Short description of the Research Project:

Foundations of the Results Chain Concept: Applying Statistical Physics Methodology to the Program Logic Model of International Development Projects

The proposed interdisciplinary research project aims at a better understanding of the results chain concept commonly and broadly applied in the planning, description and analysis of projects and programs of international development. The research project does this by applying the methodology of statistical physics to the social and material mechanisms of development interventions.

Background from the Perspective of International Development

Over the past five decades, international development assistance has attempted to reduce poverty and increase livelihoods of vulnerable groups in the developing world. Numerous bi- and multilateral projects, programs and other interventions based on grants or loans aim at positively influencing specific situations in beneficiary countries. Financial amounts involved are substantial: total net disbursements of official development assistance of the OCED countries have passed the 100 billion USD mark in 2005 and represents up to 1% of the gross national income of some donor countries[1].

In spite of these commitments, tangible macroeconomic results have remained limited[2], reflecting a less than satisfactory effectiveness and efficiency of aid in terms of the achievement of development objectives. Consequently, the international community has shifted its focus from ensuring quality aid *activities* to ensuring aid development *results*[3]. Among other consequences, this shift produced an increasing demand for thorough planning and evaluation of the development results of aid interventions.

A key concept in the planning and evaluation of development interventions is the development *results chain* that links the activities of an intervention through a series of logical steps of cause and effect to the desired development impacts. Sometimes, this or similar concepts are also referred to as *program theory*, a *program's theory of change* or *impact pathways*. Similarly, the *logical framework (LogFrame)* introduced by the U.S. Agency for International Aid in 1969 and widely adopted by the international development community builds on the notion of results chains[4].

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[1] Data from: OECD Development Assistance Committee (DAC) statistics website, http://stats.oecd.org/qwids/, visited on February 16, 2010.

[2] See "Aid Effectiveness: the micro-macro paradox", P. Mosley, IDS Bulletin, 17, 214 (1986) as an example for the gloomy discussion in the 1980s and early 1990s about the absence of positive macroeconomic effects of aid and, for example, "Development Aid: Expectations, Effectiveness, and Allocation", G. Mavrotas, M. McGillivray in "Development Aid", G. Mavrotas, M. McGillivray (editors), Palgrave MacMillan, 2009 for a summary of the somewhat more positive picture emerging in the last two decades.

[3] See the "Paris Agenda", 2005 and the "Accra Agenda for Action", 2008 as examples for international resolutions for the improvement of aid effectiveness.

[4] See, for example, „The LogFrame Handbook", World Bank. Results chains are referred to as "results frameworks" in that publication.

An example[5] of a results chain from the education field might be the following: 1) teachers' salaries are increased. This leads to 2) improved teachers' morale which, in turn, causes 3) teachers to work harder at teaching and to put more effort into preparation and pedagogy. This, in turn, leads to 4) improved students' understanding of the taught material and, ultimately, leads to 5) improved student achievement. Alternative or additional results chains may connect the same endpoints (1 and 5) by different pathways, e.g. starting by causing teachers to give up second jobs, or by attracting abler people to teaching.

While a useful and widely applied concept, the use of results chains is almost entirely common-sense based and lacks a rigorous foundation. Consequently, terminology varies widely and most development evaluators have developed their own way of deriving and defining results chains.

While some schools of thought reject the notion of program theory altogether[6], others are quick in making implicit assumptions about the possibility to disaggregate a highly complex process into a series of relatively simple steps of cause and effect without investigation of the plausibility of the underlying assumptions.

Overall, there seems to be a lack of practical guidance for the construction of results chain as well as of ways to assess the viability of the approximations made when simplifying complex development processes in this way.

Background from the Perspective of Statistical Physics

Compared to the systems traditionally described by statistical physics, the social systems in which international development takes place show additional levels of complexity. In the language of statistical physics, they show stochastic, non-linear, strongly interacting, chaotic and critical behavior. On the "microscopic" level individuals take decisions that cannot be predicted with certainty and the sheer number and diversity of variables of social interaction has lead to the fact that the mere idea of any mathematical description or modeling had seemed too great a challenge for some time.

However, during the 1970s, pioneering work by a number of physicists began[7]. This work has given rise to a young and thriving field of study, sometimes referred to as (quantitative) Sociodynamics[8] which is essentially based on statistical physics methodology and borrows concepts from non-linear dynamics (Synergetics[9]), chaos and catastrophe theory, and the theory of phase transitions and critical phenomena.

The description is based on microscopic and macroscopic social and material states that are described by (large) sets of personal and material variables. Unlike in classical applications of statistical physics where deterministic equations of motion on the microscopic level are known, the evolution of individual social states can only be described in probabilistic terms by transition

[5] Adapted from „Evaluation", 2nd edition, Carol H. Weiss, Prentice Hall, 1998, p. 56.
[6] See, for example, "4th Generation Evaluation", E. Guba, Y. Lincoln, Sage, 1989 for the point of view of the constructivist school of thought in evaluation.
[7] Numerous papers, for example by the following authors: P. Allen, H. Malchow, H. Haken, E.W. Montroll, I. Prigogine, D.F. Walls, and W. Weidlich.
[8] Main contributions have been made by W. Weidlich (e.g. "Sociodynamics", Dover, 2000), D. Helbing (e.g. "Quantitative Sociodynamics", Kluwer , 1995) and H. Haken (e.g. "Synergetics", Springer, 1983).
[9] See, for example, the books by H. Haken: „Synergetics", Springer, 1983 and „Advanced Synergetics", Springer, 1983.

probabilities between different states. This leads to master-equations for the evolution of macroscopic social states of groups of individuals or entire populations.

Planned Research Content

The planned research project represents a classical case of applying methodology from one branch of science (Statistical Physics and Sociodynamics) to another (evaluation research). The main target groups of the results of this research are the community of evaluation researchers and evaluation practitioners. Consequently, the publication of findings in academic, peer-reviewed evaluation journals will be complemented by a number of "easier to digest" publications targeting evaluation practitioners. The ultimate objective of this research project is to improve the understanding and usage of the results chain concept in evaluation and, in this way, to make a contribution to better planning and more thorough evaluation of international development interventions.

The research is based on a systematic investigation of the properties of a "generalized results function" that expresses an observable on the level of development impacts in terms of all variables of relevance to the related intervention. The planned research project does however not attempt to calculate or approximate generalized results functions themselves but utilizes the related methodology and concepts.

Developmental results functions could be as diverse as, for example, the improved performance of a water ministry (in terms of the quality of produced policy) in a developing country as a consequence of diverse staff training activities or the increased income of coffee farmers caused by the installation of improved irrigation systems.

Due to the obvious complexity of underlying mechanisms as well as the sheer number and diversity of variables involved, the generalized results function may be non-local and non-linear with respect to its variables. If macroscopic stochastic behavior is of importance, the generalized results function can be replaced by a probability distribution over macroscopic states. The solutions of sociodynamical master equations discussed above are examples for generalized results functions.

Based on the mathematical and logical properties of the generalized results functions, lessons are drawn for the design and the range of applicability of the results chain concept used in international development. In addition, a more specific results chain terminology will be developed.

The planned project will research the plausibility of results chains and further develop the graphical language and specify the terminology used for their design and description. The work has three distinct aspects.

First, the preconditions for the existence of a macroscopic, deterministic causal relationship in the mathematical sense are investigated and translated into the language used in international development. The conditions under which stochastic effects persist on the macroscopic level are elucidated and consequences for a description in terms of results chains are derived.

Second, the underlying concept of a series of independent steps of cause and effect linking development activities to development impacts is analyzed by investigating the conditions under which generalized results functions can be decomposed. This approach can be most easily understood by conceptualizing a generalized results function f{X} as the result of a "generalized results operator R acting on a macroscopic state X. The concept of separate logical steps can then be

understood as a decomposition of R into a generalized product $R = R_1R_2…R_n$ that can be investigated using conditional probability analysis. The result of this analysis will provide a set of conditions under which such decomposition – and thus the notion of separate logical steps in a results chain – is likely to represent reasonable approximations.

Third, as part of the previous analysis, a simple graph language will be developed, e.g. building on representations used in causal theory[10], that will allow for the description of more complex results frameworks than the commonly used one-dimensional (chain) approach.

[10] See, for example, „Causality. Models, Reasoning and Inference“, J. Pearl, Cambridge, 2009.