

## GSDP Agent-based modeling workshop

September 2011 8th-10th

Salle Marc Bloch et Cavallès, Sorbonne, 17 rue de la Sorbonne, Paris

### Rationale

A number of ongoing projects in agent-based computational economics start delivering promising results: from networks of interacting agents emerge dynamics reproducing a growing number of stylized facts of economic systems. The usage of computer simulations has indeed allowed to explore economic dynamics beyond the frontier of analytical tractability where general equilibrium theory had been left without proper dynamical foundations.

Agent-based models exhibit a variety of structures, interactions, behavioral assumptions and use different software platforms and/or programming languages. Though it underlines a large range of potential applications for agent-based models, this variety also suggests a possible lack of common structures in the field which could hamper the communication, the comparison and the evaluation of such models. In order to prevent these failures and to foster the development of future research, it is thought useful to gather leading actors in the field so as to define a set of structuring guidelines. Therefore, the workshop will bring together economists and complex scientists with an expertise in agent-based modeling with the aim of developing standards for the description, the specification and the validation of agent-based models and to identify promising avenues for formal analysis of such models. More precisely, the workshop will be structured along three main themes:

*Transparency:* There are several groups working on agent-based models but the details of implementation are obscure, so there is virtually no scientific interchange concerning what modeling decisions are reasonable and what decisions are suboptimal or erroneous. A dialogue is required to correct this situation.

*Calibration and validation :* A weak point of agent based models is the large number of parameters one typically needs to specify them. Considering the complicated phenomena they are trying to capture, this is very natural, however high dimensional models are very hard to calibrate and validate, therefore there is a serious danger of overfitting. Discussions (involving also computer scientists) on this issue will aim at drawing a realistic picture of the merits and limitations of this high dimensional approach.

*ABM vs. Analytical:* On the one hand hand ABM provide new approaches to problems currently faced by analytical models (e.g in general equilibrium theory). On the other hand, the set of mathematical techniques available for the analysis of agent-based models is yet relatively sparse. A dialogue with mathematical economists shall identify promising approaches as well as open problems at the interface between these two lines of research.

As a by-product, these discussions shall facilitate the communication of ABM outside the scientific community, in particular to the policy-making world. Such a communication channel will conversely help encompassing practitioners' needs in the design of the future generation of models.

### Organizing Committee

Herbert Dawid, Bielefeld University  
Herbert Gintis, Central European University and Santa Fe Institute  
Armin Haas, Potsdam Institute for Climate Impact Research  
Imre Kondor, Eötvös Loránd University and Collegium Budapest  
Antoine Mandel, University Paris 1 Panthéon-Sorbonne

### GSDP

GSDP is an FP7 funded coordination action to develop a research program for the study of global systems in an ongoing dialogue wit decision makers, see <http://www.gsdp.eu/>

## Program

### **Thursday, September the 8<sup>th</sup>. Salle Marc Bloch**

8:30-9:00 *welcome*

9:00-9:15 *Introductory remarks.*

09:15 -12:15 *ABM and Theory I (chair Bouchaud)*

Herbert Gintis: "Stability and Fragility of Economies with Many Markets."

Luciano Pietronero : "Agent based models, self-organization and systemic risk."

11:15-11:30 : *Coffee*

Franklin Fisher : "The stability of general equilibrium - what do we know and why is it important"

12:30-14:00 *Lunch*

14h-16:30 *ABM and Theory II (chair Dawid)*

Giorgio Fagiolo and Andrea Roventini "On the Scientific Status of Economic Policy: A Tale of Alternative Paradigms"

Carlo Jaeger : "Shaking an Invisible Hand"

Mauro Gallegati : "Dynamic aggregation in the times of heterogeneous interacting agents and network: an analytical solution for agent-based models"

16:30-17:00 *Coffee*

17:00 -18:30 *Panel discussion on ABM and Theory (chair Gintis)*

20:00- *Diner at "Buisson Ardent"*

### **Friday, September the 9<sup>th</sup>. Salle Cavallès.**

9:00-11:00 : *Modeling and Transparency I (chair Lux)*

Mikhail Anufriev : "Evolutionary Selection of Individual Expectations and Aggregate Outcomes."

Silvano Cincotti : "Agent-based modeling for macro-economy policy design"

Michael Neugart: "Executive compensation, implicit incentives, and competition"

11:00-11:15 *Coffee break*

11:15- 12:45 : *Calibration and Validation I (chair Midgley)*

Francis Bach : "Structured sparsity and convex optimization"

Guido Caldarelli : "Interbank network data and modeling"

12:45-14:00 : *Lunch*

*14:00- 15:30 Modeling and Transparency II (chair Bach)*

Jeremy Gibbons : "Dependent types for dependable modeling"

Nicola Botta : “Decentralized models of exchange from a reinforcement learning perspective”

*15:30-15:45: coffee*

*15:45-17:15 Calibration and Validation II (chair Roventini)*

Robert Marks : “Simulation Models are Tools, Not Toys"

Matteo Richiardi : “Validation and Estimation of agent-based models”

*17:15-18:45 Modeling and Transparency III (chair Haas)*

Ilan Chabay ``Learning To Cope With Complexity By Understanding Models Of Nature And Society"

Panel discussion on Modeling and Calibration.

*20:00- Diner at La “Bastide Odeon”*

## **Saturday, September the 10<sup>th</sup>. Salle Marc Bloch**

*9:00- 11:15 ABM and Policy I (Chair Summer)*

Thomas Lux : “Modeling 'Animal Spirits' and Network Effects in Macroeconomics and Financial Markets”

Jean-Philippe Bouchaud : "Agent-based approach to liquidity and impact in financial markets"

Herbert Dawid: “Stabilization Policies, Technological Diffusion and Economic Growth: An agent-based Analysis”

*11:15-11:45 Coffee and Snacks*

*11:45-13:45 ABM and Policy II (chair Kondor)*

Giovanni Dosi, Giorgio Fagiolo, Mauro Napoletano, Andrea Roventini: “The Role of Technical Change, Finance, and Public Policies in an Evolutionary Model of Endogenous Growth and Fluctuations”

Alan Kirman: "Crisis in Economic Theory"

Panel discussion on policy challenges and ABM

## Participant List

Mikhail Anufriev, University of Amsterdam  
Francis Bach, Ecole Normale Supérieure  
Giulio Biroli, CEA  
Nicola Botta, Potsdam Institute for Climate Impact Research  
Paul Bourgin, CREA, Ecole Polytechnique  
Jean-Philippe Bouchaud, Ecole Polytechnique et CFM  
Guido Caldarelli, Institute for Complex Systems, CNR  
Ilan Chabay, Chalmers University of Technology  
Silvano Cincotti, University of Genoa  
Herbert Dawid, University of Bielefeld  
Giovanni Dosi, Scuola Superiore Sant'Anna, Pisa.  
Franklin Fisher, Massachusetts Institute of Technology  
Steffen Fuerst, Potsdam Institute for Climate Impact Research  
Mauro Galegatti, Università Politecnica delle Marche Ancona  
Herbert Gintis, Central European University  
Jeremy Gibbons, University of Oxford  
Armin Haas, Potsdam Institute for Climate Impact Research  
Sandrine Jacob Leal, ICN Business School.  
Carlo Jaeger, Potsdam Institute for Climate Impact Research  
Jeffrey Johnson, The Open University  
Alan Kirman, Université d'Aix-Marseille III  
Imre Kondor, Eötvös Loránd University  
Markus Knell, Austrian Central Bank  
Thomas Lux, University of Kiel  
Antoine Mandel, Université Paris I Panthéon-Sorbonne  
Robert Marks, University of New South Wales  
David Midgley, INSEAD  
Sylvain Mignot, Université Paris II Panthéon-Assas.  
Mauro Napoletano, OFCE Sciences-Po  
Michael Neugart, free University of Bozen-Bolzano  
Laetitia Papaxanthos, Ecole Normale Supérieure.  
Luciano Pietronero, University of Rome "La Sapienza"  
Matteo Richiardi, University of Torino  
Andrea Roventini, Université Paris Ouest Nanterre  
Francesco Saraceno, OFCE Sciences-Po  
Martin Summer, Austrian Central Bank  
J. David Tabara, University Autònoma Barcelona  
Marco Tarzia, Université Pierre et Marie Curie  
Tania Treibich, Université de Nice-Sophia Antipolis  
Sander Van Der Hoog, Bielefeld University  
Michiel van de Leur, University of Amsterdam  
Annick Vignes, Université Paris II Panthéon-Assas.  
Francesco Zamponi, Ecole Normale Supérieure

## Abstracts

### **“Stability and Fragility of Economies with Many Markets” (Herbert Gintis)**

This paper investigates the out-of-equilibrium price and quantity adjustment process for a decentralized market economy with individual production. The economy is modeled as a Markov process. Each agent has a set of private prices that are updated through experience, less successful agents copying the strategies of more successful agents, as well as varying private prices in response to personal trading experience.

With an initial random assignment of private price vectors to agents, this economy with Markov dynamics quickly moves to an ergodic subprocess with a set of quasi-public prices, in which the standard error of private prices across agents becomes very small. In the long run, over a wide range of parameters, the stationary distribution of this Markov process approximates a Walrasian equilibrium of the system. We call this stationary distribution a quasi-Walrasian equilibrium.

When agents are permitted to trade in goods they neither produce nor consume, a money good appears in the stationary distribution. The Markov dynamical system is, moreover, highly resilient in the face of exogenous shocks when the number of producers per sector is sufficiently large, but is unstable when this number falls below a (relatively high) threshold.

These findings suggest that the Markov process is an appropriate analytical tool for modeling the dynamics of a market economy, and a fully decentralized market economy in which information is derived purely from individual trading experience can be stable under a wide range of conditions, but is predictably fragile in the face of aggregate shocks under certain specifiable conditions.

### **The Stability of general equilibrium – What do we know and why is it important ? (Franklin M. Fisher)**

This paper discusses the history and state of the analysis of general equilibrium stability. Contrary to what most economists seem to believe, that theory did not end with Scarf’s demonstration<sup>1</sup> that tâtonnement is not always (or even generally) stable. Rather, there has been substantial work on what can be said when attention is paid to the way in which trades take place out of equilibrium. Building on that work, I have investigated a model in which participating agents realize that their plans may not be fulfilled and in which they themselves set prices individually. Unfortunately, it turns out that stability can only be assured if agents do not continually discover previously unsuspected opportunities. Further, even if there is convergence to an equilibrium (and how fast that convergence operates remains to be studied), that equilibrium may very well not be Walrasian. This is closely related to the Keynesian Liquidity trap and to the extent to which individual price setters see the progress of their market power brought about by search behavior. (A good many theorems are proved along the way.)

But the fact that stability of Walrasian general equilibrium is a difficult subject does not alter the fact that it is a very important one. The propositions and policy advice about the efficiency of such equilibria are fairly pointless without such stability (and rapid convergence), and, even with it, the path-dependency of the equilibrium reached makes the use of the Walras correspondence and computational general equilibrium irrelevant. Indeed, even if we are willing to assume that the actual economy is stable, without a theory as to why that is true, there is a gaping lacuna in the theory of value.

### **“Agent-based models, self-organization and systemic risk.” (Luciano Pietronero)**

ISC-CNR and Univ. Sapienza, Roma, Italy  
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We discuss how complexity ideas can have an important impact in socio-economic disciplines with specific relation to the Agent based Models and their implications for the analysis of systemic risk. The critics to the standard model of economics has now reached the main institutions as mentioned by the president of the ECB J.C. Trichet in a recent speech<sup>(1)</sup>. He suggests the introduction of concepts like finite rationality and strong interactions among agents, intrinsic instabilities and self-organized critical states which are typical of complexity models. On the other hand the strong fluctuations of the number of agents and the self-organization of the market

towards the critical state imply new ideas which are usually not contained in the physical models. We have a large variety of Agent Based Models which are all able to reproduce the main anomalies of the market fluctuations. In order to progress it is therefore necessary to increase the number and quality of the Stylized Facts. We describe the state of the art of the Agent Based Models and outline the possible developments and their implications for the problem of systemic risk (2). We also consider the properties of Order Book Models and Networks and their possible integration in the Agent based Models.

References:

1. J.C. Trichet (president of EBC): Reflections of the nature of monetary policy. Frankfurt conference, Nov. 2010
2. L. Pietronero, A. Cristelli and Z. Zaccaria, Varenna Lectures 2010, in print. <http://arxiv.org/abs/1101.1847>

### **“Shaking an invisible Hand” (Carlo Jaeger)**

TBA

### **“Dynamic aggregation in the times of heterogeneous interacting agents and network: an analytical solution for agent-based models” (Mauro Gallegati)**

One of the consequences of the failure of mainstream theory in convincingly taking into account the heterogeneity of agents is the misrepresentation of markets with asymmetric information. In fact, the consideration of players with diverse information sets is at odd with the idea of the representative agent. The Global Financial Crisis spectacularly exposed this inconsistency, casting doubts on the core neoclassical assumptions for the representation of markets. Moreover, standard modelling techniques leave no or little room for agents interaction, which is the most intriguing and relevant corollary of the heterogeneity. In this paper we propose a model with heterogeneous and interacting firms and banks, which is solved analytically. Methodologically, the economy is modelled as a network, a theoretical structure which is particularly suitable to represent the interactions among different individuals. In this credit network firms interact directly with banks and, indirectly, among themselves. The main novelty is the use of the master equation to perform the aggregation over a population of heterogeneous firms and to describe the endogenous evolution of the network. The asymptotic solution of the master equation provides a system of coupled equations, governing the dynamics of growth and fluctuations of the network degree.

### **“On the Scientific Status of Economic Policy: A Tale of Alternative Paradigms” (Giorgio Fagiolo and Andrea Roventini)**

In the last years, a number of contributions has argued that monetary – and, more generally, economic – policy is finally becoming more of a science. According to these authors, policy rules implemented by central banks are nowadays well supported by a theoretical framework (the New Neoclassical Synthesis) upon which a general consensus has emerged in the economic profession. In other words, scientific discussion on economic policy seems to be ultimately confined to either fine-tuning this “consensus” model, or assessing the extent to which elements of art still exist in the conduct of monetary policy. In this paper, we present a substantially opposite view, rooted in a critical discussion of the theoretical, empirical and political-economy pitfalls of the neoclassical approach to policy analysis. Our discussion indicates that we are still far from building a science of economic policy. We suggest that a more fruitful research avenue to pursue is to explore alternative theoretical paradigms, which can escape the strong theoretical requirements of neoclassical models (e.g., equilibrium, rationality, etc.). We briefly introduce one of the most successful alternative research projects – known in the literature as agent-based computational economics (ACE) – and we present the way it has been applied to policy analysis issues. We conclude by discussing the methodological status of ACE, as well as the (many) problems it raises.

### **“Evolutionary Selection of Individual Expectations and Aggregate Outcomes” (Mikhail Anufriev)**

Recent 'learning to forecast' experiments with human subjects (for a review see Hommes (2011), "The Heterogeneous Expectations Hypothesis: Some Evidence from the Lab", *Journal of Economic Dynamics and Control*, 35: 1-24) produced an evidence that aggregate behavior often deviates from fundamental benchmark implied by the rational expectations model. Alternative models of expectation formation have been proposed and tested on the experimental data. For example, Hommes and Lux (2009, "Individual Expectations and Aggregate Behavior in Learning to Forecast Experiments") explain some experiments by means of a Genetic Algorithm model of individual behavior, while Anufriev and Hommes (2009, "Evolutionary Selection of Individual Expectations and Aggregate Outcomes in Asset Pricing Experiment") fit to the data a parsimonious model of switching between behavioral heuristics. In this talk I will compare these approaches applied to a number of

learning to forecast experiments.

### **“Executive compensation, implicit incentives, and competition” (Herbert Dawid and Michael Neugart)**

CEO compensation has risen dramatically during the last four decades. Compared to the seventies CEO's of the 50 largest firms in the U.S. earn (in real terms) almost 10 times as much today. Simultaneously, the share of earnings paid in terms of stocks or stock options has risen from being almost non-existent in the seventies to about 60%. The existing strands of literature attribute the rise and change in composition of CEO compensation to either powerful managers setting their own pay, or to firms contracting optimally in the search for managerial talent in a competitive environment. We build an agent-based model that adds to the second strand of literature by investigating the role of (industry) sector characteristics for optimal contracting. In particular, we are interested in how the share of skilled workers, their skill level, and the skills of a CEO influence a firm's choice of contract as it faces competition in the product market. We conjecture that firms choose different compensation packages as competition in the product market changes and as the composition of the workforce changes. Both developments may lead to different implicit incentives for individual workers in a firm who compete for promotion by exerting effort and thereby increase a firm's productivity.

### **“Agent-based modeling for macro-economy policy design” (Silvano Cincotti)**

The talk addresses the main features of an agent-based model for macroeconomic policy design. In particular, the Eurace framework is considered as reference. Eurace is a large-scale agent-based model and simulator representing a fully integrated macroeconomy consisting of three economic spheres: the real sphere (consumption goods, investment goods, and labour markets), the financial sphere (credit and financial markets), and the public sector (Government and Central Bank). Coherently with the agent-based approach, Eurace economic agents are characterized by bounded rationality and adaptive behaviour as well as pair wise interactions in decentralized markets. Furthermore, the balance-sheet approach and the stock flow consistency checks are followed as modelling paradigm. A set of computational experiments are presented with specific attention dedicate to the emergence of endogenous business cycles in coexistence of long-run growth. Finally, the real effects on the Eurace economy of the dynamics of monetary aggregates is also considered in relation with different monetary and fiscal policy.

### **“Structured sparsity and convex optimization” (Francis Bach)**

The concept of parsimony is central in many scientific domains. In the context of statistics, signal processing or machine learning, it takes the form of variable or feature selection problems, and is commonly used in two situations: First, to make the model or the prediction more interpretable or cheaper to use, i.e., even if the underlying problem does not admit sparse solutions, one looks for the best sparse approximation. Second, sparsity can also be used given prior knowledge that the model should be sparse. In these two situations, reducing parsimony to finding models with low cardinality turns out to be limiting, and structured parsimony has emerged as a fruitful practical extension, with applications to image processing, text processing or bioinformatics. In this talk, I will review recent results on structured sparsity, as it applies to machine learning and signal processing.

### **“Interbank network data and modelling” (Guido Caldarelli)**

We use the theory of complex networks in order to quantitatively characterize the formation of communities in a particular financial market. The system is composed by different banks exchanging on a daily basis loans and debts of liquidity. Through topological analysis and by means of a model of network growth we can determine the formation of different group of banks characterized by different business strategy. The model based on Pareto's law makes no use of growth or preferential attachment and it reproduces correctly all the various statistical properties of the system. We believe that this network modeling of the market could be an efficient way to evaluate the impact of different policies in the market of liquidity.

### **"Dependent types for dependable modelling" (Jeremy Gibbons)**

Scientific practice these days is not confined to short-lived experiments in small, stable, homogeneous laboratories; most interesting areas of investigation involve long-running, large-scale, dynamic, and interdisciplinary collaboration. As the scope of scientific practice "heterogenizes" in this way, it becomes untenable to depend on implicitly shared assumptions about scientific context, procedures, measurements, and so

on; for collaborative modelling to be dependable, it is important that such assumptions be explicitly documented, and preferably even automatically checkable. Dependent types represent the state of the art in programming language technology for checkable assumptions about software components; I will present the case for using dependent types for constructing dependable computational models.

### **“Decentralized models of exchange from a reinforcement learning perspective” (Nicola Botta)**

In agent-based models of decentralized exchange of the kind originally proposed by H. Gintis in (Gintis 2006, 2007), agent-specific prices evolve according to an imitation-mutation rule. The rule is controlled by a trading fitness which, at each prices iteration, is computed in a trading game. The game is played at fixed prices and the time scales of learning and trading are separated: the agents do not modify their strategies while playing. By design, the trading game assumes the agents to 1) be equipped with utility functions which support unique optimal allocations and 2) to be able to compute such allocations for arbitrary prices. We discuss how 1) and 2) could be relaxed by merging learning and trading in a single reinforcement learning step.

### **"Simulation Models are Tools, Not Toys" (Robert Marks)**

Critics of simulation models argue that, since modellers can make any assumptions they wish, such models are little more than toys. But serious modellers see their models as tools in the scientific enterprise. I posit two types of simulation models: Demonstration models, essentially existence proofs for phenomena of interest, and Descriptive models, which attempt to track dynamic historical phenomena. Both types require verification. Descriptive models require validation against historical data as well. I compare a new metric for measuring the distance between two sets of dynamic data, such as sets of time series: my State Similarity Measure, with the earlier information-theoretic notion of the KL divergence, using data from a dynamic simulation model of brand rivalry and history.

### **“Validation and Estimation of agent-based models” (Matteo Richiardi)**

TBA

### **“Learning To Cope With Complexity By Understanding Models Of Nature And Society” (Ilan Chabay)**

In every part of the world and at every organizational level of society, rapidly accelerating changes in conditions from the very local to global require us to make urgent personal and public policy decisions about the highly complex coupled social-ecological-economic system in which we live. Due to inherent complexity, models using current knowledge under specific limited assumptions and conditions are essential tools for making decisions to lead us on paths to a sustainable future. Models are fundamental to human thinking and functioning. They are approximations of the behavior of things and reflect perceptions of patterns and efforts to categorize, explain, and predict future behavior of physical, biological, social, and economic phenomena and systems. Models are essential in organizing and interpreting information, whether implicit and intuitive, or elaborate mathematical constructs, and they serve as engines of simulations and games. In games and simulations, they provide experience in considering and analyzing multiple possible outcomes dependent on input assumptions and knowledge. Yet models and modeling per se are nearly invisible in most educational curricula from elementary school through university. Consequently, most individuals from young students to government ministers have little experience or understanding of the strengths, limitations, and modes of use of models for gaining insights and making decisions. How can the capacity to understand and effectively use models to guide society toward sustainability be developed? That is the central question of this chapter, which is intended to stimulate thinking and action to build this capacity.

The chapter addresses the question by outlining a starting point for developing and implementing strategies and structured methods for introducing students from elementary school through university and the public outside school to the concepts, methods, and uses of modeling, including in games and simulations. This approach introduces powerful, fundamental knowledge and skills and integrates in a meaningful way natural and social sciences, humanities, and arts in learning. It can be used in existing curricula and to strengthen trans-disciplinary, collaborative, inquiry-driven learning.

The pedagogical challenge includes designing, testing, and improving effective instruction at each level that helps students learn to identify the essential components of a model, translate social, physical, and mathematical ideas in developmentally appropriate ways into representations useable for modeling, and gain proficiency in the reasoning necessary to understand and predict the behavior of the models. The social and cultural challenge lies in understanding how models appear in different contexts and how they can function in different educational systems and environments. Pre-service and in-service professional development on this approach for teachers must also be developed, tested, and implemented in collaboration with local resources.



**“Modeling 'Animal Spirits' and Network Effects in Macroeconomics and Financial Markets” (Thomas Lux)**  
TBA

**"Agent-based approach to liquidity and impact in financial markets" (Jean-Philippe Bouchaud)**

We propose a dynamical theory of market liquidity that predicts that the average supply/demand profile is V-shaped and vanishes around the current price. This naturally accounts for two striking stylized facts: first, large metaorders have to be fragmented in order to be digested by the liquidity funnel, leading to long-memory in the sign of the order flow. Second, the anomalously small local liquidity induces a breakdown of linear response and a diverging impact of small orders, explaining the “square-root” impact law, for which we provide additional empirical support. We test our arguments quantitatively using an agent-based model of order flow based on the same minimal ingredients.

**“Stabilization Policies, Technological Diffusion and Economic Growth: An agent-based Analysis” (Philipp Harting, Herbert Dawid, Sander van der Hoog)**

This paper uses the Eurace@unibie model, an extended version of the agent-based macroeconomic model EURACE, to study the relationship between the generation and diffusion of new technologies and the business cycle, in particular how the diffusion speed varies and how it affects long-term economic growth.

In our model an important driver of the diffusion of new technologies is the investment decision of firms. Over time investment goods of increasing quality become available, but they only become part of the capital stock used for production if consumption goods producers decide to invest in physical capital and decide to purchase recent vintages of the capital good. These decisions are strongly affected by firms' expectations of the short- and medium-term development of their relevant markets. Innovation activities of investment good producers are positively related to the revenues of these firms, which implies that the arrival rate of new and more productive vintages of the investment goods vary pro-cyclically over the business cycle.

It is first analyzed how the pro-cyclical variation of investment good innovations paired with the considered diffusion process of vintages affects variation key technology variables, like the quality of firms' capital stocks and labor productivity. Furthermore, it is demonstrated that a stabilizing fiscal policy has negative implications on the average growth rate if the speed of change of the technological frontier is driven by R&D activities in the considered economy. This effect mostly disappears if the frontier is determined by factors exogenous to the economy where the policy is applied.

**“The Role of Technical Change, Finance, and Public Policies in an Evolutionary Model of Endogenous Growth and Fluctuations” (Giovanni Dosi, Giorgio Fagiolo, Mauro Napoletano, Andrea Roventini)**

We study an evolutionary, agent-based model, which is a bridge between Keynesian theories of business cycles and Schumpeterian theories of economic growth. We employ the model to analyze the properties of macroeconomic dynamics and the effects of supply and demand policies. The model describes an economy composed of capital- and consumption-good firms, workers, and a bank. Capital-good firms perform R&D and produce heterogeneous machine tools. Consumption-good firms invest in new machines and produce a homogeneous consumption good. The bank finances firm production and investment plans and collects firm savings. Before carrying out policy analysis exercises, we empirically validate the model showing that it is able to replicate a wide spectrum of macroeconomic and microeconomic stylized facts. Simulation exercises show a strong complementarity between factors influencing aggregate demand and drivers of technological change that affect both “short-run” fluctuations and long-term growth patterns. From a normative point of view, simulations show a corresponding complementarity between “Keynesian” and “Schumpeterian” policies in sustaining long-run steady growth paths characterized by milder fluctuations and relatively lower unemployment levels.

**"Crisis in Economic Theory" (Alan Kirman)**

TBA

## Directions

### **To get to the hotels or to the conference venue:**

-From **Roissy CDG airport** a taxi will cost you around 50€. It will take you 45 minutes, more if you arrive during the rush hour (8am-10am, 5pm-7pm). You can also take the train which is called RER B (follow the signs Paris by train in the airport, if you are arriving at terminal 2 you can walk to the train station, if you are arriving at terminal 1 or 3, you might need to take first the airport internal metro). The fare is a little bit less than 10€ and the trip shall last around 40 minutes. Get down at Saint-Michel (choose the exit boulevard Saint-Germain), your hotels are within a 10 minutes walk (see the map below).

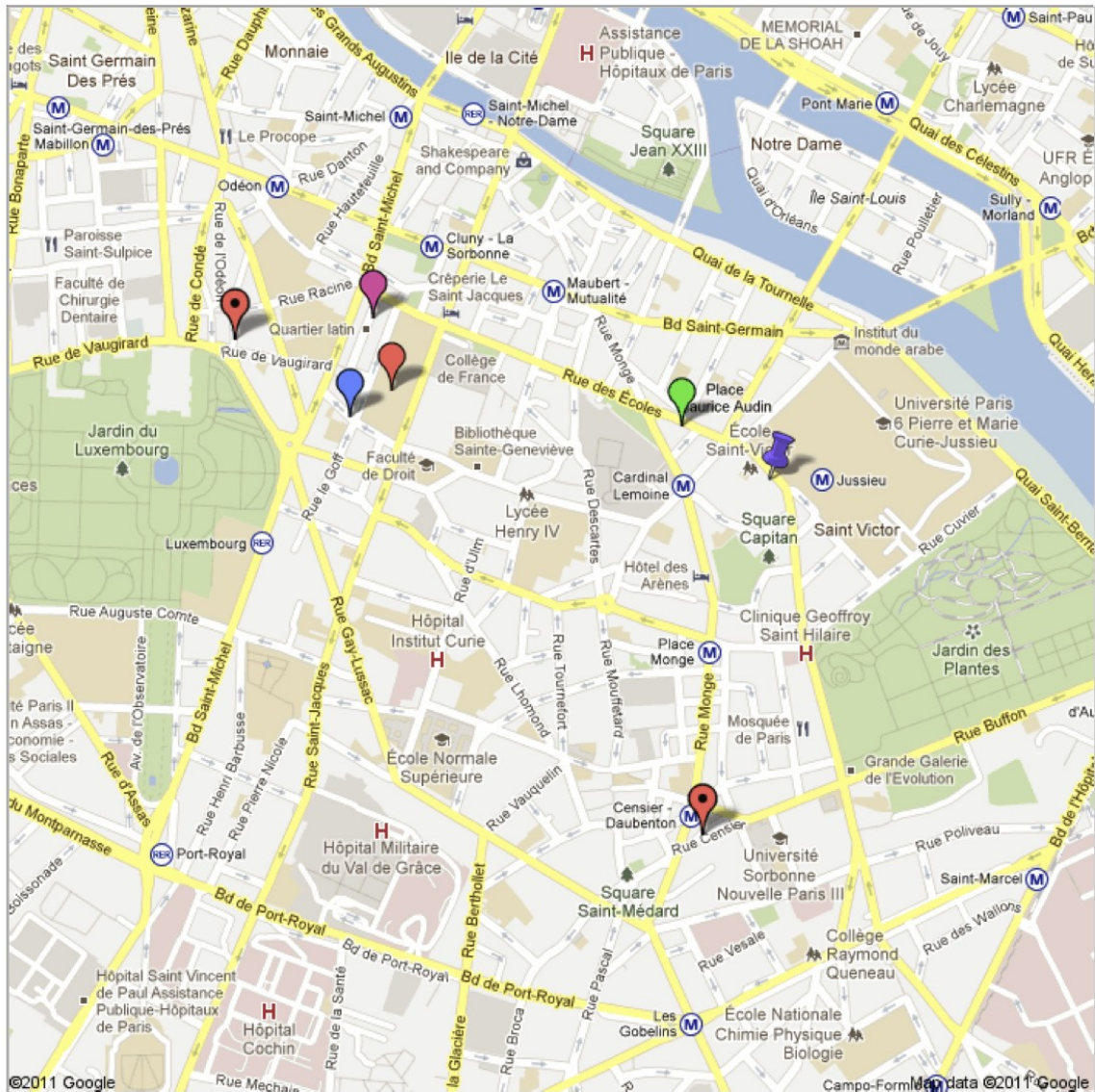
-From **Orly airport**, a taxi will cost you around 30€. It will take you 30 minutes, more if you arrive during the rush hour (8am-10am, 5pm-7pm). You can also take the train: first pick-up the automatic metro orlyval inside the airport. This will take you to the Antony station where you can catch the RER B to Paris. Get down at Saint-Michel (choose the exit boulevard Saint-Germain), your hotels are within a 10 minutes walk (see the map below). The fare is around 10€ and the trip shall last around 40 minutes.

- The hotel des Trois Colleges is in front of the Sorbonne, the Hotel Minerve is 800 meters away (maps below)

### **To get to the conference rooms:**

- To get to Room Marc Bloch (stair C, 2<sup>nd</sup> Floor): enter the Sorbonne by the 17 rue de la Sorbonne, take the first corridor on your left (galerie Rollin), there is first an elevator on your left and a staircase 10 meters further. Take either of these to the second floor. The room Marc Bloch then is on your right at the end of the corridor.

-The directions to Room Cavailles are identical except it is on the first floor.



### GSDP ABM workshop

Publique · 1 consultations  
Créée le 12 août · Par antoinem · Mise à jour il y a 5 minutes

-  Hotel Minerve, 13 Rue des Écoles 75005 Paris, Tel 01 43 26 26 04, <http://www.parishotelminerve.com>
-  Hôtel des 3 Collèges, 16 Rue Cujas 75005 Paris, Tel 01 43 54 67 30, [www.3colleges.com](http://www.3colleges.com)
-  Sorbonne
-  Hôtel Central Saint Germain, 3 Rue Champollion 75005 Paris, Tel 01 46 34 14 20, [www.hotelcentralsaintgermain.fr](http://www.hotelcentralsaintgermain.fr)
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# Plan de la Sorbonne

