An Agent-Based Model Suitable for Discussion of Institutions, Welfare and Capitalism

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Abstract. In the Tiebout's model are operationalized assumptions about the decentralized behavior of a population of autonomous individuals who seek greater utility through choices between jurisdictions with different political institutions designed to aggregate preferences. Based on an agent-based model inspired by Tiebout's model, we discuss the validity of these assumptions for the case of empirical situations present in capitalist societies.

Keywords: agent-based models, institutions, welfare, capitalism.

1 An Agent-Based Model of Tiebout: Efficiency from Decentralized Behavior

For an initial understanding of the relationships between agents, institutions and criteria of efficiency for determination of social outcomes, three starting points:

i. Social systems are both complex and adaptive, must be thought through agents interacting in micro-scale to creating systemic properties that feeding back these micro levels of interaction.

ii. Diversity is inherent to individuals and social systems: means exclude some reductionisms (representative agents and symmetric behaviors) and incorporate diversity (different incomes, learning, memory, cognitive sophistication, and asymmetric information) in the core of a theory. The incorporation of diversity requires significant changes and adaptations in many theoretical models and canonical methodologies. [1]

iii. Social agents act according to inductive reasoning: both economists and political scientists increasingly point to the resulting confusion in dealing with assumptions of deductive rationality in decisions that are complicated and potentially ill-defined or poorly structured. There is clearness that humans can apply perfect rationality very modestly. Humans often use inductive reasoning: they create hypotheses, act upon the more credible, and change the hypotheses if these does not work immediately or cease to function after a period of success. Regularly, this leads to a world psychologically rich of ideas or mental models that compete for survival with other ideas or mental models. [2]

An agent-based model (ABM) developed by Kollman, Miller and Page [3], based on the model of Charles M. Tiebout (1924-1968), will be presented as an approximation of a perspective that considers the three points quoted above. We believe that the

adfa, p. 1, 2011.

MBA will allow an initial illustration of how the issues about institutional efficiency could be thought.

The hypothesis of Charles M. Tiebout is that local public goods can be efficiently produced if the agents can freely choose between alternative jurisdictions that compete in the provision of basic public goods in order to attract citizens. This assumption allows comparative research on the differences between institutional designs to aggregation of preferences. Kollman, Miller and Page [3] develop an agent-based model based on hypothesis of Charles Tiebout to explore how social outcomes are affected by political institutions designed with the purpose of aggregate individual choices on issues concerning the production of local public goods.

In the ABM, the political institutions simulated by the authors are the referendum, direct competition and proportional representation. Once defined for each jurisdiction the political institution, citizens "vote with their feet" in each time period by migrating to jurisdictions according to public projects or policies offered by jurisdictions. The resulting policy in a jurisdiction depends on the preferences of citizens located within this jurisdiction in each period, in a manner determined by the existing institution of preference aggregation. Citizens may continue to relocate in response to change in local political positions, and the local political positions may continue to change in response to relocation of citizens. The authors found that social efficiency is higher, respectively, in jurisdictions with institutions such as direct competition and proportional representation, because allow citizens execute a greater degree of experimentation among alternative jurisdictions. Only in the case of a model with only one jurisdiction, the one-party democratic referendum will produce higher aggregate gain, because it allows an average platform of a generated set of random preferences and there is no possibility of migration of discontented voters to other institutions.

1.1 The model, variations and results

We now make a brief description of the math model developed by the authors [3] from which the computational model was developed. This description is for the comparative case between democratic referendum and competition between two parties for two jurisdictions.

The authors assume a set of agents N_a, and each agent must reside in one of possible jurisdictions N_{aj}. Within each jurisdiction, local government is obliged to position itself on a set of local public issues N_i. All jurisdictions should take positions on each issue N_i. The positions on the issues are "absence" or "presence" of public goods or policies, and the expression $p_{ji} \in \{Yes, No\}$ will denote the position of jurisdiction j on issue i. A platform $P_j \in \{Yes, No\}^{N_i}$ will denote the vector of decisions with all issues N_i of the jurisdiction j. The utility of agent to the issue i will be represented by V_{ai}. If the issue is part of the party platform, the agent obtains utility V_{ai}, and if not, the agent does not get any utility. The utility of the agent to the platform P_j is given by:

$$u_a(P_j) = \sum_{i=1}^{N_i} V_{ai} \cdot \delta(p_{ji}), \text{ where } \delta \text{ (Yes) = 1 and } \delta \text{ (No) = 0.} \qquad (1)$$

Table 1. Preferences of eight agents about three issues. (Source [3], p.200)

Agent preferences			
Agent	Issue 1	Issue 2	Issue 3
1	+1	+1	+1
2	+1	-1	+0.5
3	+1	+0.5	-1
4	+1	-1	-1
5	+1	-1	-1
6	-1	-0.5	-1
7	-1	+0.5	-1
8	-1	+0.5	-1

Table 1 lists the utilities of eight agents on three issues. First, consider a jurisdiction containing three of eight agents (agents 1-3 in table). If the institution is democratic referendum, with platforms (Yes, Yes, Yes) (Yes, Yes, No) (Yes, No, Yes) and (Yes, No, No) – all these platforms are members of a top-cycle set –, then the platform chosen will be (Yes, Yes, Yes), because the aggregate utility is 4.0, the higher utility. The aggregate values of these platforms are respectively 4.0, 3.5, 3.5, and 3.0. If there is a direct competition between two parties in that jurisdiction, with each receiving a set of randomly generated platforms, dispute can happen between platforms with inferior utilities in the democratic referendum, so that the democratic referendum will always be preferred to direct competition. To understand the results, simply apply the utility function (1). For example, for the platform (Yes, Yes, Yes), the first agent in table 1 has a utility of 3.0, since the sum of the utilities of the three issues accepted as the party's agenda is equal to (+1.0) + (+1.0) + (+1.0) = 3.0. For the second agent will be 0.5, since the sum of (+1.0) + (-1.0) + (+0.5) = 0.5. And for the third agent, (+1.0) + (+0.5) + (-1.0) = 0.5. Thus, the total utility for such jurisdiction is 4.0.

Now, consider a second jurisdiction containing the remainder of agents in Table 1 (agents 4-8). In this jurisdiction, the middle platform of greater utility under the democratic referendum is (No, No, No) with a value 0. It is worth remembering that when $\delta(p_{ji})$ takes the value No, that is, $\delta(No)$ = 0, any use associated with the issue, whether positive or negative, is void; hence the value is 0. Thus, any other configuration of the issues that not (No, No, No) will produce negative utilities. For example, to the platform (Yes, No, No) for the agent 4: (1.0) + (-1.0) + (-1.0) = 1.0; for agent 5: (1.0) + (-1.0) + (-1.0) = 1.0; for agent 6: (-1.0) + (-0.5) + (-1.0) = -1.0; for agent 7: (-1.0) + (0.5) + (-1.0) = -1.0, and for agent 8 (-1.0) + (0.5) + (-1.0) = -1.0. The total utility of the sum of the individual utilities will be -1. The aggregate utility for the two jurisdictions is 4.0 + (-1.0) = 3.0.

This equilibrium is not stable for the case of direct competition between two parties. In this second system, the first jurisdiction, the platform (Yes, Yes, Yes) with value of 4.0, can be defeated by a rival platform, for example, (Yes, No, No) with a utility of 3.0. That is because, with this new configuration, the agents 4 and 5 will have more utility if they migrate to the first jurisdiction, and, as result, the utility of

the first jurisdiction as a whole will increase from 4.0 to 5.0. Thus, after migration, the utility for the first jurisdiction for each agent will be 1.0 and the total score will be 5.0. After migration, in the second jurisdiction, the platform (No, Yes, No) becomes the only member of the top-cycle, because will produce the value of 0.5. Thus, the new equilibrium to the two jurisdictions with direct competition and two parties will have an aggregate utility of 5.5, higher than the prior aggregate utility of 3.0 for the previous case of democratic referendum.

To Kollman, Miller and Page, the absence of a single result in the direct competition between parties generates a process of relocation of agents in order of increased of aggregate utility. The above example illustrates that increase of utility requires a temporary decrease in utility of a given jurisdiction in order to induce migrate of agents and, possibly, increase the aggregate utility to the entire system.

In Tables 2 and 3 are the results for models with one or two jurisdictions. In the simulations were added institutions of proportional representation. The proportionality is ensured in the way as follows. After a party receive votes on its platform, say 18%, the party shall have their votes weighted by 18% over each of the issues. The final decision on each issue will be equal to Yes if the total weight of all parties in a jurisdiction which advocate Yes to the question is more than 50%, otherwise the decision will be Not.

In the tables, is observed that increasing the number of institutions implies in the increase of the utility. However, the unexpected outcome was that the performance of various political institutions reversed completely. For example, democratic referendum, the better performance in the model of a single jurisdiction, has become worse,

Table 2. Results for only 1 jurisdiction. (Source [3], p.197)

Single Jurisdiction: Per Capita Utility after Ten Elections (200 Trials)		
Institution	Per Capita Utility	(s.e. of the mean)
Democratic referenda	2.69	(0.12)
Direct competition (2 parties)	1.45	(0.13)
Direct competition (3 parties)	0.67	(0.13)
Direct competition (7 parties)	0.33	(0.13)
Proportional representation (3 parties)	1.33	(0.13)
Proportional representation (7 parties)	1.36	(0.13)

Table 3. Results for multiple jurisdiction. (Source [3], p.199)

Average Number of Agent Relocations per Trial (50 Trials)						
Institution	3 Jurisdictions	(s.e. of the mean)	7 Jurisdictions	(s.e. of the mean)	11 Jurisdictions	(s.e. of the mean)
Democratic referenda	864.16	(17.24)	863.2	(10.41)	887.3	(5.26)
Direct competition (2 parties)	915.68	(14.67)	1162.5	(8.63)	1293.7	(7.13)
Proportional representation (3 parties)	1277.60	(34.41)	1371.06	(25.75)	1420.28	(21.74)

and now the proportional representation has the best performance.

Two features of the model could generate this trend. First, the aggregate value for a configuration of agents is positively correlated with the homogeneity of preferences in each jurisdiction. Secondly, the instability of the direct competition and proportional representation is connected to the heterogeneity of preferences in a jurisdiction. Combining these two effects, if agents in an institutional configuration are not quite homogeneous in each jurisdiction, the aggregate utility will be low, and the party competition will generate new platforms that produce an unstable configuration. If, however, the agents are homogeneous in each jurisdiction under any configuration, the aggregate utility is high and the platforms are stable. Thus, equilibria reached by competitive institutions are correlated with political platforms and agent settings with higher aggregate utility. Indeed, comparing Table 3 with Table 4, the utility is positively correlated with the relocation of agents.

The instability caused by the addition of more jurisdictions may be interpreted as "errors" in the sense that the platform chosen by direct competition and proportional representation typically start with lower utility than the medians platforms generated by democratic referendum. Errors allow the system to create new configurations of agents and to escape from the old equilibrium, thus opening the possibility of creating new equilibria of greater utility. According to the authors, if the institutions allow more errors in settings relatively more poor in utility, the system will “act as” if it recognized the potential value of a local optimum between jurisdictions and, thus, escape from a bad equilibrium if the local optimum is recognized as inferior.

The final result shows that competitive institutions often have a relatively worse performance in models with only one jurisdiction. The same error in a model single jurisdiction can lead to higher utility model in a number of jurisdictions, if that induce agents to redistribute into configurations best. The reason, according to the authors, is that a system with multiple jurisdictions creates a system of multiple equilibria.

Table 4. Average number of agent reloctions per trial for 1000 agents. (source [3], p.204)

Average Number of Agent Relocations per Trial (50 Trials)						
Institution	3 Juris-dictions	(s.e. of the mean)	7 Juris-dictions	(s.e. of the mean)	11 Juris-dictions	(s.e. of the mean)
Democratic referenda	864.16	(17.24)	863.2	(10.41)	887.3	(5.26)
Direct competition (2 parties)	915.68	(14.67)	1162.5	(8.63)	1293.7	(7.13)
Proportional representa-tion (3 parties)	1277.60	(34.41)	1371.06	(25.75)	1420.28	(21.74)

1.2 Analytical models and agent-based models vis-a-vis empirical validation

According Kollman, Miller and Page [3, p.208-209]:

> The idea that decentralized mechanisms can be used to refine equilibrium outcomes toward those equilibria with higher aggregate payoff has important implications for mechanism design. Our results indicate that three conditions help in the effective design of such mechanisms. First, the decentralized mechanism must be able to acquire information about the state of aggregate payoff from local information. In our model, agent heterogeneity at any given jurisdiction is a good proxy for the quality of global sorting. Second, the mechanism must be able to disrupt global equilibria through local action. For example, a platform change at a single jurisdiction might cause sufficient migration to result in a cascade of platform changes at other jurisdictions. Finally, the decentralized mechanism must link the local information to local action in such a way that as the global system improves, local action is dampened. Given these three conditions, a decentralized mechanism can bias the outcome towards those configurations of higher aggregate pay off.

Still according to authors, the process under discussion, namely, the decentralized 'sorting' (operation that divides players into groups according to some criterion) of interactive agents, is of great interest for understanding a broad class of social processes: buyers seeking sellers, workers looking for employers, firms finding locations, and individuals forming coalitions.

Beside the many subjects for which the model showed can shed light, many canonical by the way, the model has simplifications, for example: the parties do not have preferences, voters do not vote strategically and preferences are assumed to be linearly separated. The same occurs with the hypothesis of Tiebout not assume that any relocation of people involves transaction costs – is certainly hard to imagine a situation in which the mobility of persons are not subject to costs.

May run the assumptions of Tiebout in an ABM is a great advance to development methods for research that aim improve mechanism design theory. But, obviously, the limits of that ABM is inherent to limits of Charles M. Tiebout's hypothesis. The discussion about how make a ABM more suitable for empirical validation, will come together with the discussion about how mechanism design theory can offer a set of assumption more adequate to model dynamic social processes in which neoclassical assumptions almost not play any reasonable role.

In general, a common concern to all types of simulation of scenarios and analytical model in social science is the hyper-simplification in favor of handling. Questions about how to model efficient institutions under criteria of applicability to empirical situations are well synthetized in the question made by Samuel Bowles [4, p.337]:

> The failure of the assumption of efficient design poses an intriguing challenge: if the structure of contracts and other institutions are not the result of some

hidden algorithm that implements efficient solutions to allocational problems, what analytical tools can we deploy to empirically explain observed institutions and their evolution?

For Bowles, one must start by empirical analysis of the emergence, evolution and extinction of the institutions of capitalist economies.

2 Institutional Evolution and Capitalism

We believe that valuable insights of ABM showed above can be seen as complementary to the knowledge produced by sociology and political science as well as classical economics made by authors as Adam Smith, Karl Marx and John Stuart Mill. According to Bowles [4, p.15], "in place of deduction from a few (once) uncontroversial behavioral and institutional axioms […] the classical economists were *nondisciplinary* (the disciplines had not been invented) *concerned about the empirical details* of the social problems of their time and *modesty on the degree of generality for their theories*".

According an evolutionary perspective, Bowles asserts that social outcomes are the combined results of a large number of autonomous people acting, even when it involves rise and perpetuation of national states and other powerful bodies as continental confederations. For the specific case of the capitalist societies, he states three assumptions that provide conceptual inputs to interpreting it as a process of co-evolution of institutions and social behavior [4]: a non-contractual nature of social interaction, adaptive behavior and preferences in relation to others, and generalized increasing returns.

For non-contractual nature of social interactions, economic relations are not only governed by complete contracts and non-contractual aspects of social interactions, but are governed also by a combination of norms and power. That assumption assumes that existing contracts are non-complete, since that there are always aspects that are not specified in contracts and possible to run later at no additional cost to the parties. For example, an employment contract does not specify the level of workers' effort, and things as some ethic norm of work, fear of lose their jobs and pressure from colleagues can make the agents reach a superior level of effort that the only execution of the contract terms cannot. The adaptive behavior and preferences in relation to the other refers to situations in which people subject themselves to reduce their own well-being to increase the welfare of others and to punish those who harm others or do not respect an ethical norm. Also called-social preferences, helps explain why people often engage cooperatively for common ends, even when behavior oriented only to own benefit can bring a higher gain. Finally, the so-called generalized increasing returns, which can be thought in terms of positive feedbacks, are situations where the gains of a person to take an action to increase as much as more people take the same action. Small changes can create durable consequences in the long-term and became a persistent equilibrium.

The importance in consider preferences in relation to others, or social preferences, increases when taking the contracts by their nature incomplete. The process in which social preferences evolve exhibits strong generalized increasing returns. And finally, if generalized increasing returns are commons and started of different initial conditions, results can become very different equilibria; societies are systems of simultaneous multiple equilibria. Which equilibria will be more likely to be exist will depend critically on the institutions that govern relevant dynamics, such as the exercise of power, collective action and other forms of non-contractual social interactions. That's an equilibrium selection process that cannot be solved by analytical methods.

Ultimately, Bowles says that the diversity involved in the constitution of individuals, institutions and the role of externalities can be powerful constraints to fully competitive markets. With all the risk of simplification, capitalist societies can be locked on equilibria of low economic growth, political corruption and social inequality or achieve undoubtedly higher levels of human development. The stage of development of a society is path dependent in a highly nonlinear way. By the amount of factors involved, leave the former state of affairs towards the latter depend on efforts that are often beyond any kind of institutional engineering and in a long-term horizon. Things like internal changes and external shocks such as wars, economic crises and climate change may be the only forces capable of dislodging a society of a long-term equilibrium.

The conceptual framework used by Bowles to understand the evolution of capitalist institutions are helpful in understanding how and to whom the production and distribution of social utility is made. Improve the Tibout's hypothesis e ABM algorithms development by Kollman, Miller and Page with Bowles's framework is a good opportunity to model political and economic issues present in capitalism societies.

If empirically oriented, a discussion on institutional efficiency in capitalist societies should take into account that the establishment of public institutions will always have the background of a society marked by, among other asymmetries and inequalities: social division of labor, competition and maximization of private interests, different properties allocations, and stratification, for example, degrees by income, race and gender. Any attempt to model human behavior must accept the thesis that a key factor in the determination of adjustment of behavior to incentives, beyond the factors of cognitive and informational bounded, is the location of agents in the social substratum. In other words, behind every intention or manifested interest, there is a concrete network stratified by the cultural-social-economic capital possessed by each agent. Such circumstances are hardly simulated – and it may be impossible – by math models in which the types of agents and institutions are "representative", for any interpretations of social and economic phenomena.

The establishment process of liberal-democratic institutions in modern capitalists societies, once started, produces generalized increasing returns in the direction of provide the existence of rights such as universal suffrage and freedom of opinion and association, or, in another direction, maintenance peculiar types of political domination associated with notions of co-optation and corruption. Important to build hypothesis and models (math or algorithmic) is awareness of empirical situations between the continuum along those two ideal types, namely, the total absence of liberal-

democratic institutions and existence in effect of these institutions, situation in which the necessary cooperation to production of public goods, development and well-being is ensured.

What remains is the conclusion that there are many constraints on design of institutions in order to achieve their expected efficiency. No one should be naive about the development of a theory of institutions and the production of well-being, instead, should be, in the words of Bowles, modesty about the interventions that an evolutionary approach can perform on institutions. Thus said, let's finish with your words [4, p.17-18]:

> Though motivated by an interest in the impact of economic institutions on human well-being, I have adopted an evolutionary rather than a social engineering approach. Like the idea of "selfish genes" seeking to maximize their replication or an auctioneer presiding over a general equilibrium exchange process, the omniscient and omnipotent social engineer seeking to maximize social welfare is a fiction whose usefulness depends on keeping in mind its fictive character. Social outcomes—even those involving states and other powerful bodies—are the combined result of actions taken by large numbers of people acting singly. Such devices as fictive auctioneers, social engineers, or anthropomorphic genes cannot substitute for an understanding of how real individuals behave and the ways that distinct institutions generate population-level dynamics that aggregate these behaviors to produce social outcomes. The evolutionary character of the analysis will become evident in the way that individual behaviors are modeled, the kinds of population-level dynamics studied, the ways that behaviors and institutions co-evolve, and the absence of any grand blueprints for human betterment. The evolutionary approach is modest about what interventions can accomplish, but it does not restrict the economist to purely contemplative pursuits.

References

1. RUIZ, Ricardo M.: **Growing Regions From The Bottom Up: Regional Economies as a Self-organizing System**. Submitted to the Graduate Faculty of Political and Social Science of the New School University in partial fulfillment of the requirements for the degree of Doctor of Philosophy (2003)
2. ARTHUR, W. Brian: "Inductive Reasoning and Bounded Rationality (The El Farol Problem)". **American Economy Review (Papers and Proceedings)**, 84: 406 (1994)
3. KOLLMAN, Ken; MILLER, John H.; PAGE, Scott. E.: "Political Institutions and Sorting in a Tiebout Model". Kollman & Miller & Page (eds.) **Computational Models in Political Economy**. MIT Press. (2003)
4. BOWLES, Samuel.: **Microeconomics: Behavior, Institutions, and Evolution**. Princeton University Press. (2004)