Complexity Research Initiative for Systemic InstabilitieS

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Workshop 1

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Abstract	The following is a report on the first internal Workshop of the CRISIS project, organized by the Università Cattolica del Sacro Cuore in Milan, from the 29th to the 31st of October 2012. The Workshop was attended by representatives of all the project partners and its aim was to review the progress made so far and coordinate future activities.

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Table of Contents

Introduction

The present report describes the activity carried out during a workshop of the CRISIS consortium organized from October 29th to 31st, 2012 on the premises of the Università Cattolica del Sacro Cuore, coordinator of the CRISIS project.

The Workshop was attended by representatives of all the partners (see Annex II : List of Participants) and there was one invited speaker, Dr. Co Pierre Georg from the Research Center of Deutsche Bundesbank.

Although this was the project's first official internal workshop, another informal workshop was held in June 2012, organized by CITY University in London. This preliminary workshop had been deemed necessary by the Consortium partners in order to review the progress achieved since the kick-off meeting in November 2012, following the first technical review which had taken place in May 2012, and with a view to coordinating subsequent activities.

The first day of the Milan Workshop was devoted to a general overview of the project and the accomplishments to date. The guest speaker, Dr. Co Piere Georg, presented his work on the Black Rhino financial simulator which was followed by a lively Q&A session.

The second day started with a presentation of the software developed for the online game: one of the objectives of this workshop was to obtain comments and suggestions from all the partners in order to fine tune the software so that it responds in an optimal way to the project's requirements.

There followed a series of presentations by both senior and junior members of the teams, while part of the day was also devoted to a meeting of the Steering Committee.

During the third day of the workshop, the financial team discussed the experiments they intend to carry out while another presentation dealt with the progress towards an integrated multi-country macro and financial agent based model (Mark 3 model).
At the end of the day, all participants proposed areas of research that could be pursued in the coming months and which would enhance the overall progress of the CRISIS project.

Description of the Workshop

Day 1 – Monday 29 October 2012

The first internal CRISIS Workshop started at 12 on Monday 29 October 2012. Doyne Farmer (INET-Oxford) outlined how the Workshop would proceed over the following 2 days and reported on his contacts with the Bank of England in view of a possible collaboration in the field of research that could be beneficial to both parties. Domenico Delli Gatti then reported on the FOC-CRISIS School on Complex Financial Networks that had been held in Lucca, Italy, the week before with the aim of providing participants with the latest know-how for understanding and analysing the complexity of today's financial networks. He also reported on the latest contacts with the CRISIS Project Officer regarding the date of the next Technical Review.

After a short lunch break the Workshop resumed with a presentation by the only invited speaker, Dr. Co-Pierre Georg from the Research Center of Deutsche Bundesbank.

Invited talk by Georg Co-Pierre

Dr. Georg gave a presentation entitled "Heterogeneous Agents, Contagion, and Macroprudential Policy". He analyzed the transmission of different forms of contagion in an interconnected and heterogeneous banking system by using the Black Rhino financial multi-agent software. Banks engage in interbank lending, exposing them to counterparty risk. They hold potentially illiquid risky assets that give rise to endogenous fire-sales. The default of a bank makes other banks more cautious, leading to a credit crunch and a breakdown of interbank lending. In his models various macroprudential measures (countercyclical capital buffers, liquidity ratios, SIFI surcharge, and target leverage ratio) can be implemented and their effectiveness in countervailing the different forms of contagion can be assessed. It is shown that a leverage ratio and a SIFI surcharge can be effective in countervailing the various channels of systemic risk.

Following Dr. Georg's presentation, there were several questions from the participants particularly regarding the Black Rhino software and the possible interaction with the software currently being developed under the CRISIS project.

The floor was then given to representatives of all the Consortium partners who reported on what their units had accomplished in the previous six months.

Domenico Delli Gatti, representing Università Cattolica (UCSC) briefly outlined the research work carried out by the UCSC group in building the current version (labeled "Towards Mark II" in deliverable D3.2) of the macroeconomic agent-based model (MABM). He also reported on joint activities with UPM and UNIPA (Palermo meeting, September 2012).

Vasco Carvalho, representing CREI at UPF in Barcelona briefly outlined the research work carried out by the CREI group in surveying recent development in input-output analysis and exploring new detailed datasets.

Gabriele Tedeschi, from the Università Politecnica delle Marche (UPM) reported that his unit deals with the sources of instability in credit and financial systems and the effect of credit linkages on the macroeconomic activity. By combining agent-based models with network theory, the group analyzes the evolving dynamics of the economy as a complex, adaptive and interactive system, which allows them to explain some key elements that occurred during the recent economic and financial crisis. In particular, they study the repercussions of inter-bank connectivity on agents' performances, bankruptcy waves and business cycle fluctuations. Interbank linkages, in fact, let participants share risk but also create a potential for one bank's crisis to spread through the network. The purpose of the work carried out at UPM is, therefore, to build up the dependence among agents at the micro-level and to estimate their impact on the macro stability. Joint work with UCSC and UNIPa

is already under way.

Luca Marotta, representing the Università di Palermo (UNIPA) presented an analysis of the Japanese credit market as monitored during the years 2000-2005. The available database involves only publicly quoted firms, whose total number varies from 2629 in year 2000 to 2674 in year 2005. Specifically, the unit studied some aspects that might be useful for the implementation of the credit market in the CRISIS ABM.

Their results can be summarized as follows.

1. **Entry/Exit**: the dynamics of firms entering or leaving credit market is almost constant during the different years. It should be noted that the word *exit* here doesn't necessarily imply that the firm undergoes bankruptcy; the absence from UNIPA's database could mean that the firm was delisted or changed legal status due to merger and acquisition.

2. **Multiple lending**: it emerges that every firm has on average credit lines with 8 different banks . Since many European Countries have a credit-based economy similar to Japan's, some mechanism to implement multiple lending should be introduced in the ABM.

3. **Changes of the set of lending banks to a firm**: UNIPA also analyzed the changes in the set of lending banks to a firm. Evidence was found of very strong dynamics in the credit relationships of firms. Actually, always more than 50% of firms (with peaks of almost 75%) change the number of banks in their set of lending banks or switch to other banks. UNIPA's study shows that the distribution of the change of the number of banks lending to a firm follows a power law with an approximate exponent coefficient of -2.0, almost equal in the analyzed five years.

4. **Long/short term credit**: The distribution of long term credit (and the complementary short-term credit distribution) appears to be bimodal plus a roughly Gaussian central part. A histogram of this quantity shows two very pronounced peaks at the first bin (firms that almost ask

only short-term credit) and at the last one (firms relying only on long-term credit). The bimodal nature of this distribution could be related to different firm behaviour based upon its size, but this hypothesis needs more verifications.

5 **Bank credit distribution**: finally, UNIPA also looked at the distribution of credits given by a specific bank to firms. First of all banks were divided in quartiles of their sizes, using the total assets as a size measure. Then, for each bank, they plotted the rank-order distribution of the credits it gave to firms. As a result, we find that, whenever the bank has enough credit relationships to ensure a good fit, this distribution approaches a Zipf distribution (critical exponent $\simeq$-1); more precisely, restricting our fits to those banks with more than one hundred lendings greater than 10^3 million of yen and then selecting only fits with a coefficient of determination R^2 greater than 0.96, we find a mean value of -0.95 for the power-law exponent. One possible explanation is that firms ask for credit according to an average leverage level so that bank loans distribution reflects the distribution of the assets of the firms.

Besides these empirical findings, UNIPA also used its database to begin a study of the credit network induced by credit relationships between firms and banks. Credit networks are examples of the so-called bipartite networks, which are formed by two different sets of nodes and in which links exist only between nodes not belonging to the same set.
Using two methods developed by the group, it was possible to statistically validate some links, in order to preserve the ones carrying the most relevant information. After applying a community (cluster of nodes) detection algorithm to the resulting network, a statistical characterization of the clusters thus obtained was also performed. This analysis shows that firms and banks belonging to the same subset usually have their main offices in the same city and, moreover, that inside a community firms are more likely to share the economic sector in which they operate.

Following this presentation, **James Porter** gave an overview of the completed and ongoing **City University London** CRISIS-related projects.
He reported that at City University much research has taken place, particularly that associated with the Forecasting Financial Crises (FOC) project into the interbank markets, in particular looking into behaviour on interbank market, information theoretic quantification of the behaviour and cross sectional comparisons. This may be of particular use in informing the interbank market in the main CRISIS model.

An agent-based model has been built to look at:

- Trust evaporation in the interbank market as an herding effect
- Banks' decisions to exit the market
- Relationship lending in the interbank market

Furthermore, a survey chapter has been prepared for the Handbook on Computational Economics and Finance. Eds. Shu-Heng Chen and Mak Kaboudan, Oxford University Press. It will be available as a working paper shortly.
Ongoing and planned work includes looking at longer duration interbank loans, in particular assessing systemic importance and understanding intercountry variation. Projects looking at news sentiment and market events, and monetary policy for crises are in early stages.

The last hour of the first day of the workshop was devoted to administrative and logistic issues including a review of all the deliverables to be submitted by April 2013 and all the tasks to be undertaken by the partners in view of the next Technical Review, scheduled in January 2013.

Day 2 – Tuesday 30 October

The second day of the workshop opened with a presentation by **Laszlo Guylas** who gave a brief overview of **AITIA**'s activities during the last period of work (project months 7 to 12). According to the DoW, three deliverables

were due in this period that AITIA was responsible for: i) D5.2 (Integration Plan), ii) D5.3 (Game, first release) and iii) D6.1 (Specification of the simulator).
In addition to these, AITIA was also involved in three other efforts within the CRISIS project. These were iv) participation in and coordination of the development of the Base Modeling (Financial) library intended to provide a common platform for all models to be built in the CRISIS project, v) development of the software framework for the laboratory experiments to be carried out in WP4, and vi) the development of an easy to use authoring tool for the creation of new laboratory experiments.
It was pointed out that the software framework for the laboratory experiments closely corresponds to the technical infrastructure created for the online game.
In addition to the above, AITIA was also involved in the maintenance of the CRISIS website.
In the second part of the presentation, a detailed overview of the Base Modeling (Financial) library was given which was followed by a lively discussion during which all the project partners contributed their ideas and suggestions so as to help the AITIA unit develop a product able to meet the complex requirements of the CRISIS project.

The next presentation was given by **Jacob Grazzini** and regarded the Mark I plus model on which the **UCSC** unit has been working. The current version of the macroeconomic agent-based model is populated by households (workers and capitalists), consumption goods producers, capital goods producers and a bank. The consumption goods sector produces consumption goods using labor, supplied by the workers, and capital, supplied by the capital goods sector. The interaction between the two production sectors produces interesting emergent properties. In particular, the financial fragility of a relatively small capital sector heavily influences the behavior of the whole system. The results of the new model were presented during the workshop.

The morning session continued with a presentation by **Niccolò Stamboglis of City University, London** on Modelling the Interbank Market**.** He reported that the agent-based model developed by CITY aims at explaining the increase of dispersion of interest rates paid by individual banks in an Overnight market during a crisis.
The model proposes a mechanism of private and public information elaboration by market participants which influences market dynamics. The private information on counterparties increases with reiterated exchanges. Nonetheless, during a crisis event agents may enter into an herding regime where they do not consider private information and rely on a more volatile public information to assess the reliability of their counterparties. The model ests whether the presence of preferential lending represents a stabilizing factor in the system, thus reducing the dispersion of interest rates.

The next presentation was given by **Joao de Gama Batista from CEA** on the Dynamics of Trust in Networks.
He indicated that the feeling of “confidence” or “trust”, which is driven both by objective information (e.g.: the state of the economy) and interaction between agents, has been widely considered a crucial "macro" variable to describe the dynamics of the financial markets. Agent based models should thus account for this collective variable, whose underlying dynamics can be much faster than conventional economic factors. It is highly sensitive to expectations about what other people expect, which is one of the fundamental feedback loops for self-fulfilling prophecies, such as liquidity breakdown or evaporation of trust. Both the creation and destruction of the network is modeled over time, with a mutual feedback between one's links to one's trustworthiness, taking into account the empirical evidence that losing trust tends to be a much faster phenomenon than gaining trust (asymmetry). Within this framework, avalanches and sudden disintegrations of the trust network emerge in some regions of the parameter space, which researchers seek to analyze statistically and draw conclusions from.

Peter Klimek then took the floor and reported that in the past six months the team at the **Medical University of Vienna** had progressed along four major directions:

i. They explored and implemented behavioral rules for the central bank in the combined economic/financial simulator. The team proposed a design where the central bank can serve as a liquidity provider by following a quantitative monetary policy rule, such as the Taylor rule. In addition, they evaluated actual bailout mechanisms observed in systemic banking crises in the last forty years and discussed various proposals of how they can be implemented in the simulator.

ii. They studied the effects of global accessibility of credit information and their implications on systemic risk. In particular, they implemented systemic risk-dependent interest rates on the Interbank market and will further try to find and test indicators reflecting global credit information and systemic risk.

iii. The unit also studied various forms of hedging collateral for leverage and their systemic consequences. The MUV team tested different regulation scenarios for leverage and compared them with the unregulated case.

iv. The team is also dealing with the ongoing issue of migrating the developed code to the MASON architecture in JAVA.

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During the afternoon session the participants were divided into several groups. One group consisted of the CRISIS project's Steering Committee while the rest of the participants formed smaller groups to discuss specific issues such as software development, etc.
After the group sessions, a brief report was given so as to acquaint all participants with what had been discussed in each one.

The Steering Committee discussed among other things:

- The progress made in each WP and future development;
- The state of the deliverables and tasks to be undertaken to ensure their delivery within the deadlines;
- The preparation of the next technical Review;
- The organization of the next CRISIS workshop in Leyden.

There followed two presentations, the first by the Scuola Normale di Pisa and the second by CEA:

Fulvio Corsi (SNS) gave a presentation entitled “Financial innovation, leverage and correlations”.
He reported that while the proximate cause for crises is very often an expansion of the balance sheets of financial intermediaries, the reasons for the acceleration of credit growth remain unclear.
Hence, the SNS unit proposes a simple model where the introduction of financial innovation in a financial system subject to mark-to-market accounting rules and VaR constraints leads to an increase in leverage and correlation of risks which raises the amplitude of balance sheet variations of financial intermediaries and systemic risk.

Next, **Francesco Zamponi (CEA)** reported on the activity of the Paris node which is focused on two main issues:

1. Understanding the relation between the macroscopic and the microscopic descriptions of the economy, in a physicist's meaning of these words.
   Namely, the macroscopic level corresponds to the thermodynamic limit of an economy with N agents when N goes to infinity. In this limit, it might be possible to describe the system through differential equations for average quantities. Instead, the microscopic level is intended as described by an agent-based model, where heterogeneities are present at the level of a single agent, and where fluctuations and fat tail effects are treated exactly. The question is: under which conditions a

simple (mean field)thermodynamic limit exists, and what kind of differential equations emerge?

2. Coupling of "confidence" (or "trust") to macroeconomic variables. The concepts of overall confidence is important in determining the collective behavior of agents in an economy. CEA would like to construct a simple but semi-realistic macroeconomic agent-based model (a "simplified" version of Mark I), and then couple it to a simple model of trust formation and collapse that they have already developed. By merging the two models the team will be able to investigate how "confidence" can be coupled with macroeconomic variables.

This concluded the second day of the workshop.

Day 3 – Wednesday 31 October

The last day of the workshop began with a presentation by **Cars Hommes** from the **University of Amsterdam** on Laboratory Experiments on Human Subjects.

He reported that UvA unit has been working on the design of laboratory experiments with human subjects. In particular, the concrete designs for two experiments have been finalized. The first design refers to a “price-quantity” experiment (joint project with the UCSC unit) in which the aim is to analyze the price-quantity setting behavior of firms in an environment of monopolistic competition. The second design concerns a “bubble” experiment (jointly with the CEA unit) which aims at studying episodes of trust collapse and occurrence of irrational crashes in financial markets. In the next 6 months the UvA unit plans to test the experimental software developed jointly with the AITIA unit and to run the experiments in the CREED lab at the University of Amsterdam. The unit has also advanced proposals for future experiments, such as large-scale learning-to-forecast experiments and economic stabilization experiments involving policy makers.

Vasco Carvalho (CREI at UPF) briefly outlined the research work to be carried out by the CRISIS consortium towards MAMB mark 3.

The last part of the workshop was devoted to discussing two important issues: the first discussion focused on the software effort while the second was a brainstorming session regarding research problems.

The software effort is currently at a critical stage. Most of the core level software is written, but the actual implementation of models must be completed. Furthermore the consortium is at a critical point because, while it was decided to use Java as the language for the project, and most people have learned java and taken the course organized in Budapest early in 2012, it is necessary to get everyone programming in Java using the platform that is being built. To confront this problem it was decided to set up a task force to implement different parts of the design, planning who would do what, setting up a weekly phone call, and organizing a face to face meeting for the task force at the end of November.

The second main activity was the brainstorming session about research problems. Because the CRISIS team is large with overlapping interests there is a substantial coordination problem to, on one hand, get everyone to use the same platform but, on the other hand, to get them to do different things with it. During the brainstorming session a fairly long list of research problems was generated, which can be regarded as a "research menu". These problems include, among others, the determination of a leverage cycle and the design of policies to mitigate its consequences (such as the macro effects of deleveraging strategies), risk management and macroeconomic performance, alternative monetary policy regimes (e.g. quantitative easing – asset purchase vs interest rate setting).

After the lunch break the problems that had emerged during the brainstorming session were thoroughly discussed. The interests of each group and the pros

and cons of focusing on different research problems were assessed and the research tasks were divided among the different units.

The Workshop ended at 4 pm.

Agenda
CRISIS workshop
Milan 29 – 31 October 2012
Università Cattolica di Milano – Via Carducci 28/30

Monday 29 October

12:00	Welcome, overview of what we will try to accomplish at this workshop, discussion of agenda
12:30	Lunch
14:00	Co-Pierre Georg. Presentation of Black Rhino financial simulator
15: 00	15 min. presentations by each group leader of what their unit accomplished in the last six months
16:15	Coffee break
16.30	15 min. presentations by each group leader of what their unit accomplished in the last six months
18.00	Review of deliverables for next 6 months
18:30	End of 1st day

Tuesday 30 October

9.15	Demo of 2.0 financial model and high level discussion of software design, problems, etc. (AITIA)
10.30	Discussion of specifications for Mark II (UCSC)
11.00	Coffee break
11.30	Short talks by junior team members (CITY, CEA, MUV)
12.45	Lunch
14.00	Meeting of steering committee to discuss various issues: Review of deliverables for next 6 months and next review, state of the amendment, Credit allocation, Leyden and beyond, what issues aren't working and need attention? Everyone else participates in a more detailed discussion about how to use 2.0 software. In particular with a focus on what it takes to create a new kind of bank
16.00	Coffee break
16.30	Reports on Steering Committee meeting and group sessions
17.45	Presentations by SNS and CEA
18.30	End of day
20.00	Social Dinner

Wednesday 31 October

9:30	Laboratory Experiments on Human Subjects (Cars Hommes-UvA)
10.30	Towards the MARK III model (Vasco Carvalho-CREI)
11.15	Coffee break
11: 30	General discussion. Does the division of labor make sense, overlaps, etc.? Is this coherent?
12:15	Brainstorming session
13:15	Lunch
14:30	Discussion on research ideas that emerged during the brainstorming session and the workshop as a whole
15.30	Discussion of work assignments, coordination, strategies for producing deliverables
16.00	End of Workshop

CRISIS Workshop

29-31 October 2012

Università Cattolica del sacro Cuore

Via Carducci 28/30, Room 211

List of participants

	Affiliation	Name	Signature
1	UCSC	Domenico DELLI GATTI	
2	UCSC	Tiziana ASSENZA	
3	UCSC	Jakob GRAZZINI	
4	UCSC	Alessandro GOBBI	
5	UCSC	Maria Grazia BONANOMI	
6	UCSC	Eleni PAPAGEORGIOU	
7	UvA	Cars HOMMES	
8	UvA	Domenico MASSARO	
9	AITIA	Laszlo GULYAS	
10	AITIA	Richard LEGENDI	
11	INET/Oxford	Doyne FARMER	
12	INET/Oxford	Olaf BOCHMAN	
13	MUV	Stefan THURNER	
14	MUV	Sebastian POLEDNA	
15	MUV	Peter KLIMEK	
16	UNIPA	Rosario MANTEGNA	
17	UNIPA	Luca MAROTTA	

18	CREI	Vasco CARVALHO	
19	CEA	Francesco ZAMPONI	
~~20~~	~~CEA~~	~~Marco TARZIA~~	
21	CEA	Joao da GAMA BATISTA	
22	SNS	Fabrizio LILLO	
23	SNS	Fulvio CORSI	
24	SNS	Stefano MARMI	
25	UPM	Gabriele TEDESCHI	
26	CITY	Niccolò STAMBOGLIS	
27	CITY	James PORTER	
28	Santa Fe Institute	Fabio CACCIOLI	
29	INET	Christoph AYMANNS	
30			
31			
		Speakers	
32	Deutsche Bundesbank	Co-Pierre GEORG	
33			
34			
35			
36			