the evaluated unit, the evaluators and others to find out what is the «individual» optimal path of best performance considering the internal and external conditioning.
- *Rationale*: if we account for all possible internal and external conditioning, all the assessed units are performing at their own best.
- Having access to a multidimensional performance model which include the information on the multiple inputs/outputs/results/outcome and so on, facilitate to find out what is the «individual» optimal path in terms of combination or production mix
- a best mix which considers the internal and external conditioning

IV. Performance Measurement and Performance Management

Performance and Performance Management

- Performance “an organization's ability to achieve its goals and objectives measurably, reliably, and sustainably through intentional actions” (Hunter and Nielsen, 2013, p. 10).
- Performance management includes several constitutive elements, such as
  - performance leadership,
  - operational leaders,
  - operational managers,
  - management structure,
  - accountability systems,
  - performance budgeting,
  - information and knowledge production,
  - measuring and monitoring systems (Hunter and Nielsen, 2013).

Performance Measurement and Performance Management: an overview



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