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Abstract:
The correspondence between your and my beliefs is surprisingly hard to model, yet it is of great importance to understand phenomena of interconnected behavior such as fashion and fads, diffusion of ideas, financial contagion, consumer confidence, and stock market crashes. The world faces an economic climate of faster connectivity, and channels for contagion multiply. Individuals are increasingly interrelated. Identifying the channels and understanding how they work are adamant. Understanding macro outcomes of micro interaction requires tools we do not yet have: models of semi-rational individuals acting upon signals from others and rules-of-thumb. In this article I discuss how computer simulation with simple, plausible algorithms describing consumer behavior can be used to obtain insights into the link between individual choices and aggregate outcomes. I discuss several approaches and put them together in a common framework with pointers to the relevant literature. In particular, I describe one attempt at capturing individual heuristic action rules in micro and its lessons on geometry and information penetration, and argue that economists need to cooperate with psychologists and sociologists when they model motivation and network structures. Modeling interdependence and belief contagion will challenge the neoclassical orthodoxy, but there are gains of relevance to be reaped from the sacrifice of algebraic rigor.

Keywords: Beliefs, business cycle, consumer confidence, contagion, critical mass, herd behavior, interdependence, micro economics, network geometry.

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1. Introduction

Interdependent behavior of agents underlies aggregate macro thinking yet interdependence of individuals has only infrequently appeared in macro models. So far economists have relied upon very simple assumptions written down in closed-form algebra. Rigor has often been chosen at the expense of relevance, as Mayer (1993) argues. In the words of Douglass North: "The price you pay for precision is an inability to deal with real-world issues."[1]Strict assumptions deliver elegant algebraic solutions that unfortunately do not furnish politicians and policymakers with adequate tools to handle the real world. Simulation models of interdependence based on psychological insights of human behavior and sociological network structures promise to change some of that.

Economists have up to recently modeled human behavior by using agents that are rational, independent individuals seeking maximum utility within given budget constraints. Agents look at prices, income and good qualities only in their demand, not to what other agents may do. Lately, models have been explored in which people behave differently, see Colander (2000). Unorthodox economists embrace models in which the agent is a semi-rational agent seeking to reach a somewhat vague target of material standard and social position through usage of heuristic guidelines and rules-of-thumb. What is a satisfactory standard of living depends partly on surroundings and relative positions. In the quest for materials and social standing, the individual acts within a social context that makes him dependent of others and others dependent of him. In the quest, he seeks advice and look for social evidence before he acts. Purchases, for example, depend upon consumer confidence. Consumer confidence is an aggregate of interdependent beliefs. Models that take interdependence seriously lose some in algebraic clarity and intellectual transparency because the models may not come in closed-form or offer algebraic solutions. They may only specify action rules from psychology and the outcomes in the aggregate are sufficiently complex to demand computation by computers only. Potentially, they gain in explanatory power and relevance. Some mathematical beauty is sacrificed for a more useful end product. The modeling of interdependence using computer simulation challenges neoclassic economics. Below, we will see how.

2. Interdependence of individuals and nations

A great economist once said that speculative capital can shift with the speed of the magic carpet.[2] In a dull reformulation, we say that economic activity is endogenous. It is determined within a system of interacting forces. Most models of macro entities consist of a bouquet of equations. Some variables are given from outside; they are exogenous. Other variables are determined within the system; they are endogenous. Equations describe how endogenous variables depend on exogenous variables. It is no trivial task to decide whether variables are exogenous or endogenous and how they influence each other. What you think is determined within the system depends on your framework and the length of your time period. The debate about endogeneity is core in economics and policymaking; confer with Boldrin and Woodford (1990) for an interesting survey of endogenous fluctuations. What is sorely longed-for is a way of doing things that start with the atoms of economic science, individuals, and end up with laws of motion--at least probability laws--of inflation, unemployment and national

[1] Wall Street Journal, July 29th 1994. Hanemann (1994) uses the same quote in his argument against neoclassical traditionalists.

[2] It was, of course, John Maynard Keynes.

product. It will take some time. And it certainly will challenge the neoclassic establishment. In the meantime, let us consider how e. g. consumer confidence can--maybe should--be modeled.

Despite impressive mathematics, economists still do not understand well how and why capital all of a sudden decides to flee. Nor why economic activity often times is well below capacity. For a while, macro economists have been dissatisfied with the foundations of their craft. They have regretted the missing link to micro; i.e. a base in theories of how individuals really behave. On the other hand, microeconomics itself offers beautiful theory, but has had neither the punch nor the impact the profession hoped for some decades ago. Moreover, there seems to be in the microeconomic community some dislike for using experimental and psychological insights of peculiar and erratic behavior or even socially interconnected ways of handling the world. There are promising new developments, though, for example in the rising field of *complexity science.*

Contagious Behavior

While Keynes spoke of animal spirits, the word today is contagion. The concept is powerful: Ideas and beliefs spread from innovators to neighbors and make them change beliefs and behavior (see e.g. Smith et al. (1988) for an early study of endogenous expectations). When innovators observe the new behavior, they change their original ideas and beliefs themselves, see S. Morris (2000) for an analysis of how one player may interact strategically with a subset of a population. Loops create feedback systems and potentially what we see as the result is herd behavior. In interconnected systems this may affect a large number of people. With falling cultural barriers, disappearing language difficulties, and vanishing economic hindrances, Europe for example, with its common market and common currency, is in a unique position when it comes to connectivity and interrelation. European policymakers have much to win if they can come to grips with interdependence and mutual economic influence.

A synchronization of beliefs of large number of individuals can trigger an avalanche once critical mass is reached (see e. g. Grandmont (1998) for an analysis of large socioeconomic systems). Understanding core features of these phenomena may help understand the mass psychology of consumer and investor confidence and therefore prevent, or at least reduce the probability for, belief-induced recessions.

What Simulation Can Tell Us

Using simple algorithms on computers, I have collaborated with a physicist[3] and simulated scale and geometry effects of connectivity in a project ambitiously called 'The Geometry of Consumer Confidence'. Two main results stand out: the importance of *Information penetration* and *geometry of connections*. Let us consider historical examples. Before the telephone, societies experienced little information penetration. It took a long while for pieces of information to spread from Jones in London to Hoffmann in Berlin. However, during the last century, information channels such as the telephone, radio, television, and Internet have allowed more and faster paths for information to flow. The probability that Jones, or node A, will come to learn about how Hoffmann, or node B, reacts to a stimulus increases with information penetration. As a result, the likelihood increases for system-wide reactions in tandem. This is what outsiders will observe as flock or herd behavior. Geometry matters, too. In simulations, we see that critical levels depend on how neighbors are linked together.

[3] Dr. Anders Malthe-Sørenssen at Dept. of Physics, University of Oslo.

Dimensionality of node arrangement is crucial to understanding avalanches and trigger points. Put differently, when people belong to several social contexts, fashions and fads spread more easily. So do beliefs about the economy, and those beliefs can become self-fulfilling. In other words, when Jones works in Berlin and resides in London during the weekend, he connects his London friends with his Berlin colleagues. Shiller (1995) says that people who interact with each other regularly tend to think and behave similarly. Ellison and Fudenberg (1995) model such word-of-mouth communication. Beliefs about economic variables may become synchronized among interacting people. In short, before the railroad, manias would be local. After the invention of Internet and the expansion of world networks, expectations can be global. That raises the stakes. In Japan, for example, people share one language, one culture and a small area. People there are highly connected. It means beliefs may spread easily. During the 90s, beliefs probably did.

A Brief History of Economic Fashion

Let us step back for a second and take a look at the history of economic modeling. In traditional neoclassical economics, we model individual behavior as one arising from an optimizing agent who operates under constraints. The agent is fully informed about governing parameters and own preferences. Preferences are stable and independent of other agents' preferences. Agents are identical and share preference functions and parameters. We say such agents are homogeneous and that such models use representative agents. In addition, agents possess the ability to compute very difficult inter-temporal solutions. During the rise of complexity science in the 90s, economists allowed departures from deductive theories. Rosser (1999) discusses recent approaches and how complex models have gained acceptance. The hope is that *complex economics* can deliver for social science what quantum mechanics did for physics, namely a way of dealing with inherent unpredictability of small scales such that it is possible to obtain results for patterns of large scales. Macro patterns may then be put on a probabilistic footing.

The axiomatic system does have advantages over simulation. Conceptual exploration is worthwhile. Simple, transparent models that can be grasped easily because they use only uncompounded relationships have made economic reasoning accessible to many. Policy has improved over the last half century, mostly thanks to parsimonious models with derivable effects. Economists showed how the powerful first welfare theorem arises from an axiomatic model, starting from not entirely unreasonable assumptions. The theorem states that market solutions are efficient and the impact on social organization from that theoretical insight was large. Adam Smith's invisible hand was thus given mathematical legitimacy. However, the theorem is not applicable when preferences and behavior are interdependent. Mathematically, interdependent behavior makes for cumbersome, sometimes algebraically insoluble, problems. Demand functions become functions of themselves. Put differently, algebraically we face a special type of equations in which demand occurs on both sides of the equality. How? Let x_i denote individual i's demand for a vector of goods. Let p be prices and y_i income individual i has at her disposition. If social context and social evidence matter, we have that demand x_i is a function of prices, income and demand x_{-i} of other agents not i, thus $x_i = f_i(p,y, x_{-i}(p,y_{-i},x_i))$ Here, x_{-i} is a vector of demand representing other agents and their demand contains the demand of individual x_{-i} since they look to individual i for social evidence. We have no guarantee for the solubility of demand x_{-i}, especially not when we introduce a realistic time element of sequencing the search for social evidence.

Implicit demand functions may be hard or impossible to solve in closed-form. In order to accept difficulties and loss of transparency we must require new insights from models of interdependence. The burden of complexity must be outweighed by the benefit of increased explanatory power. Models of interdependence probably satisfy that criterion. It becomes possible to understand, in a better way, consumer confidence and financial contagion because their micro footing is based on how agents actually behave, not on how a fully rational, fully-informed, singly-operating agent would have behaved in an ideal world. While neoclassicists emulated mathematicians in constructing an axiomatic system of behavior, practitioners of complexity simulations look to physicists and how they simulate the world on computers. In fact, physicists have started doing economics because they feel their understanding of complexity surpasses that one of economists, see Mantegna and Stanley (2000) for an introduction to the rising field of Econophysics. Also, study how the physicist David Lamper and his colleagues at Oxford believe they can predict the future of markets using methods obtained from physics.[4]

What Keynes Would Have Done With a Computer

The structure of simulation typically follows an arrangement like this: Write down the heuristic rules agents use. For example, in modeling how a belief about an economic variable spread through the economy you specify number of types of agents and what rules-of-thumb they follow. A simple rule would say: 'Adopt the average belief of my neighbors.' A complex rule would let the individual weigh different beliefs of different neighbors in order to update his own prior belief and change his own only when the weighted function of neighbor-beliefs is above a certain threshold. Consult Orléan (1995) for a study of relative weights given by an individual to own observation and group opinion. You must also position individual agents in space by assigning identifying coordinates to each agent (a node, on the computer). You allow different geometrical structures in order to investigate sensitivity to geometry. The simplest structure is linear, a chain. Another structure consists of groups of agents or nodes spread out in, say, star formation so that all agents within a group are connected but only some agents are connected to agents from another group. You decide what initial beliefs agents have, if any. Additionally, you choose and experiment with how to start the system, in what directions influence works, whether or not to include random elements, how many rounds the system is allowed to experience. Then you start the simulation on the computer and watch. Study Strogatz (2001) for an excellent overview of how network modeling is done throughout science, from neurobiology to statistical physics.

As percolation theory in physics predicts, when seemingly innocuous heuristic rules are non-linear (for example, by a simple go/not-go discrete choice) aggregate behavior of the system displays sensitive non-linearities. The development of aggregate systems of agents is smooth in certain intervals of parameter perturbation, then the development shows critical levels succeeded by reaction avalanches. Let us be more specific. To study the spread of mobile phones, say, a researcher mimics how she believes people behave. Some people will be enthralled by the technical novelty and embrace usage immediately; others are attracted to the status signal and acquire it quickly. Thus, there will be some initial owners. In the computer simulation, the researcher distributes some nodes as 'yes', meaning that these nodes represent early owners, other nodes are given 'no'-modes. Nodes are connected to each other, like people are. Some people are well connected, others have few connections. The researcher specifies an algorithm of runs such that when the algorithm stops to inspect a node,

[4] See 'Predicting the Unpredictable. Patterns in financial markets,' *The Economist* June 2nd 2001, pp. 91-92 for an easily-accessible exposition.

represented by geometrical coordinates, the mode of the node turns into 'yes' if a sufficient number of neighboring nodes is 'yes'-nodes. The algorithm may be designed to allow for inspection of nodes sequentially or partly simultaneously in some pre-specified but thought-through way. The researcher can give different weights to different neighbors, like people give more weight to opinions and habits of close friends. The researcher can run the simulation and do iterations. She can play with neighbor geometry and probabilities of switching from 'no' to 'yes'. By experiments, insights are won.

How Little Things Matter

The results are intriguing. If the researcher changes a certain parameter a little bit, the resulting proportion of yes-nodes in her system will change a little bit, too--in the beginning. Then she changes the parameter some more and observes the expected change in resulting proportions. At one point, around critical levels, an avalanche will occur. A little change in the parameter triggers a much larger proportion of yes-nodes than was seen before. What this tells the researcher is that for some phenomena you will see abrupt changes. The process is similar to how snow can trigger an avalanche, a non-linear relationship between cause and consequence. When we realize that in many areas of life people look to others before acting, we also realize that computer simulation is a powerful tool in understanding important components of interdependence. Since the economy relies on geometry of cities and market organization and since information spreads with different speed at different levels of development, the frequency with which and structure in how economies experience such phenomena can be studied by way of complexity science. It is what we will do in the future. In fact, it is what scientists are doing already in physics, meteorology--and now in economics.

Of course, simulation is not necessarily a substitute for neoclassical theory of individual choice and adaptation. But it is at least a supplement. Prices and income are still key parameters in analysis. Complexity approaches can model the additional component where agents look around for social evidence before acting. Let us consider an example. People weigh the price of a house with its qualities and location thoroughly before purchase. They inspect their budget constraints and credit possibilities. A house offers lodging services for many years at a user price. The user price consists of (resell) price change, depreciation (and thus repair expenditures), and interest payments. The sum of discounted future utility streams is compared with user price. Future price changes and interest rates are uncertain, thus the buyer must guess. In that guess she looks for social evidence among her neighbors and friends, in newspaper articles and expert opinions. The social evidence process is what we want to model with complexity approaches and simulations, and economists need to cooperate with psychologists and sociologists in order to obtain relevant knowledge.

The outcome of belief formation simulation can be linked to standard models of aggregate behavior in macro. Thus, you can keep structures of neoclassical models and add a component of simulated interdependent expectation. You may find how self-reinforcing systems can create fashion and fads, stock market crashes and currency changes. It is possible to discover what are crucial features: heuristic rules, heterogeneity, geometry, transmission probabilities, initial conditions or random elements. In fact, that ought be the aim of a whole research program of interdependence. Gladwell (2000) speculates that heterogeneity of individuals are important. In his theory, some people gather information, others are well-connected and others yet are persuasive. The proportions of such different types may prove to determine certain outcomes of economic processes. Shiller (2000) leans on similar ideas when he describes how stock market fluctuations are based on micro psychology of investors. These are insights that may *guide*--by simulated approximation, not exact calculation--world policymakers towards appropriate policies.

Lessons From High Drama in World History

Computer simulation may extend the frontiers of economic knowledge. Keynes said he preferred to be vaguely right to precisely wrong. With simulation the economic entrepreneur constructs models in that spirit. Non-linearities and interdependence are too intricate for algebraic solutions, thus we must device algorithms that grind through all permutations for us. Let us speculate. One of the great mysteries of economic analysis is the Great Depression. Why did idle workers sit outside doors of shutdown factories? Workers wanted to work, and factory owners wanted to produce and sell. But factory owners did not hire car workers because there did not exist buyers. There were no buyers because factory owners hired nobody. How could such a vicious self-fulfilling circle prevail?

Economic historians have offered many solutions. One prominent explanation is that monetary policy was poorly designed. When authorities acted, expansion dosages were too small and came too late. Adherence to the Gold Standard prevented the necessary stimulation to the economy. Probably, this explanation has great merit, see Eichengreen and Sachs (1985) for the full flavor of the argument. What about the mysterious drop in aggregate demand? In a complexity approach, we say aggregate demand became depressed when expectations were synchronized and fluctuated in tandem. In general, expectation shocks occur when information penetration outpaces system limitations. In the late 1920s, telephones and radios equipped agents with channels to communicate their beliefs and fears but policy-makers had not anticipated widespread bank-runs. As a consequence, no deposit insurance existed. When collective beliefs reached critical mass of pessimism, an avalanche would occur. In 1930s, it did. The long expansion of the 20s could have made people wary. Millions of wary people would then have a sensitivity that could have sustained a triggering event. There were a stock market crash and a precipitous drop in aggregate demand. Today, the world is not immune to belief-induced valleys of the economic cycle, especially not when economies become interdependent. A bad equilibrium does not necessarily require bad monetary policy in order to last. To see it, examine the following example.

Is A Depression Possible in an Economy with No Money?

Consider an island populated by Robinson and Friday. Robinson fishes, Friday hunts. Both need fish and meat so they trade at the end of every day. Storing is impossible; they have to eat or throw away. Both work eight hours a day and trade their products in a happy equilibrium. One day a thunderstorm surprises them. Lightning strikes. Robinson is certain that Friday's bows are damaged. Friday believes Robinson's equipment is mostly destroyed. Fact is that nothing is destroyed; the economy is fundamentally unchanged. But not beliefs: Both expect the other to show up on the market the next day with fewer units to offer. They face a choice, either produce their usual amount and trade at unfavorable rates or produce less and trade at old rates. After all, Robinson believes that Friday will show up offering only half the usual amount for trade. Friday suspects Robinson can put fewer fish on the table. Both adapt to the perceived new economic climate and reduce their workday to four hours. When they meet up, their suspicions are confirmed: The other shows up with less stuff than before, and both congratulate himself for prescience in predicting demand.

Here, supply and demand declined because of beliefs. If Robinson and Friday could communicate, they would probably convince each other that there would be demand and payments for more products in future exchanges. In a large economy, they may not meet to talk. However, strange and inaccurate beliefs most often cancel out. Some people err on the positive side, others on the negative side. On the other hand, in an economy with high information penetration dramatic news can trigger avalanches if a critical number of agents believe in it. Japan is now stuck in a bad equilibrium producing under capacity partly because too few people believe the economy will come out of the depression soon. If economists understand interdependence, or at least acquire a rudimentary grip on it, we have a better chance of avoiding the place where Japan is now. Key variables in macroeconomics are consumer and investor confidence, much like the beliefs and expectations of Robinson and Friday above. Confidence is nothing else but the belief an individual forms after having consulted with other people or metrics of macroeconomics. The exchange of information is multilateral in nature, and the aggregate result is a typical interdependent system.

Evolution of Beliefs
Since Duesenberry's (1949) ideas and Festinger's (1954) theories of social comparisons social scientists have been curious about how dependent people are on other people's views of themselves and the world. Stigler and Becker (1977) claim preferences are constant and reconcile seemingly contradictory choices with changes in human capital. I take a different position: Preferences and beliefs can change and they do so when people interact with other people. Constancy of preferences begs the question of the origin of preferences. It is a peculiar view that people are born with a script that only needs to be filled out by experience. Preferences, beliefs, and views of the world are in part created in an interdependent system of agents. If this is the case, it must be a priority for policy-makers to understand how beliefs are formed.

3. Conclusions and Policy Implications

The origin of beliefs and expectations is still a mystery. Interdependence is a large part of the puzzle. Beliefs and expectations are interwoven since your take of the world depends on how I see it.

When individuals act together in an interdependent system the resulting aggregate behavior becomes complex. Complex systems need complex models; thus the legitimacy of advanced computer simulation. Individual action rules must be specified such that they are psychologically reasonable. Network structures and information penetration mechanisms must be laid out so they are sociologically plausible. Then, Policymakers may be furnished with instruments to understand better how information penetration, geometry and heterogeneity relate to spread of ideas, behavior contagion and interdependence. For world policy-makers, when barriers are falling and people move around, this will be useful knowledge.

References

Boldrin, M. and M. Woodford (1990): 'Equilibrium Models Displaying Endogenous Fluctuations And Chaos,' *Journal of Monetary Economics,* **25**, pp. 189-222.

Colander, D. (2000): 'New Millenium Economics: How Did It Get This Way, and What Way Is It? *Journal of Economic Perspectives,* **14**:1, pp. 121-132.

Duesenberry, J. S. (1949): *Income Saving and the Theory of Consumer Behavior*, Harvard Economic Study 87.

Eichengreen, B. and J. Sachs (1985): 'Exchange Rates and Economic Recovery in the 1930s,' *Journal of Economic History,'* **45**:4, pp. 925-946.

Ellison, G. and D. Fudenberg (1995): 'Word-of-Mouth Communication and Social Learning,' *Quarterly Journal of Economics*, **110**:1, pp. 93-125.

Festinger, L. (1954): 'A Theory of Social Comparison Processes,' *Human Relations*, **7**, pp. 117-140.

Gladwell, M. (2000): *The Tipping Point. How Little Things Can Make a Big Difference*. New York: Little, Brown.

Grandmont, J.-M. (|998): Expectations Formation And Stability of Large Socioeconomic Systems,' *Econometrica*, **66**:4, pp. 741-781.

Hanemann, M. (1994): 'Valuing the Environment Through Contingent Valuation,' *Journal of Economic Perspectives,* **8**: 4, pp. 19-43.

Krugman, P. (1996): *The Self-Organizing Economy*. Oxford: Blackwell.

Mantegna, R. N. and H. Eugene Stanley (2000): *An Introduction to Econophysics. Correlations and Complexity in Finance*, New York: Cambridge University Press.

Mayer, T. (1993): *Truth versus Precision in Economics*, Brookfield: Edward Elgar.

Morris, S. (2000): 'Contagion,' *Review of Economic Studies*, **67**, pp. 57-78.

Orléan, A. (1995): 'Bayesian Interactions and Collective Dynamics of Opinion: Herd Behavior and Mimetic Contagion,' *Journal of Economic Behavior and Organization,* **28**, pp. 257-274.

Rosser Jr., J. B. (1999): 'On the Complexities of Complex Economic Dynamics,' *Journal of Economic Perspectives*, **13**:4, pp. 169-192.

Shiller, R. J. (1995): 'Conversation, Information, and Herd Behavior,' *American Economic Review*, **85**:2, *AEA Papers and Proceedings*, pp. 181-185.

Shiller, R. J. (2000): *Irrational Exuberance*. Princeton: Princeton University Press.

Smith, V. L. G. L. Suchanek and A. W. Williams (1988): 'Bubbles, Crashes, And Endogenous Expectations In Experimental Spot Asset Markets,' *Econometrica,* **56**:5, pp. 1119-1151.

Stigler, G. J. and G. S. Becker (1977): 'De Gustibus Non Est Disputandum,' *American Economic Review,* **67**: 2, pp. 76-90.

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