

Aiding agents of competition

or

an innovative approach to modeling financial aid

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1 Abstract

Over the past decades, economic modeling of the aiding process have many times been revisited by criticism. Using the age-old symbolic models theoretical economics predicts significantly different outcomes than what can be experienced in the real world. This paper attempts to summarize the underlying reasons behind that failure, and tries to assess the situation from an IT-oriented perspective. An alternative approach will be suggested that is hoped to provide better explanatory power.

Keywords: agents, agent-based modeling, social modeling, economic growth, financial aid

2 Introduction

The issue of financial aiding is an ever relevant one. In the past few years, international developments have shown, that the world is becoming ever smaller, and that local problems can escalate to global matters in a very short time. Freedoms have their price, and the freedom to travel means that different cultures meet each other, learn about each other, and differing living standards become apparent. It is only human, that people living in a poorer country want to have better opportunities, and thus it is not only humane, but also prudent for wealthier nations to try to raise the living standards of poorer nations.

Modeling this aiding process is crucial, so that it can be predicted what kind of outcome a given aiding scheme will have on the recipient nation; and also to evaluate the aiding scheme after it's execution. It is therefore of great importance to have a model that is realistic, since it can both save millions of dollars, and determine for decades the growth path of the recipient nations.

3 Aid and competitiveness

Providing financial aid it a complicated issue. The reason for it is usually a lot more complex than simply "make people satisfied enough not to come here" In the capitalistic world aiding a nation means aiding oneself, since the aid-recipient will hopefully turn into a future consumer. In order for that to be economically sound, the aid provided should generate more wealth than the aid itself. If, for example, an aid receiving nation spends the foreign aid buying weapons from the aid lender, this only means that the aid providing nation gave a one-time aid to it's weapons' industry. On the other hand, were the aid used in a production environment, it could have generated excess wealth, which (as Keynes[1] proved)

generates excess savings, higher investment and an overall growth, that might have produced a *higher* demand for the products of the original aider than the amount of aid given.¹

3.1 Output

Output, or more properly output per capita indicates the wealth a nation provides per person. It is accepted as the general measure of the productivity of a nation, but it has several drawbacks when used as the measure of welfare. The trivial is the issue of different price levels across nations (low income nations have generally lower prices, so they should theoretically fare better than the differences in per capita output should indicate), but this bias is easily corrected by adjusting the income according to the purchasing power². Even after this adjustments, significant factors of human welfare remain unaccounted for, thus adjusted output per capita remains a poor measure of welfare³. Nevertheless, it is generally assumed, that higher personal income means better quality of life.

On the other hand, if one wants to measure the ability of a nation to act as a market for goods, per capita income is unquestionably useful. It shows the ability of the 'average' denizen to purchase the services of the internal or external producers, thus higher income means better ability to purchase.

All in all, taking the dual goals into consideration, (and also the fact, that output per person can with relative ease be determined), the development of a nation is usually expressed by the changes in the per capita output.

3.2 Competitiveness

An alternative measure of development is the competitiveness of a nation. This is an even trickier term, since most authors refuse to give a definition for it. The general consensus seems to be, that a nation is competitive, if it can produce goods other nations want.

The problem of competitiveness (apart from the lack of definition) is, that it is not such a simple macroeconomic term as output. It is generally agreed, that the competitiveness of a nation depends not only on macroeconomic factors, but also on microeconomic institutions (that is, both on the government and on the corporations within the nation). So, although this measure is more accurate to compare countries (since it relies on the "market" to make such comparisons), it is not *really* a measure at all.

3.3 Aiding

Financial aid is supposed to achieve the goal described above: raise the per capita output or the competitiveness of the recipient nations. It is generally assumed, that low income countries have a lower income mainly because they have insufficient capital reserves, thus are unable to achieve the productivity of the western world.

The aiding process developed by this model is rather straightforward. It suggests, that decreasing the capital constraint of the low income countries would automatically lead them to higher production. The arising larger wealth would then be distributed among the population, and the economy would start to develop⁴.

1 Elaborate theories exist about economic growth. The mainstream model was developed by Samuelson and Solow, described in [2] and [3]. An alternative approach leads to nearly the same conclusion: the growth of the money and the possible growth of capital can lead to economic growth ([4]).

2 The PPP (Purchasing Power Parity) has a wide literature, and it's efficiency is questioned even by mainstream economists.

3 People tend to like the places where they are originally from. They will not leave their country of origin solely for economic reasons, since the attachments they developed throughout their childhood and adolescence remain a significant factor in their welfare. Another such factor is the way of life people grew accustomed to. If they have to change the way they live their life, a higher income might not be able to compensate for it.

4 Once again, this is a very capitalistic worldview, where everyone strives for growth. In societies more attuned to nature the goal is usually to keep up the standards of living, and not to improve them. This second approach might be a more stable long-run strategy, but

The first questioning of this strategy arose in the early 1990s, when empirical research[5] showed, that a significant percentage of aid recipient countries grew to rely on aid, and aid actually had an adverse effect. In the case of other countries (most notably the far-eastern nations), the aiding lead them to catch up with the aiders, giving rise to yet another set of problems. What can be the reason for this discrepancy? How can this be resolved?

4 Modeling aid

Economists model aid for the same reason a physicist models gas: in order to deal with a complex problem that is directly unsolvable. Using models is inherently problematic: if they are too simplistic, they might hide the real issues determining the behavior of the modeled system; if they are too lifelike they might be overly complex and lead to issues because of that complexity.

In order to deal with the apparent malfunction of the aiding model, we need to determine which kind of error did it have.

4.1 Problems

The predominant models of aid are all symbolic macroeconomic models. They work like any symbolic model: describing parts of the system in equations, using variables to indicate the relevant factors. This approach has several drawbacks:

- Macro-level: the model only contains information about the macroeconomic variables. If there are microeconomic effects (for example those indicated in the 'competitiveness' section), they remain hidden for the model.
- Stable and axiomatic social structure. This is a variant of the previous aspect, and means that the general models consider the society as given, mostly unimportant. In the tribal societies of many African nations, it couldn't be further from the truth.
- Lack of indicators. In most cases the models only worry about the output per person, and as it was shown, that is hugely lacking. Most models make it impossible or rather hard to install secondary indicators.
- Misleading indicators and indicator-targets: in case of using alternative indicators, the modeler runs the risk of suggesting governmental practice that maximizes the indicator, and not the underlying effect

Because of these (and other) problems, the current modeling framework is destined to fail.

4.2 Requirements

An accurate modeling framework of aid should be able to contain the following aspects:

- inclusion of the microeconomic level, but keeping the macro level as well
- the ability to include numerous indicators at the same time
- the framework should be easy to use and tweak
- a dynamic social modeling should be present

In the remainder of this paper it will be shown, that using an agent-based approach to these issues might lead to a more accurate model than the one used in current practice.

5 Agent-based social modeling

In their prominent book, Russel and Norwig describe an agent as "something that senses and acts" [6]. Thus the agent-based modeling of social entities is rather natural, since society, as a whole, is nothing else, than a large-scale 'emergent behavior' of such autonomous agents.

5.1 Pros

By it's very nature, agent-based modeling grants the most desired effect: modeling in the micro level, focusing on the entities taking part in the transactions, and the macrobehavior emerges, like the sum of the parts. It enables the modeler to focus on modeling the individual (and that model can easily be tested against observations), and given the correct framework, the model of the society is also given. This enables the observation of the social effects of individual changes (for example changing the motivation of the agents from altruistic to rational/economic and vice versa), and also the individual effects of social changes (for example the change of welfare incurred by the change in the tax rate).

Agent based modeling can also allow for non-homogeneous agents, whereas in a symbolic modeling framework usually homogeneous entities are assumed. Moreover, in an agent based framework changes on the agent level can be allowed, making the agents respond to the changes of the environment by changing themselves.

5.2 Cons

There are two basic problems using agent based approach in social modeling. One is the computational issue: the more lifelike a model becomes, the more computational power it needs. One has to make a choice between computational efficiency and explanatory power, and this line is not always easily drawn. Also, like with symbolic modeling, making the model more complex does not always result in more significance.

The other issue is more significant. Most agent based modeling tools require a high level of computer literacy, usually in the form of programming skills. In most cases this means that social scientists have to work together with programmers to create agent-based models. There is also a general resentment, disapproval, or even fear of the agent based approach. This can partially be due to a kind of "uncanny valley" effect: the agent-based approach generates models "too" lifelike to accept, and it's errors are too easy to magnify.

5.3 Precedents

When discussing the issue of emergence, emergent behaviour in their book about swarm intelligence, the first example Kennedy and Eberhart bring forth is the example of an economy. They quote Smith, and his invisible hand theory, and claim, that the seemingly self-organizing nature of the marketplace is nothing else but an emergent behaviour (see [7], page 18-19). This clearly shows, that the agent-based technology can intuitively be used for economic applications.

An interesting and early project was comprehensive agent-based model of the United States economy. It was created in 1996 (ASPEN project, [8], [9]). This proved, that economic systems can efficiently be modeled using the agent-based approach, and such phenomena, as economic cycles, can easily be explained.

6 MAAB

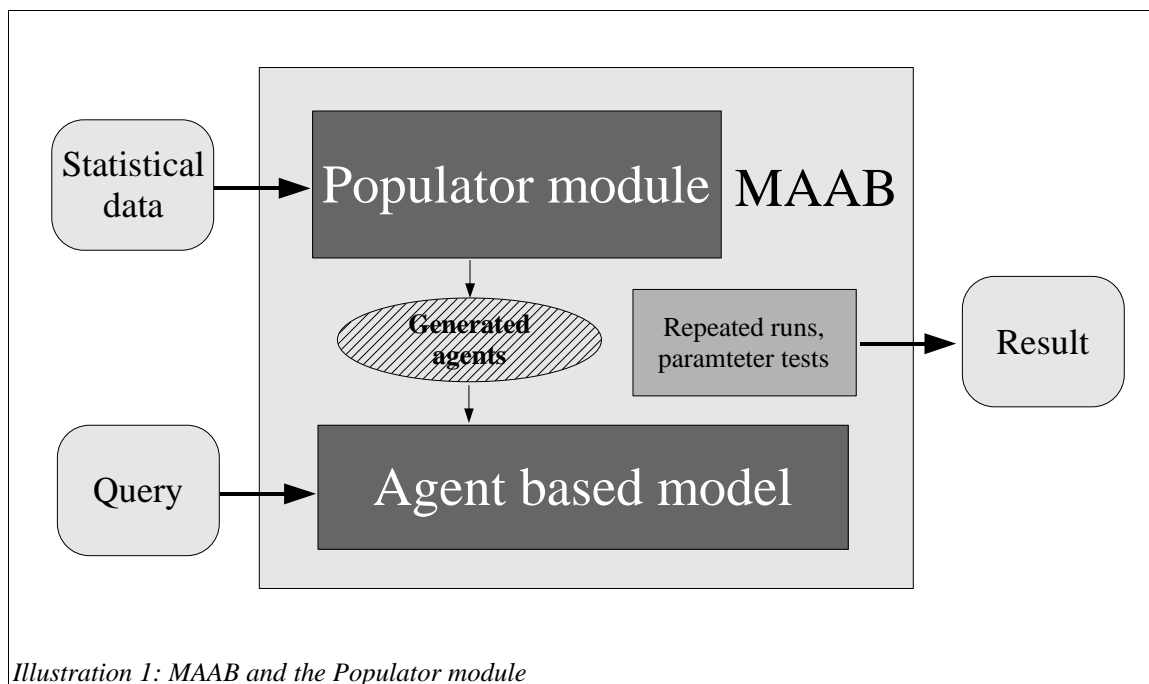
'Modeling Aid in an Agent-Based environment' is an attempt to incorporate the best elements of agent-based modeling into a comprehensive framework to address the issue of financial aid, economic growth and competitiveness. This framework has to be able to provide both 'rule of thumb'-type conclusions, and enable the modeling of specific situations.

6.1 The populator module

The most common complaint about the agent-based approach is its relative complexity. Social scientists usually lack the necessary skills to create their own models, and it is usually hard to change the parameters of existing models as well. Another problem is, that a given agent-based model is usually used to address a specific problem, and it is rather problematic to re-cycle parts of the model.

MAAB's populator module aims to solve these problems. It is, in essence, a collection of templates, that can be used in the generation of a model. In order to make MAAB more usable, the populator module knows of all the various types of pre-defined and user-defined agents, and allows templates to be created using them. These templates in turn can be initialized using statistical data, much like a 'standard' symbolic model would be. This procedure will tremendously simplify the creation of country-specific models. The general way of creating a model would be as follows:

1. Feeding statistical data to the populator module
2. The populator module analyzes the data, and selects/generates a template (selection could happen with maximum likelihood algorithm, generation could be made by mixing the components of the selected templates -- if the data shows, that the country in question conforms 80% to Template_3 and 20% to Template_8, the new template generated would contain 80% of Template_3 and 20% of Template_8 components)
3. Using the selected/generated template, the populator module generates the set of agents to be injected to the model (and, if necessary, initializes the model itself)
4. The model is ready to run



This approach obviously requires that most of the model specifics (how the agents interact with each other, how the social dynamics work, etc.) are either determined by parameters of the modeling environment, or by other agents in the system.

6.2 Agent variables and methods

To be able to model an economy, our agents have to be given a set of distinctive parameters. In our case, most notable are:

- A **type** parameter, to be able to tell the consumers, the corporations, the banks and the government apart. (There are other types of agents as well, but in an economy these are the most relevant.)
- A **grouping** parameter. This allows for the formation of families, clans, tribes among humans, and sectors among corporations.
- An **age/lifecycle** parameter. This allows for change in the system (and also makes evolutionary approach applicable). This is not only defined for the 'human' agents, as corporations and other organizations can have life cycle as well. This parameter structure is also responsible for the birth-rate and birth conditions of various agent types (some grouping pre-requisite for 'worker' agents; some profitability pre-requisite for corporate and banking agents, etc.)
- An **experience/knowledge** parameter, to indicate the skills and practices, and the past history of a given agent. This, as many others, is not obviously a simple skalar, rather a vector or a complex object (in case of a worker, past experience has to be separately taken into account for the various types of jobs the agent had, if we want to ascertain it's efficiency in a given workplace).
- A **utility/profit** function, that describes the payout of the agent. This function works as a kind of goal for the agent, maximizing it is the drive behind its actions.

Using this variable mix, MAAB will ensure, that the system will not only incorporate physical capital and the 'untrained worker' type of 'labor' most economic models use, but also the so-called 'human capital', which is lately considered one of the main driving forces behind today's growing economies. It also enables MAAB to model a truly dynamic system, where agents are introduced to and removed according to natural rules.

6.3 Social structure

The social structure is the relationships among agents. Using the 'grouping' parameter structure, complex social hierarchies can be described, thus allowing for non-individual decision processes. This obviously can be built in to the agents' utility/profit function (for example, in the form of a constraint, etc).

Examples of this behavior could be:

- A social structure describing a family with children, where the parents' utility depend on the utility of the children
- A tribal society, where the leader curbs the decision possibilities of the members of the tribe
- An international holding, whose members must maximize the profit of the holding, not their own, etc.

6.4 Aggregated indicators

One of the greatest advantages of using the agent-based approach is that micro-level data is available. So instead of using the supposed 'y' output variable, this can be calculated by adding up the net output of all the firms present in the model. Also output does not have to be the only indicator of growth, since we can also determine changes in the utility (its sum, its distribution, etc... so that we don't only know whether the society as a whole lives better or worse, but we can also determine changes in the *distribution* of welfare).

Such, previously unmodeled elements as workforce efficiency can easily be observed, and the changes in the employment structure can say a lot about the efficiency of a given governmental action.

6.5 Competitiveness, International cooperation

Last but certainly not least, the MAAB framework has to take international cooperation into account. Changes within the nation can change the quality of their product, meaning an inherent competitiveness gain *ceteris paribus*. In the 'real world', however, the situation does not remain unchanged, thus the framework allows for changes in the international environment as well.

An accurate modeling of the 'Rest of the world' sector is also crucial, since it shows the changes in the export and import structure of the aid-receiving nation. This can be used to determine which path will the nation choose, one of aid-dependency, or one of heightened economic growth.

7 Conclusion

Because of the incredible importance of worldwide economic balance, the accurate modeling of financial aid is crucial. As opposed to the currently used symbolic models, an alternative agent-based approach could provide more accurate results. Developing the MAAB framework described here provides a revolutionary approach to these issues, incorporating the ease-of-use of symbolic modeling and the greater explanatory power of the agent-based solutions.

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