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D1.1

SYMPHONY Conceptual Architecture

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Executive Summary

This deliverable documents the work performed in WP1 of the SYMPHONY project and specifically during Task 1.1 State-of-the-art analysis, Task 1.2 Stakeholder & user requirements and Task 1.3 Develop the SYMPHONY Conceptual Architecture for policy modelling.

In order to establish and describe a concise conceptual architecture that addresses user requirements we followed a Design Thinking approach which is explained in Section 2 of this document. Our aim was to identify user groups and integrate the views of the target users in the design of our concepts.

With the help of users we managed to describe in detail the two challenges we are trying to address in SYMPHONY (see Section 3). The first concerns problems related to financial stability whereas the second is concerned with more long-term issues of sustainability transition.

Based on information we gathered from users as well as our updated knowledge on the state of the art both from a research and practice perspective in the main areas of interest i.e. social media mining and information markets for collective intelligence, agent based models for policy simulations and serious games for stakeholder and citizen awareness, we formulate the project's vision and related conceptual architecture in Section 4.

Our solution specifies and defines how to orchestrate agent based macroeconomic models and simulators, experts/stakeholders/citizens expectations in a gamified and engaging manner under a novel framework.

The work described in this deliverable is the basis for the remainder of the project and will drive the efforts of all partners in order to reach the SYMPHONY vision.

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1 Introduction

1.1 Scope of the Deliverable

Deliverable D1.1 documents the work performed in the first work package of the SYMPHONY project. The objective of WP1 is to update the relevant state of the art, identify user and stakeholder requirements and define the SYMPHONY conceptual architecture for policy design and regulation of a resilient and sustainable financial economy.

Within the first task – Task 1.1 "State-of-the-art analysis" - the focus was to update our knowledge on the state of the art both from a research and practice perspective in the main areas of interest i.e. social media mining and information markets for collective intelligence, agent based models for policy simulations and serious games for stakeholder and citizen awareness. Through a series of discussions and presentations on each partner's area of expertise the consortium developed a common vocabulary which allowed communication among the members and stakeholders in a multidisciplinary and multiuser environment.

Task 1.2 – "Stakeholder & user requirements" - involved close work with the use case partners and interested stakeholders in order to elicit, define and document the stakeholder & user requirements of the SYMPHONY solution for global systems. Relevant stakeholder groups we identified included policy advisors, policy makers, citizens and politicians.

In Task 1.3 – "Develop the SYMPHONY Conceptual Architecture for policy modelling" - we established a general view of the work that will be developed within the project. The conceptual architecture specifies and defines how to orchestrate agent based macroeconomic models and simulators, experts/stakeholders/citizens expectations and gamification under a novel framework. The SYMPHONY conceptual architecture considers a global systems science approach, paves the path for the SYMPHONY solution and addresses identified stakeholder & user requirements connecting the benefits of our global systems science approach with the true needs of policy makers, policy modellers and citizens.

1.2 Structure of the Deliverable

The deliverable is structured in 5 Sections. Following the Introduction, in Section 2 we present our Design Thinking approach for Information Systems which allowed the SYMPHONY consortium to identify user requirements and reach a common vision with respect to the conceptual architecture. Section 3 describes the problem space of SYMPHONY, i.e. the two main challenges we are addressing with our solution, including the identified user requirements and the citizens' perspective. Section 4 presents the conceptual architecture. We begin with the project's vision in Section 4.1 and our envisaged architecture for addressing the identified challenges in Section 4.2. In Section 4.3 we provide detailed information on the four main components that together will instantiate our envisaged architecture. For each component we provide a short overview, the related state of the art and the research directions that we will be pursuing in the remainder of the

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project. Section 4.4 contains a set of indicative user scenarios which were formulated in cooperation with users and demonstrate how our final solution will be used. Last but not least we conclude in Section 5 with our final remarks and future work.

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2 Overview of the SYMPHONY Design Thinking Approach

In SYMPHONY we follow a Design Thinking (DT) approach for Information Systems which allowed us to identify the user requirements for our solution and establish a common understanding within the consortium as well as with the potential users and stakeholders on what our offering refers to. The approach led to the definition of the SYMPHONY conceptual architecture which will drive the work in the remainder of the project and will act as a reference point for all partners.

The idea of leveraging the power of design for ICT projects has become more and more present over the last years (see for example Brown, 2009; Neumeier, 2009; Martin, 2009; Boland and Collopy, 2004; Utterback et al., 2006; Verganti, 2009). In this respect, DT is promoted as a new way of approaching products, services, processes, structures, or strategies (Brown, 2009; Lockwood, 2010; Martin, 2009) in order to increase innovation and address user requirements more efficiently.

In its essence, DT is a design methodology, nonetheless it differs from traditional design approaches and is considered more creative and user-centred. For example, unlike analytical thinking, which is associated with the "breaking down" of ideas, Design Thinking is a creative process based on the "building up" of ideas (Baeck & Gremett, 2011). Moreover, analytical approaches focus on narrowing the design choices, while DT focuses on going broad, especially during the early stages of the design process.

In DT, project teams do not make any early judgments about the quality of ideas in order to minimize the fear of failure and maximize input and participation. What is called "Outside the box thinking" is encouraged in the earlier process stages; the aim is to identify creative solutions that would not have emerged otherwise while allowing everyone to be a designer. DT is a more user-centred approach to problem solving (Baeck & Gremett, 2011) as the core of the method is to understand the target user and structure all ideas and subsequent work around the user. In order to achieve this, DT follows a more experimental approach.

The methodology is often used to explore and define business problems and to define products and services thus bringing the design approach into the IT world. By leveraging on the designer's sensibility and methods, through DT we can address user needs, apply what is technically feasible and offer value and market opportunities. As a methodology, DT uses empathy for the context of a problem, creativity for the generation of insights and solutions, and rationality and feedback in order to analyse and select solutions that meet user needs and at the same time generates value.

When comparing DT with the traditional approaches to IT development processes, differences include (Lindberg et al., 2011):

- Building on Diversity: Although IT design professions specialized on the user perspective extend disciplinary diversity in IT development and agile development

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features strong team-based collaboration, a collaborative approach that tries to implement differing thinking styles in development teams as well as design thinking on a meta-disciplinary level is not explicitly addressed.

- Exploring the problem space: IT engineers deal with the user's perspective via specifications, which may be validated by user insights, but do not deliver the "full picture" needed for creative ideation. Also, a team-based approach that uses a collaborative understanding of the user context to come up with new ideas while addressing user requirements has not been taken into account.

- Exploring the solution space: Creative ideation is not explicitly included in IT development models. Even agile processes focus more on incremental progress than on divergent thinking.

- Iterative Alignment of both spaces: There is a strong parallel between DT and agile concerning continuous iteration of user feedbacks based on prototypes throughout the process. However, DT supports the iterative exploration of both spaces much more extensively than agile does.

The methodology is commonly comprised of a set of five step which can be presented as linear (see Figure 1), but are interrelated and can be executed in iterative cycles while trying to identify the most promising and viable solutions.

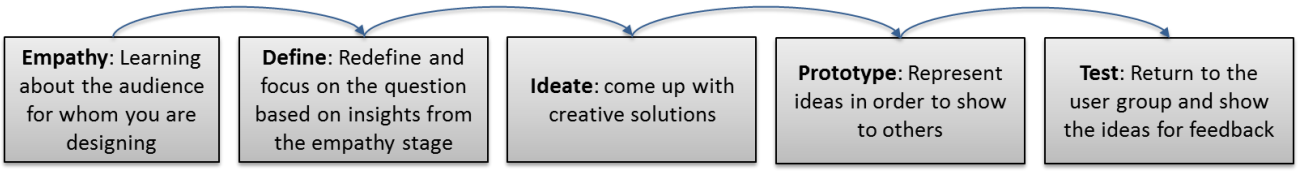

Figure 1: Overview of the Design Thinking methodology.

In SYMPHONY we already have a broadly defined problem space since the inception of the idea in the proposal phase, thus in the first months of the project duration we aligned, updated and described in more details our envisaged solution. To this direction the DT process has been adjusted as described in Figure 2, and further elaborated in the following sections. The benefits of DT were manyfold as we managed to collect opinions and views as well build a common understanding of the projects' vision during the research phase, we elicited, analysed and prioritized requirements during the synthesis phase, and we consolidated all the available information through a process of developing indicative user scenarios and paper based prototypes during the ideation and prototyping phase.

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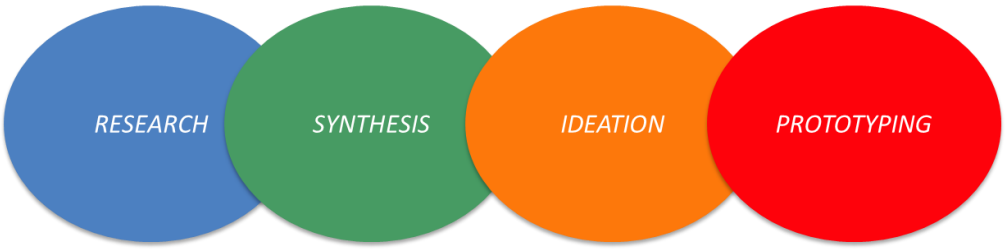

Figure 2: Design Thinking Approach in SYMPHONY.

2.1.1 Research

The first phase involved a better understanding of the problem space related to SYMPHONY. Although the SYMPHONY vision was outlined and described in the proposal, our work was to revisit our basic assumptions and communicate the different views between partners and the stakeholders. We revisited the state of the art and identified in a thorough and detailed manner recent work performed in the domain of the SYMPHONY project including the four major research areas i.e., Agent Based Modelling, Social Media Mining, Information Markets and Gamification. Our focus was on the developments performed in the duration between the submission of the proposal and the project start.

Moreover we established a process where technical partners and end-user partners (GCF and GW) could ask questions and received answers. The process assisted us into reaching a common understanding of the problem and build a common vocabulary by explaining and providing insights on the domains of expertise of each partner. For the purposes of this phase, each partner was requested to prepare a document with an overview of its technical offering, related capabilities and limitations, indicative examples of usage of the technical offering, questions to other technical partners as well as the users in order to clarify the role of the technical offering in SYMPHONY. Similarly, end-user partners were asked to prepare a document with the problem to be solved in their case, a short description of their envisaged integrated SYMPHONY solution and a short scenario of usage of the envisaged SYMPHONY solution. The input generated by the partners provided the basis for an in depth discussion during the second consortium meeting in January 2014, in Athens. A consolidated version of the questions we gathered and which were discussed during the meeting can be found in APPENDIX I.

A major aspect of our work in SYMPHONY refers to the involvement of citizens. We gathered requirements from citizens using a questionnaire based approach. Our aim was to understand whether our approach and solution is interesting to citizens as well as gather feedback on modifications and improvements. To this end, we run an online survey. In parallel targeted focus groups were held in Athens, Germany, Italy and Slovenia with citizen representatives. Our results are presented in Section 3.4 whereas in APPENDIX II we provide the citizens' questionnaire.

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2.1.2 Synthesis

In the Synthesis phase we collected and analysed all the answers and questions with an aim to extract information relevant to the SYMPHONY solution as well as elicit and prioritize requirements. From this process we were able to identify:

- The set of policy questions that SYMPHONY should be able to answer, model and provide support to policy modellers and policy makers to explore.
- The set of alternative policies that should be supported by the SYMPHONY toolset.
- The stakeholders and roles who are going to use the SYMPHONY platform as well as the insights and feedback each role should get from SYMPHONY.

The process involved a series of workshops. One between the project partners at the Athens consortium meeting on January 2014 as well as several workshops with stakeholders as described in Section 3.

2.1.3 Ideation & Prototyping

In this phase we consolidated all the available information (as derived from the previous phases) through a process of developing indicative user scenarios that showed and described the envisaged use of the platform. The set of scenarios shed light on various aspects of the technical visibility of the proposed solution and helped us to acquire feedback from the stakeholders for the subsequent prototyping phase. Our approach was iterative and in line with the Design Thinking guidelines. All the stakeholders participating or associated with SYMPHONY were involved. We began with drafting views of the scenarios based on the SYMPHONY description of work which were presented to all partners in the consortium meeting in Athens on January 2014. These were refined through a series of remote brainstorming and in-depth skype discussions in the second and third quarter of the project as well as the consortium meeting in London on May 2014. Further comments were incorporated and throughout the following months we held regular skype calls which led us to update, scrutinize and incorporate all different views in the scenarios.

Design thinking is at its best if tangible prototypes can be used to capture and validate end user needs and envision new solutions and services. However, creating tangible prototypes is not feasible or cost-effective for complex software systems with multiple users and their complex behaviour.

To overcome this problem, we employed an approach based on scenario prototyping that uses executable software engineering models including structural as well as behavioural aspects. The aim is to turn these models into tangible virtual prototypes to enable end-users to better visualize the complex interrelated behaviours and to capture feedback interactively. Our prototypes were the final scenarios and were communicated to stakeholders and citizens in order to acquire more feedback. For the list of our indicative scenarios see Section 4.4. We foresee to continue using a DT approach when testing and evaluating the actual software tools we are going to produce by following an iterative process where end users will be involved in order to provide their views and comments.

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3 Problem Space

3.1 Global Systems Science

In our globalized world, public policy making and society at large face challenges like climate change, financial crisis, governance of pandemics, or energy sufficiency that are global, shared worldwide and tightly connected with policies across different sectors. An issue of major concern is that solutions for addressing such highly interconnected challenges in a 'system of systems' world, tend to address only subsystems and so fail to achieve systemic change and anticipate impact and unintended consequences of public action.

Global Systems Science (GSS) is about providing solutions to global problems of interconnected systems in order to support policy making and decision making (Jaeger et al., 2013). This involves looking at the whole of our planet and its societies as well as providing a transdisciplinary and transformative perspective that connects all kinds of scientific knowledge, and engaging as many people as possible in collective actions. Global Systems Science studies global systems like the financial system, the climate system, the global city system, and more, develops evidence, concepts and doubts concerning such systems, helps practitioners dealing with them to reflect on their experiences and to assess possible consequences of their actions, and combines advanced computing technologies with conversations bridging the gap between science and society. A pragmatic example of a global system is the internet. It "is unique among all computer systems in that it is built, operated, and used by a multitude of diverse economic interests, in varying relationships of collaboration and competition with each other." (Papadimitriou, 2001). Other examples are global financial markets, the worldwide fabric of agents trying to address climate change, the global city system, the worldwide energy industry, and many more.

A fundamental problem arising in all these systems is how they can self-stabilize in the face of shocks despite distributed control. The problem does not arise simply because we have not yet established centralized control over global systems, but because distributed control is what makes global systems so effective – and actually human.

GSS approaches are currently possible mainly due to tremendous developments in Information and Communication Technologies (ICT) which have impacted all areas of our societies and have been considered the basic line to achieve innovation. Direct evidences can be found in the computational capabilities that are nowadays available as well as the pervasive influence of connectivity on everyday life (e.g., internet, smart phone, table, etc.).

In order to support robust decision-making and take the actions necessary in the face of global challenges, GSS requires advances that will provide scientific understanding of systems based on empirical data on highly interlinked policy issues, and develop tools capable to ensure trust and dialogue between stakeholders and scientific modellers. More specifically, GSS research employs several elements as explained in the following.

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GSS leverages high performance computing as a key enabling technology to achieve reasonable and reliable results for detailed simulation of the system under consideration or a detailed analysis of data provided to understand such a system. Moreover, essential uncertainty analyses often require very large sets of simulation runs. Fortunately, this area is witnessing sustained exponential growth.

GSS builds upon the use of big data. The increasing availability of such information assets has led to great hopes as great benefits are expected as big data becomes part of the solution to pressing global problems like addressing climate change, eradicating disease and fostering good governance and economic development. An important challenge for GSS when it comes to big data is to sift through and analyse the "raw" data to extract and visualise meaningful aggregate results. This requires new research in algorithms, probability, statistics and optimization. Massive and complex multidimensional data also requires new approaches to visualisation and data representation. One particularly useful technique which is a promising marriage of agent-based modelling and big data is synthetic populations. A synthetic population is generated for a particular purpose of study to statistically represent a real population (of a city, a region or a country). It has been very successful in addressing socially coupled systems in transport, public health and city planning. Advantages include anonymity, privacy and a direct connection to geo-spatial maps that helps in communicating results to policy-makers.

GSS provides methods for understanding the impact of faults. Decision-makers dealing with global systems have an exceptional responsibility as if such systems fail the consequences are enormous. Whenever policies are backed by simulations, they rely on the results of a computation. Yet the fact of the matter is that those computations inevitably contain faults. At present, most faults do not manifest themselves in a way that engenders practical problems. Which faults are benign, however, and which ones may seriously impact the result of a simulation, is largely unclear and can usually be said with certainty only in hindsight. Specifically, metrics need to be defined to describe the magnitude of a fault, qualitative descriptions are necessary to capture its semantics, root causes need to be identified, and the dependencies between a fault and the healthy part of the system as well as among faults need to be researched.

GSS provides methods to assess global risks. Globalization comes with risks that we don't really know how to handle and assess. The state of the art in global risk assessment is very much given by the annual assessments produced by the World Economic Forum (Howell, 2013). For the 2013 report, a team of researchers familiar with discussions about global risks defined a list of 50 global risks and asked several thousand people with a reputation as risk experts to grade those risks. Five grades were offered, once for the likelihood of each risk, and once for the impact in case the risk should materialize. A separate survey produced similar grading for the resilience of different countries in the face of different risks. The result can help decision-makers to prioritize the use of resources, including awareness, in view of different risks. Such approaches are coarse as if a risk materializes, it will affect

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different people very differently and the idea of a single actor – say some international institution – successfully managing global risk all by itself, is a dangerous illusion. What is called for is the patient development of governance structures enabling a plurality of actors to address the risks they are faced with (Renn, 2008). When assessing global risks, therefore, it is important to clarify how the same possibility looks from the perspective of different actors. It is perhaps not a surprising, but in fact a very important hypothesis to expect actual risk governance to result in avoiding primarily those risks that are considered serious by influential – powerful, rich, knowledgeable, etc. – actors.

GSS helps to structure the exploration and communication of complex and uncertain issues. Most important decisions are made in conditions of ontological uncertainty – that is, in situations where the future development of entities and their future relations are profoundly unknowable ahead of time. Acting, taking decisions in these circumstances, requires conviction. There is growing evidence that economic and other important decisions that require pictures of the future to be created are subject to the forces (in urgent need of good understanding) that produce narrative conviction and narrative truth (Balaguer, 2009). Aggregate behaviour is subject to the convergence and sudden coordination of shared narratives about the future. Whereas the state of the world changes rather slowly the state of narratives about it can alter very sharply and is strongly subject to social interaction and influence. Recent events in financial markets have demonstrated this proposition forcibly. Today, due to the large quantities of "big data" produced by the digital revolution, we can come to a better understanding of these dynamics. The new data sources (especially sources of text data) can be rigorously investigated using language technology and algorithms, in order to capture historical shifts in narrative sentiment which appear to warn about possible future patterns. Narratives are not just means of creating personal conviction, they can also help structure the exploration and communication of complex and uncertain issues, such as the scope and limits of modelling, or the unintended consequences of political actions. Narratives can help us follow a process from its beginning to the possible outcomes without losing "the big picture". Supplemented with a wide range of ICT tools, ranging from mundane pie charts to advanced virtual reality representations, narratives can convey a basic, intuitive understanding that informs stakeholder dialogues.

GSS holds the promise of making useful contributions in the coming years to a variety of global challenges. In SYMPHONY we focus on two major challenges: financial stability and sustainability transition. In the following sections we explain these challenges in details and provide the requirements we identified for mitigating and solving related problems.

3.2 The Challenge of Financial Stability

3.2.1 Description of the Challenge

In the last thirty years, most of the advanced economies and of the developing countries have undertaken a profound transformation of their financial sector; major changes can be identified in the deregulation of financial markets, the liberalization of capital transfers, and

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in the privatization of the banking system. An important consequence of this process has been the so-called financialization of the economy, namely, the increasing relevance that the financial sector has assumed with respect to the real one.

The process of deregulation and privatization has not been limited only to the financial sections of the economy, but has also interested all the other sectors. It is in the case of the financial sector, however, where most important and far-reaching changes have occurred. This is because of the importance of finance in modern services-oriented economies and the digital communication revolution, benefitted from activities characterized by immaterial assets and centralized exchange.

This profound economic, political and cultural transformation can be probably traced back to 1971, when the post-World War II Bretton Woods system of fixed international exchange rates and dollar peg to gold was repealed by the Nixon Administration in the US. The process then acquired momentum in the early 80s, with the financial market deregulation promoted in US by the Reagan administration and in UK by the Thatcher government, and accelerated in Europe the late 80s and early 90s with the fall and the breakup of the Communist bloc and the birth of the European single market. On a smaller scale, Iceland can be regarded as a case study of the deregulation, privatization, and financialization process, which began there under the Oddson premiership in 1991, and that was characterized first by the privatization of the state-owned manufacturing system, mostly fish processing plants, accompanied by tax reduction and other business oriented reforms, and later by the privatization of the banking system in the early 00s, which, within a deregulated environment, was allowed to grow and expand internationally, reaching a dimension close to ten times the Icelandic GDP in terms of balance sheet. Outside the Western hemisphere, it is worth citing the program of economic reforms promoted in China since 1978 under the Deng Xiaoping leadership, that led China towards a market-like economy, and package of market-oriented reforms undertaken in India since 1991, which included deregulation, privatization, and tax reforms measures. Finally, since the late 80s, economic policy worldwide has been devoted to the implementation of the liberalization, deregulation and privatization agenda. Under the theoretical justification of globalization, a set of policies advocated by the so-called Washington Consensus, promoting free trade, capital mobility, and financial market deregulation, were implemented with particular emphasis in developing countries in South America and Asia.

The financial market liberalization, the privatization of banking systems and of state-owned manufacturing and services companies, as well as of some forms of social security provisions, such as pensions, have determined the so-called financialization of the economy (Epstein, 2005, Palley, 2007). The increasing relevance of financial markets, actors and institutions in the operation and in the governance of the economy during the last thirty years can be observed in many ways. Financial trading activities have increased exponentially and have been characterized by the emergence of new actors like hedge funds and private equity firms. The privatization of public companies has augmented the supply of

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stock shares on one side, while the privatization of retirement financing has created new demand for financial assets on the other side.

The shareholder value has become the key reference interest in corporate governance, while capital market financing has become more relevant than bank-based financing. Financing in capital market has been made easier by financial innovation and securitization, which created new financial instruments such as collateralized debt obligations and mortgage backed securities, where households' and companies' loans have been transformed into tradable assets. Financial innovation has allowed an increase of the debt to GDP ratio of the private sector on one side, in particular for households and the financial sector, and has fuelled bubbles in the financial and real estate market on the other side. Both have been self-reinforcing during the boom period, given that inflated financial and real estate assets have been used as collateral for debt, thus fuelling again household's consumption and debt. The contribution to GDP of the finance, insurance and real estate (FIRE) sector has increased from nearly 15% to more than 20% in the last thirty years in US (Palley, 2007).

Real economic activity has been mainly characterized by a downward trend of gross investment spending as a share of GDP and by a decreasing economic growth characterized by falling rates in the last three decades with respect to the previous decade. The decrease in investment spending has been even worse considering the productive sector only, given the surge in residential investment (Palley, 2007). Workers have been subject to wage stagnation, and disconnection of wages from productivity growth; while rent earners have benefitted by an increasing profits' share of national income; income and wealth inequalities have increased (Mishel et al. 2007).

The rising of household debt-income ratios and corporate debt-equity ratios has made the economy increasingly financially fragile and potentially unstable. In fact, this debt growth dynamics is unsustainable in the long run and the economy may become vulnerable to debt-deflation and prolonged recessions (Minsky, 1986). Internationally, financial fragility has become already evident in the 1990s with the Mexico (1994), the Asian (1997/1998) and the Russian (1998) crisis, which demonstrated the degree to which a too rapid market liberalization can lead to a currency crisis, in which a sudden reversal of capital flows is followed by financial instability and a consequent sharp decline in economic activity. Another example was the Internet bubble burst of the early 2000s, when financial markets experienced a significant decline in asset prices. Finally, what started in the summer 2007 as a burst of a speculative bubble in the US real estate market developed, in the course of just a few months, into the most severe financial crisis since the Great Depression of the 1930s. The default of many subprime mortgages in US soon spread to the rest of the world by means of the transmission channel of securitization, triggering world-wide bank runs and several bankruptcies of major institutions. The supply of credit to private business soon came to a halt and the financial crisis spread to the real economy causing unprecedented GDP drops worldwide and a surge of unemployment.

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The Great Recession of 2007-2009 is a historical and economic event of major relevance which is causing a critical discussion about the cultural and theoretical underpinnings of the deregulation and liberalization process both in the political and in the academic domain. The reappraisal of the deregulation and privatization process may eventually lead to a partial reversal of the process itself.

The financial meltdown has already triggered a number of proposals worldwide for a regulatory reform of the financial sector. In particular, it is worth noting the proposals put forward by the Obama Administration[1], the European Commission[2], the UK Financial Service Authority[3] and by the UN Commission of Experts on Reforms of the International Monetary and Financial System[4]. Although there is a general agreement to improve the regulatory framework of financial markets, serious differences remain on whether regulation should be of a light touch market oriented approach or whether more public authority is needed in the wake of the international financial crisis (Helleiner and Pagliari 2009, Semmler and Young, 2010).

One of the critical aspects is the conflict between the operations of financial markets, which are essentially global, and the regulation and supervision which is largely responsibility of single Nations (Smaghi 2009). This conflict is even more problematic in the European Union, where cross-border banking integration has increased since the creation of the single market and the Euro but, due to the Lamfalussy architecture for financial regulation, the supervisory control remains firmly under national competence (Padoa-Schioppa 2004).

Within this fragmented architecture, the EU member states have more incentive to compete on regulatory and oversight tasks than to cooperate concerning the supervision of large and complex institutions (Smaghi 2009). This aspect, besides the inadequate and uncoordinated European response to the crisis, has further exacerbated its consequences. As a relevant example of the incomplete EEA/EU financial supervisory framework, it is worth citing the so-called Icesave case, related to the bankruptcy in October 2008 of the Icelandic bank Landsbanki. The bank operated, under the brand Icesave, online saving accounts in the UK and the Netherlands, but was subject to the supervision of the Icelandic Financial Service Authority. The case is still the object of a diplomatic dispute between Iceland on one side and Netherlands and UK on the other side, regarding the refunding of British and Dutch depositors.

3.2.1.1 Understanding the causes

For the most of post-war period financial factors have in general progressively disappeared from macroeconomy. The financial cycle has been accounted only by economists outside the

[1] US Department of the Treasury 2009: http://www.financialstability.gov/docs/regs/FinalReport_web.pdf
[2] The de Larosière report 2009: http://ec.europa.eu/internal_market/finances/docs/de_larosiere_report_en.pdf
[3] The Turner review 2009: http://www.fsa.gov.uk/pubs/other/turner_review.pdf
[4] United Nations 2009: http://www.un.org/ga/president/63/commission/financial_commission.shtml

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mainstream (Minsky 1982; Kindleberger and Aliber 2000). They mainly pointed out how supply of credit shows pro-cyclical changes, increasing when the economy is booming and decreasing during economic slowdowns. This led to fragility in financial system, thus increasing the arising of financial crisis (Minsky 1982). But for long time, finance has been considered a factor that, as a first approximation, could be ignored when seeking to understand business fluctuations.

After the financial crisis, economists are trying to incorporate financial factors into standard macroeconomic models, in order to investigate the links between macroeconomics and finance, i.e. between business cycles and financial cycles. The capability of bank lending to alter the level of aggregate demand means that banks, debt and money must be included in any adequate model of macroeconomics. For instance, Minsky monetary model, developed by Keen, shows how change in debt plays an integral role in macroeconomics by dynamically varying the level of aggregate demand (Keen 2014).

It is worth noting that there is no consensus on the definition of the financial cycle (Borio 2012a). The term will denote self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints. These interactions can amplify economic fluctuations and possibly lead to serious financial distress and economic dislocation (Borio et al. 2001, Danielsson et al. 2004, Kashyap and Stein 2004, Brunnermeier et al. 2009, Adrian and Song Shin 2010).

For this reason financial instability can be empirically approximated, using:

- variable, like credit and property prices (Drehmann et al. 2012). Analytically, this is the smallest set of variables needed to replicate adequately the mutually reinforcing interaction between financing constraints (credit) and perceptions of value and risks (property prices).

- periods of economic growth, that are usually associated with significant increases in the ratio of credit to GDP and recessions with declines in this ratio. Furthermore episodes of strong credit growth tend to go together with large increases in equity and property prices, and these prices tend to decline as credit contracts in the downswing (Borio 2001).

- the relation with business cycle that shows that financial cycle is longer and has a much lower frequency than the traditional business cycle. This is especially true after financial liberalisation. Furthermore recessions are much shorter than contraction phases in the financial cycle (Drehmann et al. 2012).

- the relation between financial cycle and financial crises shows that peaks in the financial cycle are closely associated with systemic banking crises. The most promising indicators of financial crises are based on simultaneous positive deviations (or “gaps”) of the ratio of (private sector) credit-to- GDP and asset prices,

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especially property prices, from historical norms (Borio and Drehmann 2009, Alessi and Detken 2009).

- the length and amplitude of the financial cycle that depend on the policy regimes, in particular on the financial, monetary and real-economy regime (Borio and Lowe 2002).

In order to address the financial instability, it is worth noting the importance of the stylized facts.

On the macroeconomic point of view, we observe a self-sustained growth with endogenous business cycles. Moreover the distribution of economic crisis is exponential (Ausloos et al. 2004). Investment are more volatile than GDP, while consumption are less volatile. We also observe co-movement with output that can be procyclical, for instance consumption, net investment, productivity, employment, inflation, wage, or countercyclical, like prices and markup and unemployment.

The correlation of business cycle and financial factor, i.e. credit and money, show that real private sector loans lead the real GDP, and the monetary aggregate M1 lags the GDP, with a significant correlation value. The lagging pattern of loans to non-financial corporations over the business cycle may have several explanations. In recoveries periods, firms usually finance investment expenditures using their internal funds and only later turn to external financing. Furthermore larger firms may prefer to finance themselves by issuing corporate bonds when capital market conditions are favourable, preferring bank borrowing, to limit their exposure to the banking sector. The cross correlation analysis shows how financial and business cycle tend to have a relation over the cycle. (ECB *monthly bulletin*, October 2013).

On the microeconomic domain (Bottazzi et al. 2007; Dosi and Marengo 2007), large dispersion of productivity among firms and persistence in productivity differential among firms can be observed. The firm size distribution are right-skewed. Profit rate distribution of large companies follow a Laplace distribution (Erlingsson et al. 2013a; Alfarano et al. 2012) and firm growth rate has a fat-tailed distribution and interest rates are lumpy (Gourio and Kashyap 2007).

The main bank-related stylized facts (Bikker and Metzemakers 2005) are the procyclicality of firm debt, credit supply, bank profits and bank equity, the boom-bust credit cycles (Mendoza and Terrones 2012), the fat-tail distribution of fiscal costs of banking crises (Laeven and Valencia 2008) and the fat-tailed distribution of duration of banking crises (Reinhart and Rogoff 2009).

On the asset bubble in real estate market, there are some perspectives that attempt to explain the source of house price fluctuations. Capozza et al. (2002) argue that house prices react differently to economic shocks depending on factors such as growth rates, area size, and construction costs. According to Hott (2009), house price fluctuations are more likely to

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be influenced by behavioural aspects like herding behaviour, speculation and momentum trading. In line with the statement, Shiller (2007) argues that a significant factor in house price boom was a widespread perception that houses are a great investment, and the boom psychology that helped spread such thinking. Those factors cause the average house price to increase and produce some bubble in the housing market.

Moreover it is important to look to the financial aspects of the market, such as housing prices, mortgage payments, household debt, the fragility of the banking sector, and the effect of the housing market dynamics on the real economy (Geanakoplos et al. 2012; Teglio et al. 2013; Erlingsson et al. 2013b) .

3.2.2 User Requirements

In order to reproduce the stylized facts cited above, there are some essential features to be considered. First of all the financial boom should not just precede the bust but cause it (Raberto et al. 2012). The presence of debt and capital stock overhangs (disequilibrium excess stocks) must be considered (Eggertsson and Krugman 2012). Eventually we have to distinguish between potential output as non-inflationary output and as sustainable output (Borio 2012b).

In order to model the previous features, the following steps must be considered. To move away from model-consistent (rational) expectations, to allow for state-varying risk tolerance, i.e. attitudes towards risk that vary with the state of the economy, wealth and balance sheets (Borio 2012b) and to capture more deeply the monetary nature of our economies.

In particular the following elements of the actual monetary and economic systems need to be explained (Wolf 2013).

- Monetary and financial system is a complex public-private partnership. On the bank side it is relevant to figure out that deposits are not endowments that precede loan formation; it is loans that create deposits. The banking system does not simply transfer real resources, more or less efficiently, from one sector to another; it generates (nominal) purchasing power. The new purchasing power will add to actual spending in the economy, creating booms in consumption or investment. By creating new purchasing power ex nihilo banks also creates debt. The new credit introduced in the economy may also leverage up existing assets.

- Money must be considered not a friction but a necessary ingredient that improves over barter. Models should deal with true monetary economies, not with real economies treated as monetary ones.

- Private institutions create credit as a by-product of their lending. The state uses its ability to create fiat money to back such private money.

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- The central bank may fail to stabilize this system by stabilizing the prices of current goods and services. Indeed, the policies chosen to stabilise inflation in goods and services may even destabilise prices of assets.

While the generation of purchasing power acts as oil for the economic machine, it can, in the process, open the door to instability, when combined with some of the previous elements.

Working with better representations of monetary economies should help cast further light on the aggregate and sectorial distortions that arise in the real economy when credit creation becomes unanchored, poorly pinned down by loose perceptions of value and risks (Theory of endogenous credit money). Only then will it be possible to fully understand the role that monetary policy plays in the macroeconomy (Baxa et al. 2013). And in all probability, this will require us to move away from the heavy focus on equilibrium concepts and methods to analyse business fluctuations and to rediscover the merits of disequilibrium analysis, such as that stressed by Borio and Disyatat (2011); Teglio et al. (2012).

In order to reproduce the stylized facts and understand the economic and monetary systems, some policies must be investigated. In a macroeconomic perspective, the most relevant are: monetary policy, macroprudential policy, fiscal policy and sustainability policy.

3.2.2.1 Monetary policy

3.2.2.1.1 Standard monetary policy in normal time

It is necessary to adopt strategies that allow central banks to tighten so as to lean against the build-up of financial imbalances even if near-term inflation remains subdued (e.g., Caruana (2011); Borio (2011a); Eichengreen et al. (2011)) what might be called the lean option. Operationally, this calls for extending policy horizons beyond the roughly 2-year ones typical of inflation targeting regimes and for giving greater prominence to the balance of risks in the outlook (Borio and Lowe 2002; Bean 2003), fully taking into account the slow build-up of vulnerabilities associated with the financial cycle. As the timing of the unwinding of financial imbalances is highly uncertain, extending the horizon should not be interpreted as extending point forecasts mechanically.

Rather, it is a device to help assess the balance of risks facing the economy and the costs of policy action and inaction in a more meaningful and structured way. Increasingly, central banks have been shifting in this direction, albeit quite cautiously (Borio 2011a).

Furthermore it is important to develop a supplementary role for indicators of financial market conditions, including, the role of credit. There is also the practical problem that there are not good index of asset prices, and it would be extremely difficult to create a satisfactory one.

Eventually under nominal GDP targeting, monetary policy would adjust to offset disturbances to aggregate demand. Nominal GDP targeting helps the balance of stable growth and inflation in responding to aggregate supply disturbances.

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3.2.2.1.2 Unconventional monetary policy during crisis

Quantitative easing is an extraordinary monetary policy measure that has been largely used by the Federal Reserve and the Bank of England during the recent crisis, and has also been recently adopted by the European Central Bank. In concrete terms, it is the fiat money created by the central bank (Cincotti and Teglio 2010).

In order to balance the quantitative easing policy, it can be useful to reduce the pace of long-term Treasuries and Mortgage-backed securities purchases.

It's not ending the purchases, it's just slowing down the pace of new purchases. In order to explore this possibility, four areas of macroeconomic performance might be considered: the labour market performance, the growth, the large balance sheet of the banks and the inflation.

3.2.2.2 Macroprudential policy

The analysis of the Bank for International Settlements (see BIS, 2011) states that one of the main reasons why the economic crisis became so severe was that the banking sectors of many countries had built up excessive balance sheet leverage. The erosion of the level and quality of the capital base determined that the banking system was not able to absorb systemic trading and credit losses nor could it cope with the large off-balance sheet exposures. The crisis was further amplified by the pro-cyclical deleveraging process; the weaknesses in the banking sector were rapidly transmitted to the rest of the financial system and the real economy, resulting in a massive contraction of liquidity and credit availability.

For these reasons, the institutional response after the crisis strengthened the systemic orientation of regulatory and supervisory frameworks, and began to question the premise that financial stability can be secured without a more active support of macroeconomic policies (Borio, 2011b). The reforms introduced in Basel III provide a macro-prudential approach to regulation and supervision that has a system-wide focus, with the goal to limit the risk of episodes of financial distress with serious consequences for the real economy (systemic risk).

The methodologies used to study this problem are mainly restricted to macro-econometric models (Andersen, 2011; Antão and Lacerda, 2011) or general equilibrium models (Heid, 2007; Acharya, 2009).

The main adjustment is to strengthen the macroprudential, or systemic, orientation of the arrangements in place (e.g., Borio (2011a); Caruana (2010)). A key element is to address the procyclicality of the financial system. The idea is to build up buffers in good times, as financial vulnerabilities grow, so as to be able to draw them down in bad times, as financial stress materialises (Cincotti et al. 2012). There are many ways of doing so, through the appropriate design of tools such as capital and liquidity standards, provisioning, collateral and margining practices, and so on.

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3.2.2.3 Fiscal policy

3.2.2.3.1 During the boom

There is a need for extra prudence during economic expansions associated with financial booms. The reason is simple: financial booms do not just flatter the balance sheets and income statements of financial institutions and those to whom they lend (Borio and Drehmann 2010), they also flatter the fiscal accounts (Eschenbach and Schuknecht 2004; Borio 2011b; Benetrix and Lane 2011). Potential output and growth tend to be overestimated. Financial booms are especially generous for the public coffers, because of the structure of revenues (Suarez 2010; Price and Dang 2011). And the sovereign inadvertently accumulates contingent liabilities, which crystallise as the boom turns to bust and balance sheet problems emerge, especially in the financial sector.

3.2.2.3.2 During the bust

The commonly accepted policy hypothesis is that austerity might have expansionary effects, because the expectations that today's sacrifices will translate into tax reductions and higher disposable income in the future might induce economic agents to increase consumption and investment in the short term. Another common defence of austerity programs is the risk that bond markets, whenever a government is not sufficiently committed to budget balance, may demand huge spreads for sovereign debt and possibly push a nation into default.

Historical evidence shows that expansionary effects of austerity measures are rarely observed (Guajardo et al. 2011); in particular, they occurred only when austerity measures were implemented in an international setting where trade partners were flourishing. Following the asset bubble burst, most of European economies (as well as UK and US) are now in an economic scenario where the over-indebted private sector is trying to deleverage its balance sheets and financial institutions are unwilling to lend, because they need too to strengthen their balance sheets and face a shortage of willing and creditworthy borrowers. This deleveraging of the private sector reduces aggregate demand, due to both lower consumption and investments, and throws the economy into a very special type of recession which has been named as balance-sheet recession (Koo 2009, 2011).

Moreover, recent studies (see e.g. DeLong et al. (2012)) have provided convincing theoretical and empirical evidence about the efficacy of temporary expansionary fiscal policy in severely depressed economies. First, the absence of supply constraints and low interest rates makes the fiscal multiplier substantially greater than in normal times. Second, preventing prolonged output shortfalls though a deficit-financed fiscal stimulus may ease rather than jeopardize the long-run government budget constraint because of hysteresis effects of present output drops on the economy's future potential, through the decrease of investments and the increase of structural unemployment. In a balance-sheet recession as well as in a severe depression scenario, like the one faced now by most Western economies, fiscal stimulus could actually turn out to be expansionary and self-financing while fiscal austerity may turn out to be depressive and self-defeating.

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3.3 The Challenge of Sustainability Transition

3.3.1 Description of the Challenge

3.3.1.1 Why Do We Need a Sustainability Transition?

In order to reach the emission reduction level necessary for staying below the politically agreed limit of 2°C temperature increase, great efforts at international level are needed. International climate negotiations show that it is becoming more difficult to reach agreements because industrialized countries are reluctant to increase their commitment due to the fact that they fear negative impacts on economic growth. Additionally, developing countries want to catch up in terms of economic development and standards of living and see strong emission targets as a threat to their development. Only if industrialized nations can demonstrate that a different growth model based on a minimal amount of emissions, waste and use of resources is possible, will developing and emerging economies be willing and able to leapfrog the industrial growth model.

Instead, industrialized nations have been struggling with the financial crisis and the economic difficulties it triggered. Finding a way out of economic recession has become a top priority. However, it is questionable that there will be an economic recovery under business as usual, if the financial crisis is tackled in isolation.

Larry Summers, in a recent speech at the IMF, has brought this into our minds when talking about the threat of secular stagnation. He argued that the Fed (and other central banks) have cut short-term interest rates to such an extent, that the natural interest rate is actually negative, often called the zero lower bound. Still there is no full employment, investment rates are low, and the scope of the Fed's action is rather limited in the near future. Summers said that we need to *"think about how we manage an economy in which the zero nominal interest rate is a chronic and systemic inhibitor of economic activities, holding our economies back below their potential"* (http://www.youtube.com/watch?v=KYpVzBbQIX0). We should not treat the economic crisis and the problem of climate change in isolation but find opportunities for synergies and win-win situations.

More and more voices are saying that we need a new growth model:

Joseph Stiglitz argued in his article "Climate change and poverty have not gone away" that "retrofitting the global economy for climate change would help to restore aggregate demand and growth" (http://www.theguardian.com/business/2013/jan/07/climate-change-poverty-inequality). He also argues that we need structural changes, which markets often do not handle well.

> *"The path marked out by the deficit hawks and austerity advocates both weakens the economy today and undermines future prospects. The irony is that, with insufficient aggregate demand the major source of global weakness today, there is an alternative: invest in our future, in ways that*

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help us to address simultaneously the problems of global warming, global inequality and poverty, and the necessity of structural change."

Michael Jacobs from LSE claimed in his blog post "Far from being a drag on growth, environmental policy can actually help drive it" in December 2012 (http://blogs.lse.ac.uk/europpblog/2012/12/05/environmental-policy-growth/) that:

"Environmental policies, as well as tackling environmental costs, can address other market failures which inhibit growth, help boost aggregate demand, stimulate employment, and drive innovation."

Martin Wolf wrote in a recent article in the Financial Times that "green growth is a worthwhile goal" (http://www.ft.com/intl/cms/s/0/cd519de0-55e1-11e3-96f5-00144feabdc0. html?siteedition=intl#axzz2lrUmTOBu) by saying that:

"it might be possible for a country to demonstrate proof of concept: that it is indeed possible for economies to grow fast while reducing emissions. In the process, such a country might even, as some argue, gain an important lead in some relevant new industries"

Until now, most arguments of these types have not been addressed sufficiently by quantitative research. It is for this project to show and evaluate quantitatively if and how such a transition towards a sustainable economy can be achieved.

Changing the Underlying Economic Framework:

The costs of climate mitigation are currently computed with integrated assessment models, combining general equilibrium models with climate models.

It follows the prevailing economic story, saying that economic actors/agents, who optimize their individual state and neglect external effects, will find one optimal state/equilibrium. In this framework climate policies are introduced as an additional constraint, as compared to the "unconstrained" case without climate policy. The difference between the two cases is the cost of climate mitigation which leads to lower welfare. The only possibility of not reducing welfare is if the models assume very large damages in the future (in combination with lower discount rates).

However, the problem can be framed differently and the possibility for multiple equilibriums can be introduced. Individuals only see one optimal state for themselves but the economy as a whole can switch to a different state. This would open up the possibility of climate policy being beneficial for an economy. Agents are then faced with a coordination problem and the question of equilibrium selection becomes a question of coordination, not of allocating resources efficiently.

Mario Draghi, in a press conference in September 2012, stated that:

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"the assessment of the Governing Council is that we are in a situation now where you have large parts of the euro area in what we call a "bad equilibrium", namely an equilibrium where you may have self-fulfilling expectations that feed upon themselves and generate very adverse scenarios."

(http://www.ecb.europa.eu/press/pressconf/2012/html/is120906.en.html)

The question arising from this for this project is: **Which climate and economic policies can mobilize untapped resources and trigger a shift to a different path?** We think that the coordination of expectations of different economic actors is crucial in this respect. Coordination of expectations can trigger a sustainability transition and help switch the state of the economy to a different path (green growth/new growth path).

Current discussion and gridlock regarding climate and energy policy:

The current discussion around climate policy is centred around finding international agreements on emission reductions. For Europe this means setting a target at EU level which is in line with international agreements. However, even in the absence of an international agreement, the EU targets will not lose their relevance and will be an important guidepost for investors, producers and consumers alike. Hence, the policy case chosen for the sustainability transition use case are the EU emission reduction targets.

It is important to note that this discussion is very much focused on the overall economic costs (mainly in terms of GDP) of such a policy and how these costs can be shared among the member states. The economic opportunities are often left aside/understudied. Therefore, this project can make an important contribution to this discussion by analysing the potential benefits, especially with respect to the prevailing economic stagnation within the EU. Results will be relevant for EU climate and energy policy as well as economic policy.

The most important political discussions at EU level are the 2030 targets (and 2050 targets in the future). Other policy discussions (and related EU Directives) are mostly related to the targets and tackle specific sectors or actors in the economy. The 2030 target discussion is part of a series of documents and decisions at the EU level.

The most important targets currently in effect are the 2020 targets. These targets were set in 2007 and enacted in 2009 through the "climate and energy package''. Today they are widely known as the "20-20-20'' targets, which stands for: 20% reduction in EU GHG emissions, a 20% share of renewable energy in gross final energy consumption and 20% reduction in total primary energy consumption of the EU (all 2020 levels compared to 1990).

Following this, in 2011, the European Commission defined the long term GHG emission reduction target for 2050, which would be in line with the EU's contribution to the global political goal of staying below a 2 °C temperature increase. The target is 80%-95% below 1990 levels. For this purpose, the European Commission published the "Energy Roadmap 2050'' (European Commission 2011a) and the "Roadmap Towards a Competitive Low-carbon

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Economy Until 2050'', often called Climate Roadmap 2050 (European Commission 2011b).

In 2012, the European Commission analysed the effects of raising the 2020 targets. The argument was that the emission reductions resulting from economic downturn due to the financial crisis and the euro crisis would make it possible to raise the 2020 targets. A Commission staff working paper "Options to move beyond 20% emission reductions'' (European Commission Staff 2012) was published. However, no agreement to raise the target was achieved.

Instead, in 2013 the European Commission has started a discussion process around the intermediate goals for 2030 by publishing a proposal called the "Green paper: A 2030 framework for climate and energy policy 2030'' (European Commission 2013). This was followed by a public consultation process. On January 22nd, the Commission published their White Paper, stating the reduction targets for 2030: 40% GHG emission reductions, 27% share of renewable energy, no energy efficiency target. The announcement was accompanied by an Impact Assessment Report (European Commission Staff 2014), which analyses the outcome of different scenarios for 2030 and 2050.

The impacts on GDP and employment are usually compared to the baseline scenario. Results depend on whether a carbon price is implemented in all sectors and how the revenues are reused in the economy, and they depend on if all sectors are included in the auctioning system and carbon taxes are applied for non-ETS emissions. Furthermore, scenarios with additional energy efficiency (EE) and renewable energy (RE) measures (assuming all sectors are included in the auctioning system, carbon taxes applied for non-ETS emissions and using revenues to lower labour taxation) show the best economic results.

The EU Emissions Trading Scheme (ETS) as the main policy instrument:

To reach its 2030 carbon reduction targets the EU will most likely rely on its emissions trading scheme. This system has been called the “flagship” (Egenhofer et al., 2006) or “cornerstone” (Convery, 2009) of EU climate policy. In the EU Climate and Energy Package of 2008, as well as in the three climate policy related Roadmaps (dealing with the low-carbon economy, transport, and energy), the ETS is expected to become the EU’s most important climate policy instrument (Egenhofer et al., 2012).

This instrument covers about 40% of all European GHG emissions by including the power generation sector, district heating, and many energy intensive industries (Matthes, 2013). All in all, it stipulates limits for more than 12,000 installations and imposes a cap that will be 21 percent lower in 2020 than in 2005, when the scheme was implemented. Thus, a well-functioning ETS is “the precondition for the EU to achieve its short- and long-term climate and other policy goals” (Egenhofer et al., 2012), also when the 2030 targets are addressed. In late 2011 carbon prices started to fall (Grubb, 2012). In April 2014 it has been lower than €6. In 2012, the surplus of allowances in the market, i.e. those allowances that are not used for actual emissions, doubled from 950 million to almost 2 billion (EC, 2013) and by 2020 the

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European Commission (EC) expects it to represent 2.4 billion allowances (EC, 2012). This is the reason scholars see the ETS in deep crisis (e.g. Matthes, 2013).

3.3.1.2 How did Low Carbon Prices come about?

Morris (2013) emphasizes that the 20% target for 2020 was "too easy to meet" right from the start (p.22). Matthes (2013) states the importance of the economic crisis leading to levels of economic activity about 15 to 20% lower than those that had been taken as a basis for the ETS's parameterization (p. 5). Egenhofer et al. (2012) also stress the "accompanying decline in demand for EU allowances" as principal reason for the large surplus and the low price (p. i). However, before the recession and also in other ETSs there have been booms and busts unrelated to recessions (Grubb/Ferrario, 2006).

Almost all scholars agree that an important reason for the carbon price being so low is the rampant use of offsets (e.g. Egenhofer et al., 2012). The prices especially for CDM credits have partly been very low because many projects did not result in real emissions abatements (Matthes, 2013). Another reason is that international carbon markets have clearly become buyer markets where suppliers accept almost every price higher than zero because most of them face considerable sunk costs (ibid.). Morris (2013) sees offsets as "the chief driver of (…) surpluses" (p.26). This is backed by Matthes (2013) who estimates that a surplus of approximately 500 million certificates arose from the recession, but about 1.5 billion from offsets (pp. 5f).

Furthermore, it has been stated that the EU's successful policies promoting renewable energy sources (RES) and Energy Efficiency (EE) have lowered the carbon price (Egenhofer et al., 2012). However, Hermann/Matthes (2012) assign RES support a minor role as the current use of RES in the EU "match[es] quite well with the assumptions made for cap-setting in 2008" (p. 4). On the other hand, Grubb (2012) points out that high prices would only have been realizable if the EU did not achieve its objectives on EE or RES (p.17). All in all, the exact interdependencies of ETS, RES and EE policies, and therefore the impact of RES and EE policies on the carbon price, are very difficult to measure[5].

Additionally, the failure of politics to create counteractions to the low carbon prices has consistently caused collapses in carbon prices (Matthes, 2013).

[5] See for an older but sophisticated analysis of interactions Sorrell (2003).

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Figure 3: Fall of CO2 prices. Source: eeX CER prices 2010 - Jul 2012

One question arising from this observation is how these low prices came about:

- Morris (2013) emphasizes that the 20% target for 2020 was "too easy to meet" right from the start (p.22).
- Matthes (2013) states the importance of the economic crisis leading to levels of economic activity about 15 to 20% lower than those that had been taken as a basis for the ETS's parameterization (p. 5).
- Egenhofer et al. (2012) also stress the "accompanying decline in demand for EU allowances" as principal reason for the large surplus and the low price (p. i). However, before the recession and also in other ETSs there have been booms and busts unrelated to recessions (Grubb/Ferrario, 2006).
- Almost all scholars agree that an important reason for the carbon price being so low is the rampant use of offsets from international carbon market, which are allowed within the EU-ETS (e.g. Egenhofer et al., 2012). Morris (2013) sees offsets as "the chief driver of (…) surpluses" (p.26). This is backed by Matthes (2013) who estimates that a surplus of approximately 500 million certificates arose from the recession, but about 1.5 billion from offsets (pp. 5f).
- Furthermore, it has been stated that the EU's successful policies promoting renewable energy sources and energy efficiency have lowered the carbon price (Egenhofer et al., 2012). However, Hermann/Matthes (2012) assign RES support a minor role as the current use of RES in the EU "match[es] quite well with the assumptions made for cap-setting in 2008" (p. 4). On the other hand, Grubb (2012) points out that high prices would only have been realizable if the EU did not achieve its objectives on EE or RES (p.17). All in all, the exact interdependencies of ETS, RES and EE policies, and therefore the impact of RES and EE policies on the carbon price, are very difficult to measure[6].

[6] See for an older but sophisticated analysis of interactions Sorrell (2003).

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Additionally, the failure of politics to create counteractions to the low carbon prices have consistently caused collapses in carbon prices (Matthes, 2013).

Why are Low Carbon Prices Problematic?

The Directive 2003/87/EC states the original intention of the scheme, i.e. "to promote reductions of [GHG] in a cost-effective and economically efficient manner" (EU, 2003). EU institutions have implicitly broadened the purpose of their "flagship". The EC (2008) has intended the ETS to provide "the right incentives for forward looking low carbon investment decisions by reinforcing a (...) long-term carbon price signal" (p. 3) and the European Parliament (EP) and the Council (2009) once were aimed at "ensuring that the emissions trading system delivers gradual and predictable reductions of emissions over time" (p. 2).

Low carbon prices are regarded as problematic for several reasons:

- Low carbon prices lead to a low level of investment into clean technologies: it would "deter investment precisely at a time when the European economy needs substantial inward investment to help generate growth and jobs" (Grubb, 2012).
- High prices might serve economic progress: "the EU's energy system needs high levels of investment even in the absence of ambitious decarbonisation efforts" (EC, 2011). Earlier investment in low-carbon technologies also causes "long-term benefits for Europe's competitiveness, by maintaining a strong position in a rapidly growing global market for [these] technologies" (EC, 2010).
- Energy savings are only incentivized by short pay-back periods for companies (Martin et al., 2011), which can only be achieved with a higher CO_2 price. However, a price of €6 "undermines the EU ETS's value as a driver of either emission reductions or investment" (Grubb, 2012).
- The EC worries that this "lock in" might result in "higher carbon prices later on and significantly higher overall costs" (EC, 2011). If low carbon prices lead to continued investments in carbon-intensive capital stock, this will stipulate a carbon-intensive EU energy supply for decades to come and make emissions reductions critically more expensive in the long run (Egenhofer et al., 2012).
- Low prices might lead to a decrease in liquidity in the market if more and more intermediaries leave the market (Marcu, 2013).
- Low prices also reduce anticipated state revenues by about €100 billion until 2020 (Grubb 2012: 11), which could have been of crucial importance in the current debt crisis.

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- Investments evoked by higher prices might generate more revenues than possible carbon price-induced adverse impacts on the EU's economies might extract (Grubb 2012: 21).

Without higher carbon prices individual member states (MSs) or the EU as a whole may launch alternative instruments to achieve their national or EU climate targets (BMU 2013), which could be less cost-effective than the ETS. National measures could blur the EU-wide price signal and they are feared by energy-intensive industries.

3.3.1.3 Policy Case/ SYMPHONY contribution to the policy debate

Since the 2030 targets are a central policy discussion, this will be taken as the main policy case within this project. The policy question resulting from this is:

"Which emission reduction target should the EU apply for 2030?"

The three main components are 1) a GHG emission target, 2) a renewable energy target and 3) an energy efficiency target.

The central political target in the EU debate is the GHG emission target at EU level. Therefore, this will be the focus of the sustainability use case.

Important questions in this context are the following:

- Is it possible to reach 30% / 40% / 50% of GHG emissions reduction by 2030?
- How much time does it take to see an effect of the price of carbon?
- How does this affect the quantity and composition of energy imports (fossil), hence current account as well as energy dependence & security?
- What are the effects on economic growth?
- What are the effects on unemployment and business cycles?
- Which effects are prevailing, price effects (increase of unit cost) or quantity effects (effect on energy efficiency initiated by price effects)? How sensitive is the producer's /user's reaction to the price?
- If the government reduces other taxes as compensation for the price of carbon (such as the income tax), which influence on growth, unemployment and business cycles will this have?
- Distributional aspect: Which countries within the EU will have which share of the burden (costs) and the opportunities (benefits)? Which agents hold the assets (energy generation units etc.), hence is there a redistribution within a country?

We aspire to address all of the questions raised. However, it is not yet decided if all of them can be addressed within the model, as problems can arise during the specification of the model.

The above-mentioned 2030 target is a pure GHG emissions target. Additionally, targets 2 and 3 should be discussed as well: **a renewable energy target and an energy efficiency target** (measured in primary energy use per unit of GDP):

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- **Energy efficiency across sectors:** A large part of the emissions comes from transport, industry and houses (electricity and heat as well as air conditioning). Therefore, increasing energy efficiency across sectors is an important additional policy case. Addressing the housing sector more specifically to raise the rate renovation of buildings (insulation, heating system etc.) might be an additional policy case.

- **A renewable energy target:** Renewable energy targets can be defined and implemented through a minimum % of renewable energy supplied by each energy provider or via renewable energy production subsidies. The general discussions centre on feed-in-tariff systems (where the difference between market price and production cost is financed via a tax that the government passes on to the electricity consumer (surcharge)).

The question regarding these two political targets would be, how these change the outcome of the above mentioned parameters. Furthermore, it would be important to see if there are synergy effects between these targets, e.g. can these two targets help reduce GHG emissions at lower costs.

3.3.2 User Requirements

The user requirements described here focus on the policy issues which shall be addressed within this project, focusing on Europe and issues around GHG emissions, renewable energy sources as well as energy efficiency. Of course, there are many other environmental concerns (water pollution, air pollution, etc.) which are very important and many other regions outside of Europe that are affected by sustainability transitions. However, we need to put a focus here. The following assessments are based on many conversations Germanwatch and GCF conduct regularly with stakeholders dealing with sustainability. The following assessments reflect our impressions from these regular talks.

Both N**ational and EU level policy makers** are concerned with the 2020/2030/2050 targets. At EU level, the main concern is to reach the midterm and long-term climate goals and at the same time emerge out of economic recession and stagnation especially in the Southern European countries. The topics of climate change on the one hand and competitiveness and growth on the other hand are of major concern at EU level.

Energy dependence and energy security play an increasing role as well. For example, in the debate about sanctions against Russia regarding the crisis in Ukraine, EU's energy dependence on Russia plays a big role.

National policy makers are concerned with the economic costs and benefits for their country.

Frequent meetings with the German Environmental Ministry give insight into the view of the policy makers (in climate and energy policy). One big concern regarding the 2030 targets is

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"burden sharing", which means: How can the cost of a more stringent climate policy be shared equally among member states? This is important for negotiations with countries where costs of adjustment/transformation will be relatively high.

Industrial companies like Siemens, Deutsche Telekom or Deutsche Bahn but also energy utilities like RWE or EnBW are very interested in questions concerning carbon prices, renewable energy targets, tax incentives for renovations of buildings and subsidies for different types of power-plants. The car manufacturers are mainly interested in issues regarding the transformation of the transport sector.

Banks (like Deutsche Bank or UniCredit Group) and **insurances** (like Allianz or Munich RE) talk about carbon prices even more frequently. They furthermore address the use of project/infrastructure bonds as well as contracting models. They are also interested in security of investments and therefore in subsidies or guarantees, concerning, investments in for example, renewable energies, renovations of buildings or infrastructure.

Civil society actors like labour unions (e.g. IG BAU) or environmental NGOs (e.g. WWF) are very concerned about other negative externalities such as the effects of nuclear energy (especially nuclear waste) and other environmental concerns, such as air pollution & water pollution. In the light of the current crisis in Ukraine, energy security and energy independence becomes an ever more important issue for all our stakeholders.

Furthermore, the Global Climate Forum and Germanwatch have organized three more formal focus group discussions on the German energy transition with stakeholders from industry, the banking sector, insurance business as well as civil society. Among them were actors like Siemens, Deutsche Bahn, EnBW, Deutsche Bank, Munich RE, Allianz, a German trade union and environmental NGOs. Furthermore, GCF and GW have had a longer one-to-one conversation with a huge German technology group. The talks were carried out under Chatham House Rules which means the stakeholders' statements can only be expressed in an anonymized way here. The following table shows their statements and theses concerning the topics EU 2030 climate targets and carbon prices. We did not explicitly ask for these two topics, but they were raised by the stakeholders.

	EU 2030 targets	Carbon prices
Industrial companies	The fact that targets are not clear and stable is preventing us from investments. Current uncertainty concerning the targets for European fossil power plant fleets affects planning certainty and destroys	Coal-fired power plants are the winners of the current state of the emissions trading scheme. More efficient fossil power plants are not profitable anymore because of low

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	investment security.	carbon prices. We cannot earn money because the carbon prices are too low.
Banks	As there is too much uncertainty concerning the targets, banks become too expensive as financiers. Currently political incentives for investments in energy efficiency are too small.	Concerning the calculation of certificate allocations there have been policy failures, because politicians answered to the lobbying of industrial actors. As the CO_2 market is too small and shy of liquidity, there are enormous price distortions. The current scheme favours lignite and discriminates gas and hard coal combined heat and power systems. This leads to rising CO_2 emissions. Politicians should reform this regulation. The scheme does not provide enough incentives to invest in the efficiency of power plants.
Insurances	Insurances will not invest as long as there are no clear targets. The EU climate and energy targets dominate the political regulatory framework. The current EU climate and energy targets are not a stabilizing and incentive-based economic factor at the	The design of the scheme determines which business cases are promoted. Because of the low CO_2 price too much lignite is burned. This could even undermine the current climate targets. The erroneous conception of the ETS leads to the fact that the EU climate targets only marginally affect economic

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	moment.	behaviour.
Civil society	There are no clear targets and therefore there is no investment security. Politicians have to set clear middle and long term climate and energy targets.	The emissions trading scheme does not work the right way.

3.4 The Citizens' Perspective

3.4.1 Online Survey

3.4.1.1 Overview

The first phase focused on the creation of an online questionnaire in order to gather feedback from the civic society. Surveys can help determine information on users, work practices and attitudes. This method was chosen because it allows quick determination of preferences for a relative user group, but also supports statistical analysis[7]. The SYMPHONY questionnaire was prepared in an easy to use on-line format (hestia.atc.gr/limesurvey/index.php/599429/lang-en).

The main goal was to validate SYMPHONY concepts by understanding if and how citizens participate in the online media for expressing views and opinions on issues of public policy as well as gain insight on the interest of citizens with respect to gamification approaches for their involvement in policy making processes.

The questionnaire was disseminated via direct mailings by all consortium partners. The survey was also disseminated through social community websites (Facebook, Twitter, LinkedIn) and the project website. Focus groups also became a very effective way to get additional feedback.

3.4.1.2 Preparations

The process of editing the questionnaire was based on the scenarios identified for the envisaged system functionalities. Overall, general guidelines of designing and editing questionnaires[8] were followed. The need to address a targeted user group with heterogeneous members (with different educational backgrounds), and to proceed to a quick statistical analysis forced questions to be short and as simple as possible, avoiding special technical issues that could create confusion among non-expert users.

[7] Methodology of the Questionnaire: http://www.statpac.com/surveys/

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We did everything possible to minimize the questionnaires' length so as to maximize the response rate. We also tried to include clear and concise instructions on how to complete the questionnaire, but also relevant information about the scope of the questions and generally the project aims.

The final version of the questionnaire is presented in APPENDIX II.

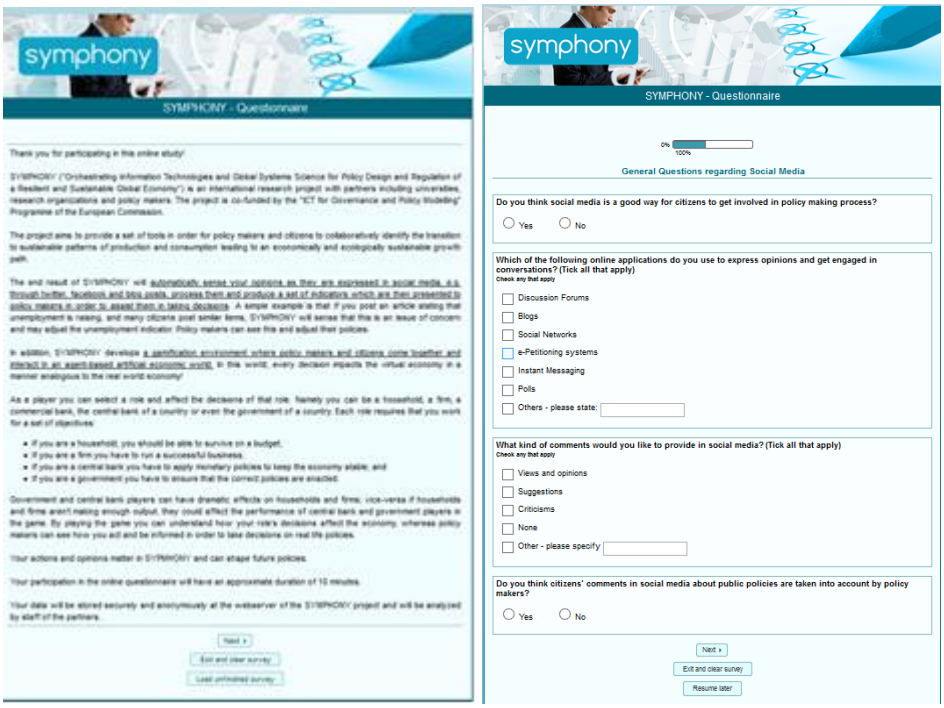

Figure 4: Snapshots of the SYMPHONY online questionnaire

The SYMPHONY questionnaire was also prepared in an easy to use online format (see Figure 4) in order to be easily accessible by a larger number of interested stakeholders. The deployment of the online SYMPHONY questionnaire was made through the use of the open source tool "Limesurvey"[9].

The questionnaire consisted of five parts, each of them focused on one particular topic:

- PART 1: PERSONNAL INFORMATION: Introductory part focused on the basic social-demographic data providing an overview about the background of the respondents.
- PART 2: GENERAL QUESTIONS: Two questions related to the interest of the respondents in participating in the public policies;
- PART 3: SOCIAL MEDIA IN POLICY MAKING PROCESS: Four questions related to the experience and opinion of the respondents about the use of social media in policy making processes as well as the constraints in using these media.
- PART 4: GAMIFICATION IN POLICY MAKING PROCESS: Five questions related to experience and opinion of the respondents about the use of gamification in policy making process.

[9] http://www.limesurvey.org/

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- PART 5: OPEN QUESTION: An open question about end users' expectations for projects like SYMPHONY;

The SYMPHONY online survey will run at least for the first year of the project. For the purposes of D1.1, we have taken a first snapshot and we analyse the results in the following section.

3.4.1.3 Results

In total we gathered **203 responses** from participants coming from various European countries and beyond (Figure 5). The number of male and female participants was fairly well balanced with 59% being male and 41% being female (Figure 6a). Most of the respondents were well educated with at least a bachelors' degree whereas the majority held a masters' degree while there was a balance between participants working in the private sector and public organizations including universities and research institutes (Figure 6b and Figure 7). With respect to age, we attracted mostly people with an age span of 25-35 years old (Figure 6c).

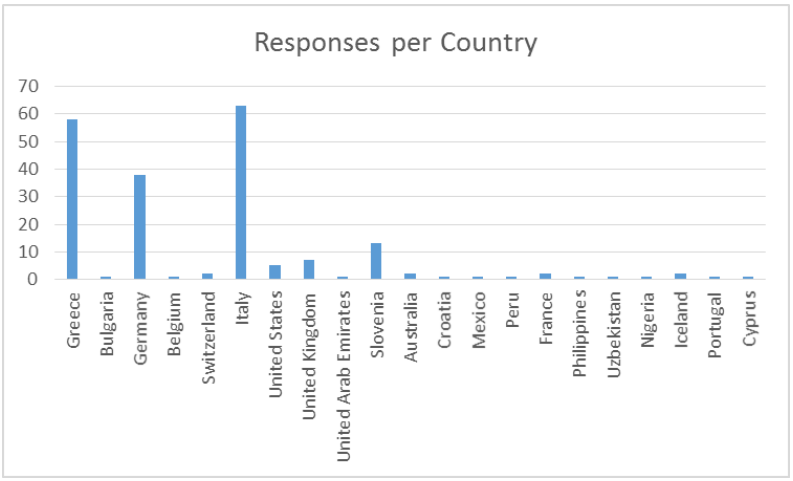

Figure 5: Participants responses per country of origin.

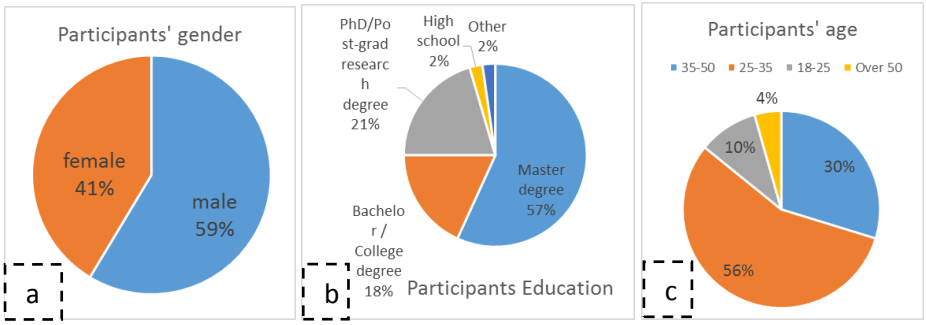

Figure 6: Participants gender, education and age.

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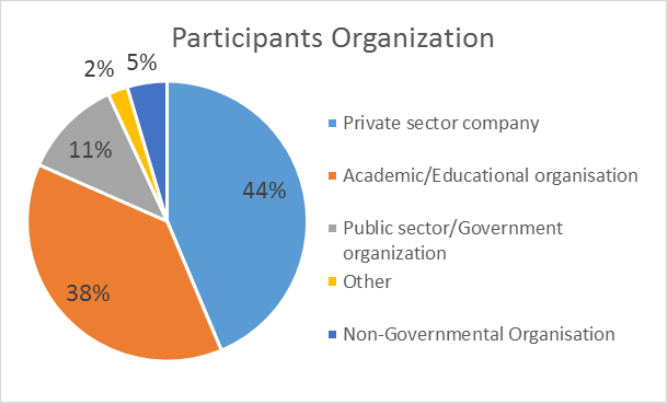

Figure 7: Participants' Organization.

In terms of the questions regarding their involvement in policy agendas, 85% of the respondents stated that they participate (although a 26% not so frequently – see Figure 8a). It is interesting that participation in online forums is not common as our results showed that only a 35% of the respondents provided a positive answer in the corresponding question (see Figure 8b).

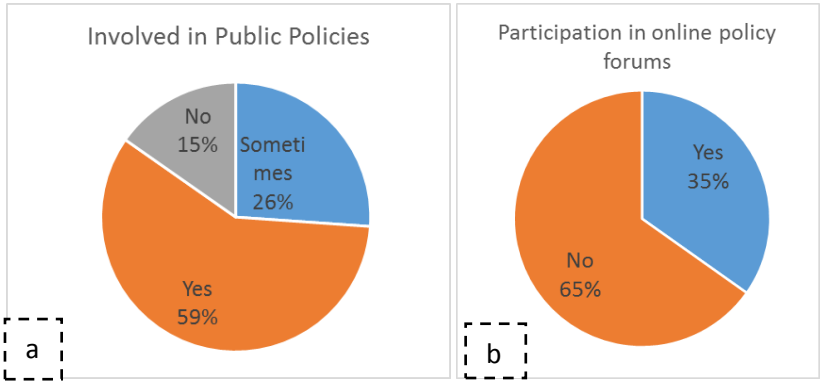

Figure 8: Results for the questions "Are you interested/involved in public policies?" and "Have you ever participated in an online political forum / debate?"

Out of those who provided a positive response and have participated in online forums, most stated that the reason was that they were interested in the topic (66%) and only a small percentage (17%) that they had the opportunity to influence decision makers (Figure 9).

With respect to the reasons for not participating in online forums, the most important was time as participants don't have enough time to spend, followed by unfamiliarity with the topics being discussed and privacy, which means that people don't want their opinion to be tracked (Figure 10).

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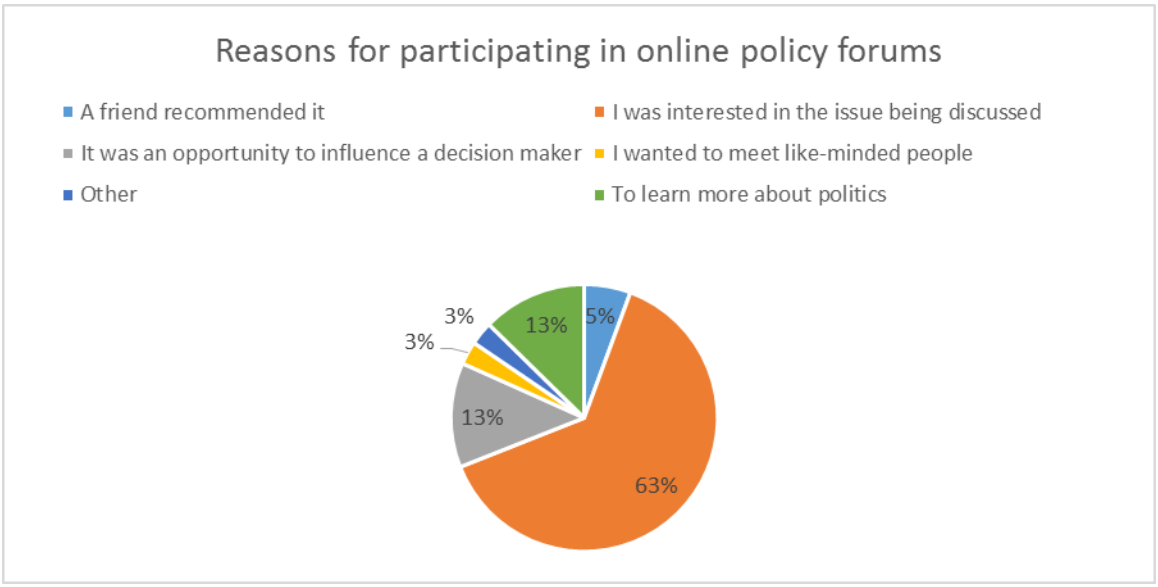

Figure 9: Results for the question "why did you participate in an online policy forum?"

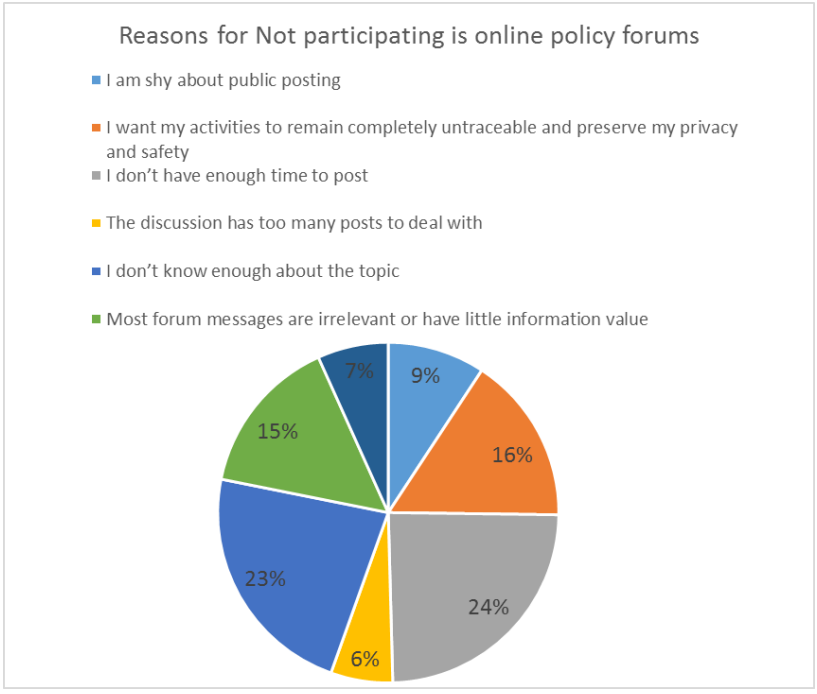

Figure 10: Results for the question "why you have not participated in an online policy forum?"

The next set of questions focused on social media and how participants use them. An above average percentage (69%) believes that social media consist a good way to get involved in public policies. Most participants use Social Networks (participants mentioned Twitter and Facebook in the 'comments' section of the question) followed by polls and e-Petitioning systems (Figure 12). In such media, participants mostly post opinions and views, but also criticisms and suggestions although with a lower frequency (Figure 13a). One of the problems is that people do not believe that the opinions expressed in social media are

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seriously considered by decision makers (Figure 13b). This means that citizens need feedback to show them that their opinions are taken into account and be convinced that their participation can actually influence decisions.

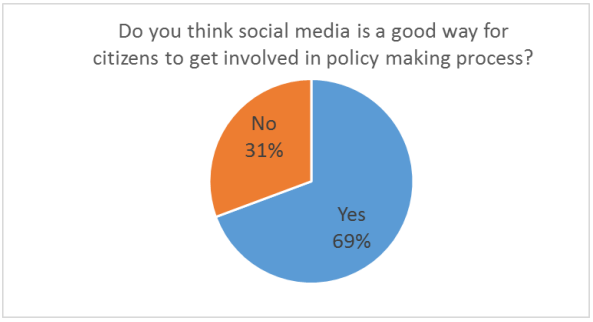

Figure 11: Results for the question "Do you think social media is a good way for citizens to get involved in the policy making process?"

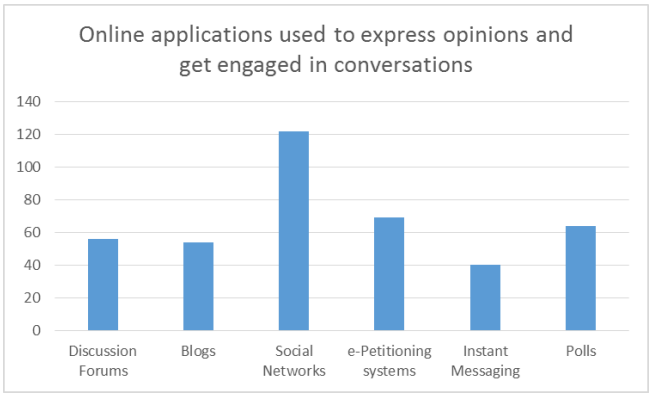

Figure 12: Results for the question "Which online applications do you use to express opinions and get engaged in conversations?"

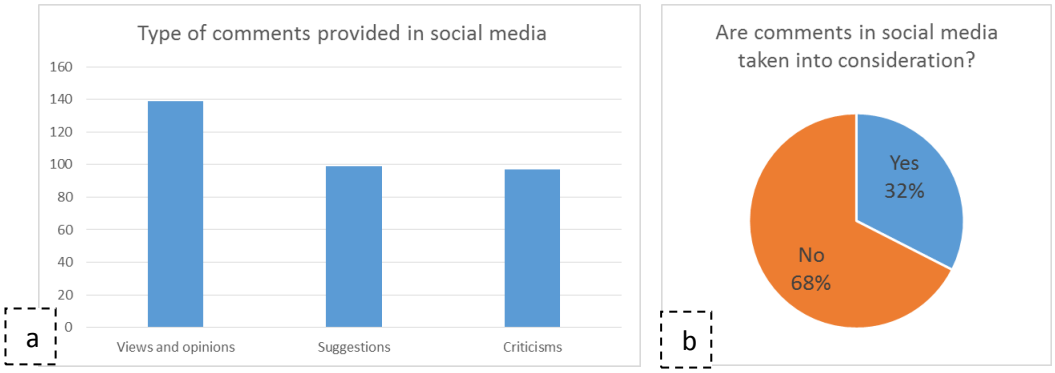

Figure 13: Results for the questions "What kind of comments would you like to provide in social media?" and "Do you think citizens' comments in social media about public policies are taken into account by policy makers?"

Our next set of questions referred to the potential of gamification as a method to be involved in policy making. The opinion of the participants was somehow divided and 58% answered that it is a good way whereas 42% believe the opposite (Figure 14a). This can be

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attributed to the fact that we didn't provide a clear explanation of how the game will look in the online questionnaire.

In terms of which kind of suggestion would intrigue users to use a game application most replied that the suggestion should come from friends on people they trust (Figure 14b). Most respondents showed interest for participating in games for affecting public policy decisions (Figure 15) and specifically for our proposed game that will help to prevent and mitigate financial and economic crises (Figure 16).

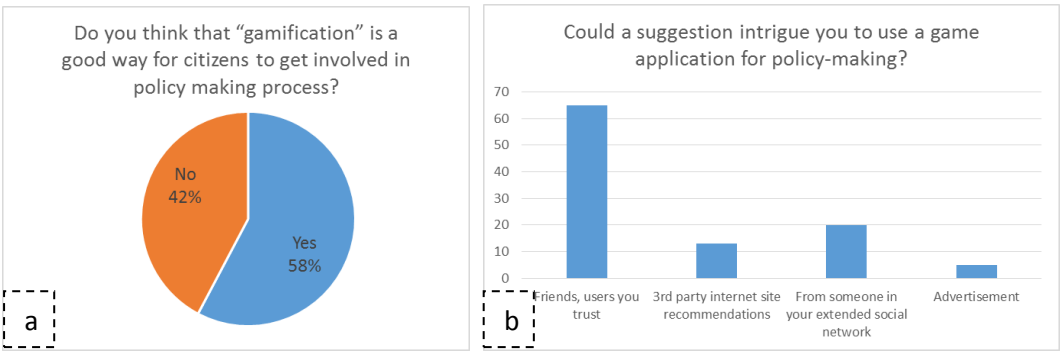

Figure 14: Results for the question "Do you think that gamification is a good way for citizens to get involved in policy making processes?" and "Could a suggestion intrigue you to use a game application for policy-making?"

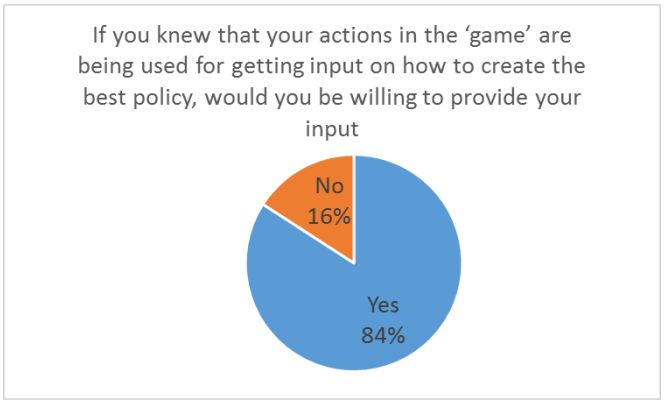

Figure 15: Results for the question "If you knew that your actions in the 'game' are being used for getting input on how to create the best policy, would you be willing to provide your input?"

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Figure 16: Results for the question "Would you be interested to participate in a game in which you select a role (i.e. government, bank, household), and test different options (decisions) for preventing and mitigating economic and financial crises?"

In the last question, participants were asked to provide their opinion on what they would expect from projects like SYMPHONY. Some interesting comments we received are:

- "Feedback on the impact the user makes to decisions made",
- "…this promising technology could be really helpful if was not meant to be controlled by some authority, but by the people that are suffering the most.",
- "I would like to see the turnout to elections rise in the future as a result of people being more engaged and interested in policy issues. If the "games" mentioned are initiated, I hope they are clear about their motivations to users, unbiased and open to different members of society."
- "Similar approach may be useful for other areas, such as environment, crime prevention. It is not clear how much influence, if any, such gamification can have on policy makers."
- "The concept is innovative, as long as it comes as a fresh, easy to use application I believe it will be successful."
- "I think it is a great idea. However, I am rather sceptic on pure online formats. I think the mix of traditional participation & online tools is what brings us really forward and helps to reach out to a wide range of different people, even those who are not active (yet)"

To summarize, citizens want an easy to use solution that will not consume their time while respecting their privacy. Moreover they need feedback on how their expressed opinions and actions influence decision makers and are being used in the policy making process.

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3.4.2 SYMPHONY Focus Groups

3.4.2.1 Goals & Process

In addition to the online questionnaire, we ran a series of focus groups with citizen representatives which included an open discussion regarding the SYMPHONY offerings.

The goal of the SYMPHONY focus group was to uncover the needs and opinions of the potential users (citizens), so that the SYMPHONY Consortium could adapt the design of the necessary tools and technologies within the project in order to meet user needs. Throughout the open discussions with this potential user group, we targeted to identify their priorities and constraints and gain as much as possible additional information for validating the project's approach. Furthermore, the SYMPHONY focus group aimed at building a common understanding and approach for the project between the consortium members which are organizations of different backgrounds and focus. Following that, all consortium members will investigate ways to design the SYMPHONY system in line with the project orientation and the end user expectations. Finally, the SYMPHONY focus group provided a very good opportunity to specify and explain a first set of terminology to be used during the project, in order to establish a common language among the partners.

Overall, four focus groups were organized in Athens, Germany, Italy and Slovenia. The discussion was organized around a presentation which provided an overview of the SYMPHONY and the user scenarios we have specified. After explaining each of the scenarios to the participants, an open discussion was held.

Finally, the audience were asked to fill in the SYMPHONY questionnaire as shown in APPENDIX II. Compared to the online questionnaire, we included an additional section with a summary of the usage scenarios which are relevant for citizens in order to be evaluated and rated according to the interest they cause. In more detail the following agenda was used.

FOCUS GROUP - AGENDA	
Duration	**Topic**
15 min	Welcome session & outline of meeting agenda
15 min	Introductory session • Overview of SYMPHONY vision and overall objectives • Workshop objectives and expected outcome
30 min	Overview of the SYMPHONY related technologies / example scenarios demonstration
30 min	Distribution of questionnaire / Discussion
30 min	Open discussion around SYMPHONY issues
15 min	Overview of the main Issues - Closing of the meeting

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The session was designed to last approximately two hours and was divided into the following parts:

- Welcome note and introduction of the moderator
- Introduction of participants
- Short explanation of the purpose of the Focus Group
- Introduction of the agenda
- Introduction of the SYMPHONY project. Explanation of the motivation, the innovation, the target and the approach to be followed by SYMPHONY
- Example scenario presentation
- Quickly going through the questionnaire (focus on specific questions, quick conclusions, etc.)
- Open discussion around SYMPHONY issues like:
    - Do you understand the aim of the project?
    - What features and possibilities would you ideally expect from SYMPHONY?
    - Who and how could benefit from SYMPHONY (Approach & tools)?
    - Have you heard about any other project similar to SYMPHONY? Have you tested similar technologies?
- End user vision about the project. Open discussion about what they would expect ideally.
- General / Final Overview.
- Briefing / Conclusions.
- End note.

The following sections provide an overview of the main outcomes of the Focus Groups.

3.4.2.2 Focus group in Athens

The focus group aimed to present the SYMPHONY project to a candidate group of end users / citizens in order to collect feedback and identify users' needs. We had 6 participants including representatives of NGOs, a journalist, a writer, a sociologist / activist as well as people with some experience to similar initiatives.

During the focus group, ATC described briefly the purpose of the Focus Group for end users / citizens and the agenda of the discussion. ICCS introduced the project to the audience, outlining the innovative SYMPHONY approach and disclosing its vision and objectives. The technical approach through the overview of the main components was also demonstrated. The usage scenarios specified for end users / citizens, were also presented in brief in order to be discussed and validated by the participants. The usage scenarios presentation triggered a lot of reactions to the audience and helped the consortium to identify how SYMPHONY is perceived by its potential end users. The following issues were raised by the attendants regarding the usage of the SYMPHONY tools:

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- The system should provide feedback to the end users / citizens on how their contributions have been used in the policy making process;
- The SYMPHONY tools could be also accessed through mobile devices and/or native mobile applications;
- SYMPHONY should address also issues related to the behavioural economics including how market decisions are made and the mechanisms that drive public choice;

The disclosure of the results obtained from the presentation of the usage scenarios stimulated also intense discussion that caused some fruitful comments from the users' viewpoint:

- There was a concern that only the 'connected 'people' will be heard since a large majority of the population has still no presence at the social media. To this end, it was suggested that physical meetings and workshops should be also part of our approach in order to give the opportunity to the people who are not connected to have also a 'voice';
- There was also a concern whether policy makers can get the whole picture through SYMPHONY, due to the fact that negative reactions are prevalent in Web. Therefore the accuracy of results is compromised. The same also applies, when there is not adequate internet discussion on the issue.
- It was also noted that citizens need more opportunities to participate. Initiatives like SYMPHONY could have an added value to the society and could be used in order to 'educate' both citizens and policy makers on how to collaborate more effectively.
- It was also mentioned that for data mining, sites like **Vouliwatch** http://www.vouliwatch.gr/ , **Parliamentwatch** (www.abgeordnetenwatch.de) should be also considered;
- It was also discussed that tools like SYMPHONY could be provided as open source in order to be reused by other small organisations and NGOs.

In general, the participants showed intense interest in the project. More specifically, they liked that SYMPHONY can involve citizens in the decision-making process through a game UI. They found also interesting the fact that SYMPHONY could 'observe' the crowd and show these results using a visual way to depict the trend of different opinions. Participant highlighted that the Information Market is also a very interesting approach for citizens' engagement.

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3.4.2.3 Focus group in Germany

The focus group consisted of 15 participants (9 men, 6 women) of different age groups and from NGOs in the environmental and social domain. The participants were asked to fill in the online questionnaire before the meeting. The questions regarding the two Scenarios (Part C) were distributed before the meeting. The meeting started with a presentation of the aim of the project, the target group, the four tools and the two policy cases. After this there was an open discussion. In the end, we gave people some time to fill in the questionnaire and to write down what they found most important in terms of feedback.

With respect to social media mining, most participants provided positive feedback and found the envisaged tools very useful and interesting. The tools were perceived as very promising because they are innovative and with a high practical relevance. One of the persons stated that this type of feedback would increase (implicit) political engagement, thereby increase interactions between decision-makers and the general public. Nonetheless an issue of discussion was that not all people use social media and the idea of social media mining can be scary, even if it is said to be anonymous. The most negative opinion was that social media mining can be a threat of self-fulfilling prophecies and one cannot derive useful information as it is easy to get “hypes and shit storms”. Participants with modelling expertize mentioned that it is interesting to include social media expectations in the model as it gets closer to the reality and not merely mathematical. Last but not least participants agreed that by knowing that their social media activities can impact real-life policies is an incentive to participate, but also expressed worries about possible misinterpretation of posts and attempts to “trick” the system in order to influence policy-makers

During the open discussion several statements and remarks were provided by the participants. One participant mentioned that citizens’ participation in the game is good idea for political education but not for policy advice since the game doesn’t fully map the real economy and no “real” data is generated. We also observed some scepticism about the credibility of the game from a policy maker perspective, an issue that is related to the explanation of the model itself, its assumptions and in which way it is different to other models which will be done at a later stage of the project. Some doubts were raised on the data collected through the game, as the actions of players can be more or less rational than in real life, hence their behaviour in the game cannot be considered as representative for real-life behaviour. Another remark was that incentives are very important to ensure participation and ‘levels’ are needed especially for less attractive roles like ‘households’ that make only everyday consumer-and-savings-decisions. Participants mentioned that they would like in-game incentives including specific goals that one has to reach (which can be determined by the player or the group of players), scores or even a level-system, competition between players (e.g. competitions could be organized for schools or firms or others), highlight and stress of the learning-effect, and ideas like being able to play “Draghi” or to beat “Draghi” (or Merkel) by taking better decisions.

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All participants requested to access and test the game prototype when it is ready. Moreover they would like to see in the game fast reactions to decisions and get the feeling of "being chancellor for a day" (should not take a week until another round or scenario can be played). Another idea we received was to be able to play the game in a group for example at a workshop and have the option for players to be able to switch roles. Other suggestions were to make the model able to show possibilities for decoupling (Growth, energy consumption, financial markets…), maybe through resource prices or other parameters, have the possibility of a no-growth scenario, which can be stable/positive as well.

3.4.2.4 Focus group in Italy

The aim of the focus group was to communicate the SYMPHONY project goals to a group of citizens and collect their feedback and their needs. The group consisted in 11 people (3 women, 8 men) including students, researchers, workers and professionals. No participants had previous information about the project and its aims, though some of them had already had some experience in similar activities. At the beginning of the meeting, UNIGE briefly presented the purpose of the focus group and illustrated the SYMPHONY project, its aims and goals. The group received a brief overview of the project so to have a reference point during the illustration. The presentation was divided into two sessions of information; at the end of each session participants were asked to submit their questions, if any.

Questions expressed after the presentation of the project concerned a clearer explanation of the final goal of the project, how data are collected by the social data mining and how the agent based model, the social data mining and the information market will be combined. The questionnaire and its aims were then illustrated. During the presentation of the usage scenarios some objections were raised because of their length and of the complexity of the technical approach.

Overall, the general reaction to the project presentation and to the questionnaire was good. Participants found it interesting and engaging, with a particular attention to the final goal of the whole activity. The group was moreover very interested in the possibility of having feedback in real time through the described solution.

With respect to the SYMPHONY social media mining scenario, participants found it interesting because it is the first step and is a way for citizens' voice to be heard and it shows the influence of the decision process on politics. Moreover much of the information collected by social media is communicated by traditional mass media but in a different way which can be inefficient. On the other hand, there were concerns on the reliability of the information, the validity of the technical solution as it can be difficult to understand crowd sentiments with software implementations and possible manipulation attempts. Some participants highlighted the difficulty to understand how this information can be useful to policy makers and that policy makers do not care about the expectations of the general public. This concern was expressed particularly by participants from Middle Eastern Countries.

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Gamification was perceived as a positive tool because people of different age can use it to become more confident with the issue at hand. The attendants found very interesting the possibility to play different roles and to play together. The possibility to play different roles helps people to better understand the meaning of some decisions taken in real life. Participants stated that by participating in a game where it is possible to select a role can help them understand the mechanisms to be taken into account in the policy making decision process since "when a person sit on a different chair can better understand other problems, developing his own empathy and understanding the needs of other stakeholders". It was also mentioned that gamification is a tool more direct and easy to understand and it is useful for private citizens and public sector to take attention to each other. Moreover it can help to evaluate the transformation of the whole economic system and the aspects of "fun" is a good motivation to participate. Nonetheless, the difficulty to understand goals and processes might cause a loss in motivation in the long run. One of the participants expressed objections because up to now no scientific result can demonstrate its effectiveness. A more general issue that was mentioned refers to the use of the English language in an activity which aims to involve a share of the population as wide and heterogeneous as possible.

Last but not least, participants provided a set of suggestions:

- The GUI of the game: it is important that people feel good communicating with this software and experience the virtual place as a real one. If the software is implemented with high quality, it will really help policy makers;
- It is important to assign a level of influence to each actor and consider the number of each type of agents. It could be a risk to simplify the project too much (presence of external interests);
- The educational role represented by the consequences of the actions and their impact on decisions should be taken into account;
- The empathy among people is a feature not to forget;
- A stronger link between Public Administration and policy makers is needed. Public Administration is different from people who write laws;
- The project is interesting but it is difficult to be convinced about the practical benefits of it. "In short I am not sure that politicians would in fact use these data. I'm also skeptical about how much the general public would participate in such a game and consequently how much the data generated in the game would be reliable.";
- It would be very interesting knowing the feedback on the influence of the user contribution on the real policy maker decisions;

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The conclusion was that the project has been perceived as a good tool to provide motivation for people of all ages to be involved in policy making activities giving the possibility to face the problems of their countries and maybe even affecting the process of decision making.

3.4.2.5 Focus group in Slovenia

The focus group consisted of 9 participants including students and experienced researchers in several fields. Most of the participants stated that the scenarios are interesting/rather interesting and also selected "interesting" option in question "How would you characterize the scenario". However, there was no single opinion about the connection of the gamification to the real state of the economy. Some people thought scenarios reflect the real life situations and the game would be easily accepted by citizens. Others, on contrary, thought that the game might become too distant from the reality and people could lose motivation. Some interesting comments about the scenarios and the game included:

- "the presented scenarios and the game can be possibly good for assessing public misconceptions about economy and policy making."
- "scenarios are realistically described (people represent their realistic roles)."
- "it is not clear how much influence such gamification can have on policy makers."
- "the game can hardly reflect real-life scenarios."
- "real-life decisions might be different in game environment."
- "the demographics might be biased."

Summarizing, the focus group revealed that the user scenarios are well described and a gamification approach fits the purpose of informing citizens and assessing misconception about the economy and policy making. Nonetheless, there were concerns raised with respect to the complexity of the game, the possibility of affecting policy makers' opinions and the potential of a bias in the list of participants in the game. Our approach for a simple and understandable game design readily to be used by novice and expert users can mitigate issues of complexity and bias in the users' mixture. Furthermore within the evaluation phase of the SYMHPONY toolset we have to check how policy makers' decisions are affected by our solution.

3.4.2.6 Summary of SYMPHONY Focus Groups Results

Our proposed approach was found interesting by the participants in all four focus groups. Participants especially liked the possibility to have their opinion heard through social media and the possibility to understand policy decisions and options through a gamification environment. With respect to the concerns participants raised, most are related to issues we are already addressing in the SYMPHONY project. For example, the credibility of social media information and the simple and understandable design of the gamification approach are issues we will be addressing within SYMPHONY. Last, we also gathered Interesting

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comments which we will consider. Citizens expressed the need for establishment of feedback mechanisms that will show evidence of how decision makers' actions are affected by their opinions. Such mechanisms could simple, like issuing statements of how decisions makers' changed after observing the citizens' opinions in social media or after playing the SYMPHONY game.

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4 Conceptual Architecture

4.1 Vision

Symphony's vision is to design and put into service an integrated set of innovative tools for supporting policy making as shown in Figure 17. The main engine will be an agent-based macroeconomic artificial economy that will be accessible through an on-line interface. It will be possible to connect to the model in order to run simulation or to participate in the artificial economy taking the role of one specific economic agent. Policy makers and other "high level" users will be able to set up different economic scenarios and to run computational experiments using the on-line interface. A complete set of visual and quantitative tools for the analysis of the real time outcomes of the simulations will be available to the user.

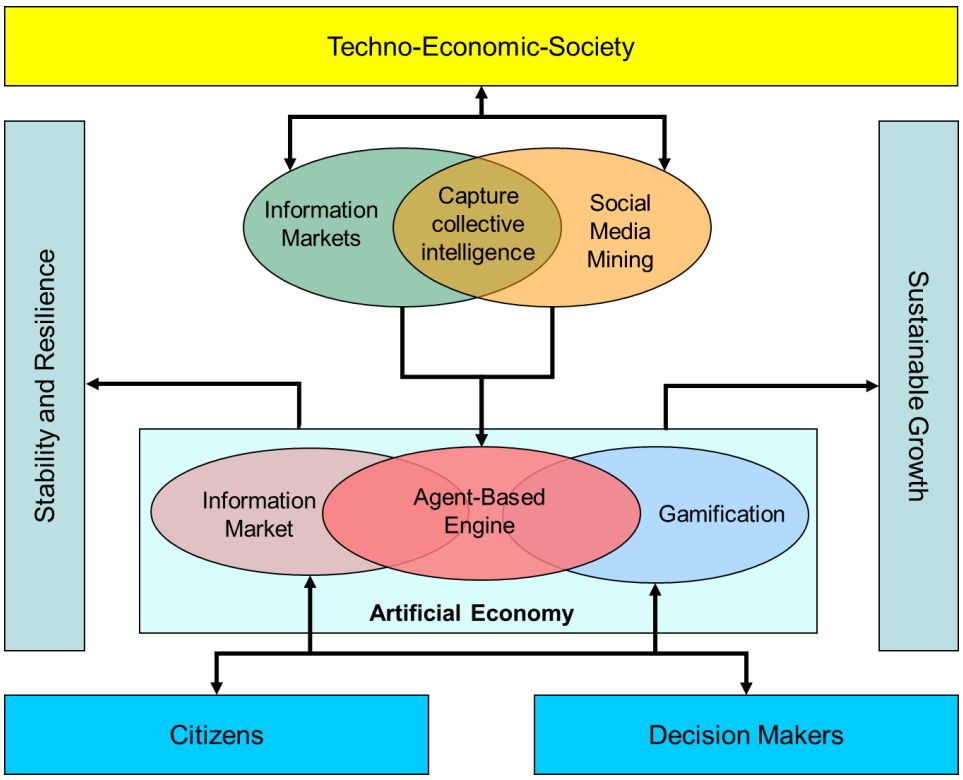

Figure 17: Overview of SYMPHONY's vision.

Citizens will be able as well to use a game like interface to the agent-based artificial economy by playing the role of a particular economic agent. They will be able to take decisions, according to their role, and to observe the consequences of their decisions through multiple panels, screens and plots. A player in the role of a commercial bank could, for instance, modify the rules for granting credit to firms or households and observe the effects of its decision on the internal variables of the bank (bank's balance sheet for example) and on the overall economy. Citizens participation into the SYMPHONY platform is

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aimed at raising awareness about the economic processes and at improving the efficacy and the transparency of the decision making process.

Besides the agent-based model, the SYMPHONY ICT platform will include social media mining tools and techniques able to collect and analyse relevant information and human sentiments from web, social networks, blogs, news stream, etc. Policy makers and experts will mainly use these tools in order to explore the evolution of people beliefs about the real world economy. In particular, the tools could be used to set up alternative real time measures of citizen's expectations about some relevant economic indicators.

The platform will also incorporate a second tool for information gathering. The user will be able to create information markets in order to collect feedback on specific economic issues. It will be possible to design ad hoc information contracts that will be traded in the markets, potentially disclosing valuable information about participants' preferences and expectations.

By combining these information extracting tools, policy makers and experts should be able to acquire a deeper vision of sentiments, trust and expectations which are prevailing among the economic agents. Moreover, apart from being useful as stand-alone tools, these instruments can also be combined with the macroeconomic engine, as shown in the user scenarios chapter of this document, in order to perform short-run computational experiments. For instance, they can be used to initialize the expectations of the artificial agents of the artificial economy in order to study in quasi-real time how different expectations can affect the economic dynamics in the short run.

In this way, the SYMPHONY platform will enable the consideration of a richer characterization of the expectations formation process and of expectations measurement. Agent-based modelling constitutes the suitable theoretical framework for this kind of task, due to the presence of many bounded rational heterogeneous agents, which act according to distinctive behavioural rules.

The framework designed by SYMPHONY provides an articulated and innovative response to the role of expectation in economics, in order to get new insights about the interplay between the policy making process and expectation formation by citizens. In this respect, it will be possible to design and run internal information markets where participants of the market predict events related to the artificial economy and express expectations on related variables. In this way, the fact that structural relationships in economics are generally not invariant with respect to changes in policy, pointed out by Lucas as a restriction of econometric models, can become a resource in SYMPHONY's policy platform, providing for an interactive system of expectations collection through these information markets.

Finally, in our vision, the ICT tools of the SYMPHONY platform, should help to increase the transparency of the policy making process, to enhance citizens' engagement, and to improve the credibility and effectiveness of policy institutions.

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4.2 Overview of the Architecture

Our vision will be instantiated through an innovative framework that will support policy-making processes. Our envisaged solution is relevant for a range of stakeholder groups as presented in Table 1.

Table 1: Summary of SYMPHONY Stakeholders.

Stakeholder group	Description	Indicative Examples
Policy Makers	They are the key actors who take the actual decisions. SYMPHONY supports them by delivering tools that provide insights on citizens' opinions (Social Media Mining), experts' opinions (Information Markets), and simulation results (Agent Based Modelling).	Politicians, European Central Bank, Bank of England.
Policy Advisors	They are the actors who support policy makers in their decisions. They may engage stakeholders (e.g. industry representatives) in discussions on the impact of alternative policy options. SYMPHONY supports them by delivering tools that provide insights on citizens' opinions (Social Media Mining), experts' opinions (Information Markets), and simulation results (Agent Based Modelling).	Global Climate Forum, German Watch, National Central Banks of the Eurozone.
Industry	They are actors who influence the opinion of policy advisors and policy makers through e.g. lobbying. SYMHONY allows them to interact with policy makers and policy modelers through a gamified agent based model of the economy. Industry stakeholders can understand the impact policy alternatives and their choices.	Large Enterprises (e.g. Siemens, RWE, Allianz etc.)
Civil Society	They are institutions and organizations that manifest interests and will of	Environmental NGOs (e.g. WWF), civil society actors

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	citizens. SYMHONY allows them to interact with policy makers and policy modelers through a gamified agent based model of the economy. Industry stakeholders can understand the impact policy alternatives and their choices.	like unions (e.g. IG BAU)
Citizens	SYMPHONY allows them to understand and influence policies.	SME owners, Public servants, Young generation, Employees.
Academia	They produce new knowledge on issues of financial stability and sustainable transition. SYPHONY can provide a computational laboratory where research on expectations elicitation can be performed.	Universities and research organizations.

The conceptual architecture of the SYMPHONY platform consists of the SYMPHONY services and the dashboard as presented in Figure 18.

The SYMPHONY platform combines various services that will be provided by the following key components:

- The SYMPHONY Dashboard (including the Information Market UI, Game UI, Social Media Observatory UI)
- The Social Media Mining (SMM)
- The Information Market (IM)
- The Agent Based Macroeconomic (ABM)
- The Gamification Engine (Gaminomics)
- The Platform Orchestrator

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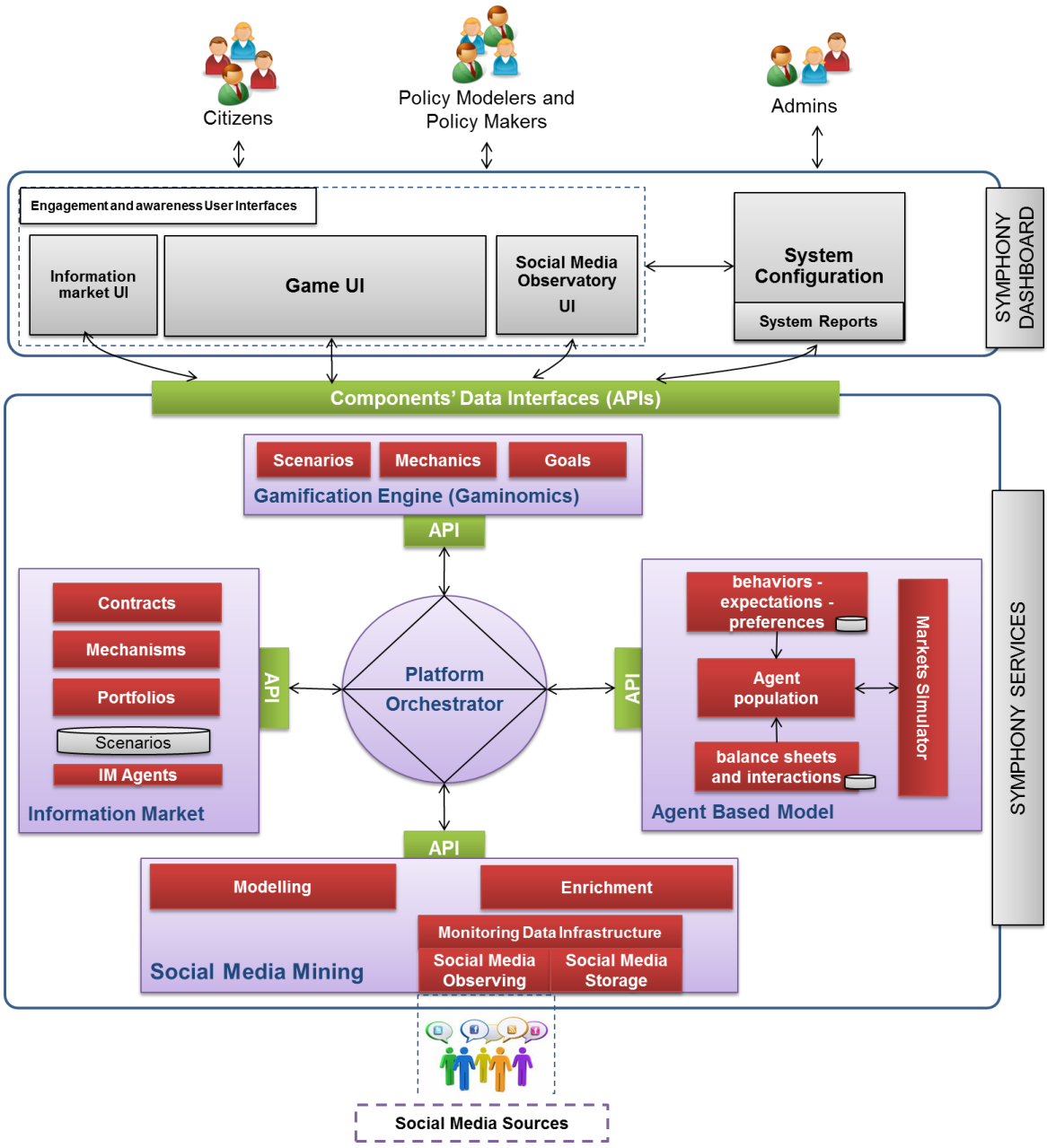

Figure 18: SYMPHONY Conceptual Architecture

The access to the SYMPHONY platform is provided through the **Dashboard User Interface (UI)**. Based on users' interest and their role, two sets of dashboard views will be provided. The first set aims at supporting engagement and awareness and is targeted to citizens and other stakeholders (including policy makers and policy modelers). This dashboard provides access to: a) the SYMPHONY gamification interfaces (the Game UI widgets which will provide Simulation Insights, Analytics and Game Results), b) the Information Market UI and c) the Social Media Observatory UI (including the Social Media Expectations' Indicators), which will provide to the users the ability to view social media data in an active way. The second set

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offers views to platform's admins to support reporting and system's configuration tasks (**Administration area**).

Additionally in terms of communication between the front-end and back-end, each of the aforementioned dashboard UI component, is directly accessed with its pair of SYMPHONY's service component through Data Interface (API) in order to fulfil a straight forward secure connection.

The **Social Media Mining** includes the Observing subcomponent which retrieves data from social media, the Enrichment subcomponent which performs enrichment of social media data**,** the Storage subcomponent which handles storage and access to social media data and the Modelling subcomponent which provides models for alignment of social media signals and macroeconomic data used for nowcasting. This component is a clean, continuous, real-time aggregated stream service of semantically enriched social media content. The component aggregates citizens' expectations expressed in social media and generates meaningful indices which can are presented to the users of the SYMPHONY platform, and can be provided as input to the ABM or the IM through appropriate data interfaces, in order to initialize the beliefs of artificial software agents.

The **Information Market** component aggregates expectations and opinions of stakeholders (including experts, policy modellers, policy makers and citizens) for issues related to policy making using the market metaphor. These expectations are presented to the users of the platform and can be used to initialize the beliefs of agents in the ABM. The IM instantiates artificial agents which trade together with human participants using input from the SMM component.

The **ABM Model** component is the SYMPHONY engine for simulating the impact of alternative policies. It incorporates the macroeconomic model that takes into account disequilibrium dynamics, includes credit and financial markets, and instantiates an artificial financial economy. This component is able to explain the functioning of a financial economy from the bottom-up. In particular it focuses on modelling and investigating the interplay between the financial and real sectors of the economy, the financialization phenomenon and their interplay with the problem of financial stability. The beliefs of the agents in the ABM can be initialized from data IM and SMM data, whereas the ABM can be access through the gamification engine.

The **Gamification Engine** provides enhanced user experience through a gamification layer that enables policy makers and citizens to engage with SYMPHONY's macro-economic engine in a meaningful and appealing way. By reducing the complexity of engaging with the agent-based model (ABM) to a set of simple and intuitive graphical interfaces supported by gaming mechanisms, the Gamification Engine guides the user through different scenario sets. These scenarios are created for key stakeholders' roles. Policy makers act as governments and central banks, citizens and other stakeholders play as households, firms, or banks or express expectations on the course of the artificial economy. The key stakeholders

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will able to understand the impact of their decisions on both the economy and agents' behaviour and understand how optimally adjust their actions and policy measures in real scenarios.

The **Orchestrator** component could be termed as the heart of the SYMHPONY platform as it is "the connector" that provides to all peripheral modules the infrastructure to accomplish successful asynchronous communication between them. Additionally, the **Orchestrator** fulfils the translation of the information that is being transferred from a module (source) to target the component(s) by putting into queue the communication calls following the necessary priority.

In the following sections we provide a detailed description for each of the SYMPHONY main components, including the current state of the art and the research directions we will be pursuing in the duration of the project.

4.3 Symphony Components

4.3.1 Social Media Mining

4.3.1.1 Overview of the Component

Social media mining refers to data mining of content streams produced by people through interaction via Internet based applications. The Social Media Mining Component developed within SYMPHONY project will perform a number of activities that will allow us to observe, enrich and store data from social media, as well as analyse how social media signals align with macroeconomic trends. The core of the Social Media Mining Component will include the following functionalities:

- Observing Component. Receives data from Social media, calls Enrichment component for data enrichment with additional features and sends data to storage.
- Enrichment Component. Enriches data from Social media with general and custom categories information, sentiment value etc.
- Storage Component. Stores data from Social media. Provides a list of query functionalities: search by hashtags, search by keywords, search by users, aggregations by different features, such as sentiment, frequency etc.
- Modelling Component. Learns models for nowcasting using SVM or linear regression to model time series from social media data.
- User Interface Module. Provides the front-end to users. Has views for users and administrators.

Figure 19 presents the interconnections between functionalities of the Social Media Mining Component.

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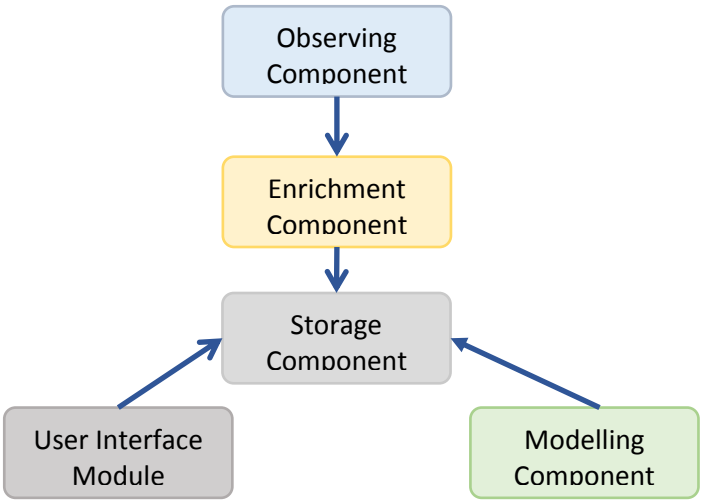

Figure 19: Interconnections between functionalities of the Social Media Mining Component.

All functionalities of the Social Media Mining Component will be further described in details in the deliverables of the WP2: Collective Intelligence for Nowcasting.

4.3.1.2 Current State of the Art and Practice

A number of data mining approaches, applicable to social media mining, include sentiment detection, summarization, classification, tagging, retrieval and recommendation, discourse analysis, as well as gathering statistics, filtering and sorting of results, trend analysis, campaign monitoring et al.

Data Mining of Social Media

Most of the approaches for social media mining are dealing with noisy, distributed, unstructured and dynamic data, as well as with informal text processing. In particular, researchers discussed summarization of tweets according to the given query (Sharifi et al., 2010), summarization of YouTube comments with sentiment detection and tag cloud (Potthast and Becker, 2010), identification of the main headlines for the day with language modelling (Lee et al., 2010). A number of approaches to classification of the informal text have been suggested by Irani et al. (2010), Ramage et al. (2010), Lambert et al. (2010) and Sriram et al. (2010). And while some researchers have been dealing with spam versus non spam classifications (Irani et al., 2010), other clustered twitter stream into several topics (Ramage et al., 2010) or classes, such as news, events, opinions (Sriram et al., 2010). Retrieval of the relevant tweets based on trained language model for each hash-tag on tweeter has been covered by (Efron, 2010). Rupnik et al. (2012) suggest a method for multilingual document retrieval through hub languages, which have alignments with many other languages. Wang et al. (2010) suggested the improvement of news recommendation taking to the account comments from the users for new articles. Tagging of informal texts has been covered by Huang et al. (2010) that trained taggers for the veterinary domain, Tsur et al. (2010) that suggested new method for identification of sarcastic posts and Singh et al. (2010) that proposed to extract named entities from advertisement slogans.

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Special attention should be dedicated to the approaches dealing with sentiment detection in social media streams. Sentiment detection has been performed at different levels, starting with user sentiments about certain topics (O'Connor et al, B., 2010). Štajner et al. (2012) addressed the problem of sentiment analysis in an informal setting in different domains and two languages. The authors explore the influence of sentiment lexicons and different lexical features and show that the improvement resulting from using a two-layer model, sentiment lexicons, surface features and feature scaling is most notable on social media datasets in both English and Spanish languages. Identification of relevant passages with sentiments within blog posts has been performed by Gerani et al. (2010). Park et al. (2010) as well suggested using NL techniques to discover and analyse user blog posts with sentiments.

Social Media Mining for Nowcasting

Nowcasting in economics is a process of measuring the state of the economy in a real time (Lansdall-Welfare, 2012). For instance, Giannone, Reichlin and Small (2008) show how the process of nowcasting can be formalized with a model describing the direction of change in GDP before official figures for GDP are published. Recently, new approaches merging social media mining with nowcasting have been developed. These approaches utilize vast data streams from social networks, like Twitter or Facebook, to assess standard economic measures in shorter periods of time. Several nowcasting approaches discussed below are based on sentiment mining of social media streams and assume that sentiment values obtained from social media streams can be correlated with financial data streams (O'Connor et al., 2010; Bollen et al., 2011; Oh and Sheng, 2011; Feldman et al., 2011). In the "Pulse of the nation" project (2013) the researchers created a visualization for the US mood from September 2006 to August 2009 based on Twitter data. Figure 20 presents several US mood examples from “Pulse of the nation” project.

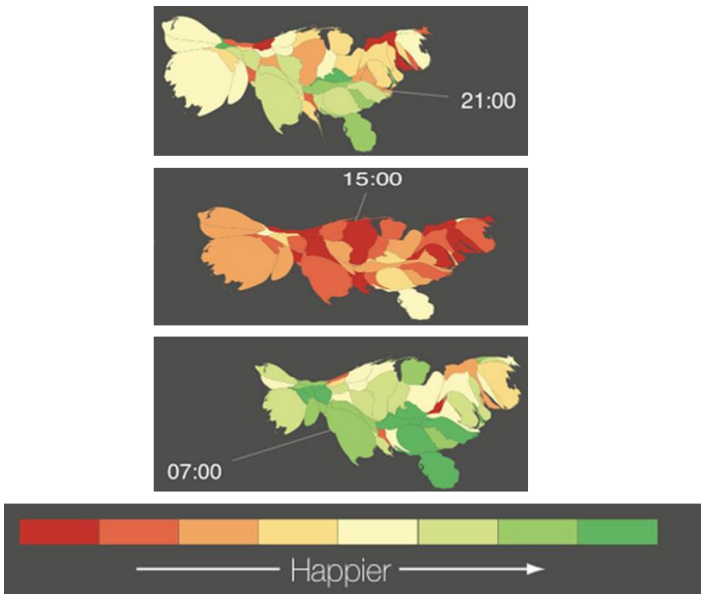

Figure 20: US mood at 7.00, 15.00 and 21.00.

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Lansdall-Welfare et al. (2012) also explore the process of nowcasting the mood of the nation. From July 2009 to January 2012 tweets sampled from the 54 largest cities in the UK over a period of 30 months have been used and associated with basic emotions (fear, joy, anger, sadness). On Figure 21 mood changes in UK are illustrated, with joyful grimace for December 24, 2009.

By analysing twits the authors find that each of the four key emotions changes over time in a partly predictable or explainable manner. For instance, there was a periodic peak of joy around Christmas due to greetings messages – and a periodic peak of fear around Halloween.

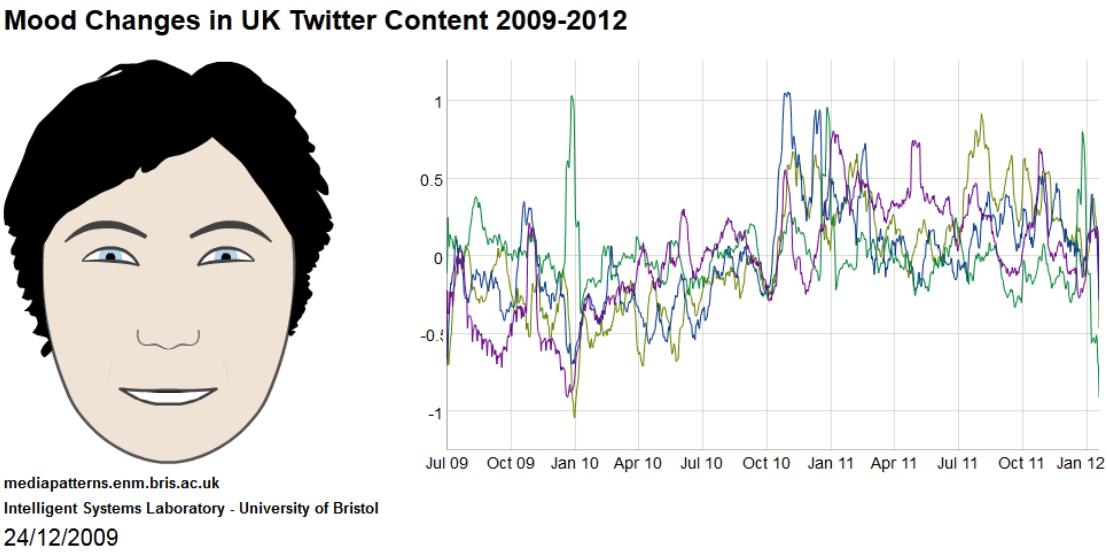

Figure 21: Mood changes in UK with grimace for 24 December 2009.

One of the most popular research topics in the area of social media mining and nowcasting is the prediction of stock market based on data from social media.

Bollen et al. (2011) investigate how Twitter mood can predict the stock market. The research deals with a question whether measurements of collective mood states derived from large-scale Twitter feeds are correlated to the value of the Dow Jones Industrial Average (DJIA) over time. Two mood tracking tools - OpinionFinder (Wilson et al., 2005) that measures positive vs. negative mood and Google-Profile of Mood States (GPOMS) that measures mood in terms of 6 dimensions (Calm, Alert, Sure, Vital, Kind, and Happy) are used to analyse daily Twitter feeds. GPMOS is an extension of the Profile of Mood States (POMS) (Norcross et al., 1984), an adjective rating scale designed to measure dimensions of affect. POMS provides an accuracy of 87.6% in predicting the daily up and down changes in the closing values of the Dow Jones Industrial Average.

Oh and Sheng (2011) attempt to discover and evaluate the predictive power of stock micro blog sentiment on future stock price directional movements. Using 72,221 micro blog postings for 1909 stock tickers and 3874 distinct authors, they constructed a number of

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robust models based on sentiment analysis. The conclusion is that stock micro blog sentiments have predictive power for simple and market adjusted returns.

The Stock Sonar (TSS) developed by Feldman et al. (2011) is a stock sentiment analysis application based on sentiment dictionaries, phrase-level compositional patterns, and predicate-level semantic events. The advantages of TSS include the possibility to obtain in-text sentiment tagging and sentiment-oriented event summaries for a particular stock.

Ruiz et al. (2012) explore the problem of correlating stock market financial time series with micro-blogging activity and try to identify the correlations between stock-market events for a number of companies and features extracted from the microblogging messages. They apply two sets of features - features that measure the overall activity in the micro-blogging platform (number of posts, number of re-posts) and features that measure the properties of an interaction graph (the number of connected components, statistics on the degree distribution, and other graph-based properties). The main finding is that the number of connected components and the number of nodes of the interaction graph are the most correlated features.

Besides correlating social data streams with stock market financial streams, the researchers as well utilized a number of other measures, such as consumer confidence and public opinions. Connecting public opinion measures from polls with sentiment values obtained from twits has been discussed by O'Connor (2010) where several surveys on consumer confidence and political opinion over the 2008 to 2009 period have been analysed. A correlation between measures of consumer confidence and sentiment word frequencies in Twitter messages is found.

Index of Consumer Sentiment (ICS) from the Reuters/University of Michigan Surveys of Consumers has been used as an indicator of how optimistic the public feels about economy as whole and their personal finances in particular. In addition, daily Gallup Organization's "Economic Confidence" index derived from answers about overall economic health of the country has been utilized.

For this particular scenario, Twitter messages have been filtered with filters "economy", "job", and "jobs". Only messages related to the topic have been identified and opinions for the relevant messages have been estimated. The authors showed that sentiment information captures broad trends in the survey data.

4.3.1.3 Research focus in SYMPHONY

The goal of social media mining in SYMPHONY project is to match micro-signals coming from social media with macroeconomic trends, along with providing justifications and understanding.

The research leading to these results has received funding from the European Community's Seventh Framework Programme [FP7/2007-2013] under grant agreement no. 611875

On one side, we shall use some of the approaches for social media mining described above to extract the signals from social data streams. On the other side, the macroeconomic data will be analysed and aligned with trends from social media.

A number of approaches for pre-processing and enriching noisy unstructured data from social media streams will be applied. Since many approaches for nowcasting and data mining of social media are based on sentiment analysis, a particular attention will be dedicated to sentiment detection from social media streams.

A number of macroeconomic indicators for exploration within SYMPHONY project are described in the European Commission department of Economic and Financial Affairs[10]. This report presents the most relevant economic statistics concerning the euro area. Table 2 shows the indicators according to the macroeconomic field.

Table 2: Indicators according to macroeconomic fields (from European Commission economic databases and indicators)

Macroeconomic field	Indicator
Output	Economic Sentiment Indicator Industrial confidence indicator Services confidence indicator Industrial production Gross domestic product Labour productivity GDP divergence
Private consumption	Consumer confidence indicator Retail confidence indicator Private consumption Retail sales
Investment	Capacity utilization Production expectations Gross fixed capital formation Equipment investment Construction investment Change in stocks Profit share
Labour market	Employment expectations (manufacturing) Employment expectations (services) Employment expectations (whole economy) Employment Compensation of employees per head Unemployment expectations

[10] http://ec.europa.eu/economy_finance/db_indicators/key_indicators

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	Unemployment rate Structural unemployment rate Total labour costs Wage costs Non-wage costs Labour productivity
International transactions	World trade Export order books Extra-euro area exports Extra-euro area imports Extra-euro area trade balance Intra-euro area trade Current-account balance Exports of goods and services Imports of goods and services Direct investment Portfolio investment
Prices	HICP Core HICP Producer prices Selling price expectation Import prices Oil prices Non-energy commodity prices
Monetary and financial indicators	Nominal interest rate (3-month) Nominal interest rate (10-year) ECB repo rate Money demand (M3) Loans to private sector Real long-term interest rates Real short-term interest rates Stock markets Exchange rates Nominal effective exchange rate
Public finance	General government balance Primary government balance Cyclically adjusted balance Cyclically adjusted primary balance General government expenditures and receipts General government debt

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European Central Bank (ECB) statistical data warehouse[11] as well contains a list of macro variables potentially relevant for Symphony project (Table 3).

Table 3: Macro variables (from European Central Bank statistical data warehouse)

Area	Macro variable
Euro area (changing composition)	HICP - Overall index, Monthly Index Commodity - Brent crude oil 1-month Forward Money Market - Euribor 3-month Benchmark bond - Euro area 10-year Government Equity/index - Dow Jones Euro Stoxx Price Index - Historical close
Euro area 18 (fixed composition)	Residential property prices Gross domestic product at market price, Chain linked volumes Standardized unemployment, Rate, 25 and over, Total (male and female)

Number of operators and functions for time series analysis presented in Zumbach (2009) and extended by JSI will be used: Moving average (MA), exponential moving average (EMA), moving norm, variance, moving variance, standard deviation, moving standard deviation, differential, derivative, moving average convergence/divergence (MACD), skewness, kurtosis and volatility.

Analysing signals from social media we intend to obtain expectations that would play an important role in the nowcasting process and serve as inputs for other Symphony components.

4.3.2 Information Markets

4.3.2.1 Overview of the Component

Information Markets (IMs) are speculative markets that serve to aggregate the beliefs of multiple traders in the price of contracts representing different outcomes of a future event (Arrow et al., 2008). Contract prices provide a reasonable estimate of what the traders in aggregate believe to be the probability of the event and as such markets are able to generate forecasts. Individuals influence these prices by buying and selling contract shares based on their belief about the outcome. At the end of the dealing period, individuals are paid off based on the accuracy of their bids.

An example

[11] http://sdw.ecb.europa.eu

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Consider the problem of estimating the chances of predicting Eurozone unemployment rates at the end of 2013. Opinions differ between policy experts, advisors, analysts and politicians. In order to acquire the aggregated view of all related stakeholders one could interview them and then synthesize their opinions or run a poll. Another alternative is to setup an Information Market. This means to create a virtual web-based stock market which includes contracts, virtual or real money, a set of trading rules and a trading interface. The contracts should be specified such that they will allow information aggregation, for example the description of a contract can be: This contract pays 1 unit of currency if unemployment exceeds 10% by the end of 2013, 0 otherwise. Participants of this virtual stock market can be all related stakeholders. Those who believe that the unemployment will exceed 10% will buy contracts (the more contracts they have at the end of 2013 the more money they will gain). Those who believe that the unemployment will not exceed 10% will sell contracts (since according to their view any contracts they own will be worthless at the end of 2013). The market transactions lead to a contract price – this price can be considered as the probability of the unemployment to exceed 10%.

A mockup showing the concept of the market including contracts and trading is provided in Figure 22.

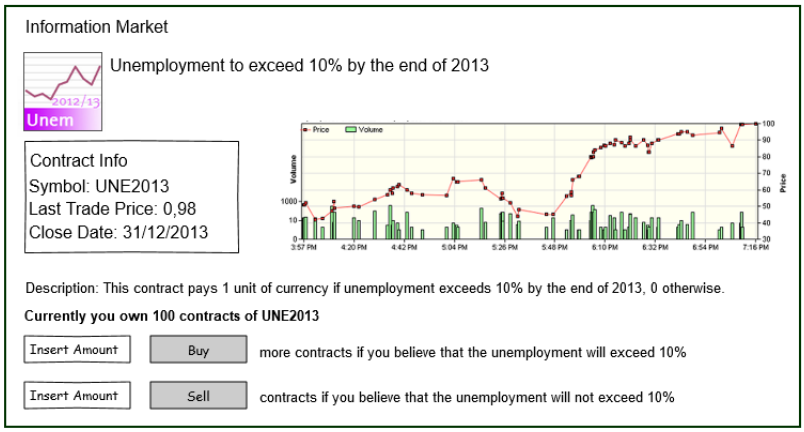

Figure 22: A mockup of an Information Market interface.

Figure 23 depicts a mindmap with all the elements of an information market. When deploying an IM all these elements need to be considered.

From a design perspective there are at least three types of IMs which can serve different goals: Prediction Markets, Decision Markets and Preference Markets. Each of these markets has contracts, trading mechanisms, payoff mechanisms and incentives. For a market to run participants or traders are needed. Each trader performs transactions in the market and has a portfolio consisting of stocks and money.

The interface to the participants commonly resembles a virtual stock market where one may access the contracts, the price evolution of the contracts, her or his portfolio and perform

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trading actions. Furthermore it is common to provide a 'hall of fame' where participants are ranked according to their performance.

The following sections provide an overview of the IM design elements and our vision for SYMPHONY. We analyse key recent contributions in each area and we discuss the elements we will be using or extending within the SYMPHONY project.

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Figure 23: A mindmap depicting all elements of an Information market.

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4.3.2.2 Current State of the Art and Practice

Types of information markets

Prediction markets aggregate forecasts of uncertain future events in order to obtain an accurate forecast (Graefe 2009). Participants trade shares according to their personal forecast and receive a reward at market end for the accuracy of their forecast. If participants are rational and act as utility maximizers, their interest is to contribute their best forecast and maximize their expected reward. Beneficial behaviour in this market type consists of the steps provided Figure 24 (Leutenmayr et al., 2013). A participant develops personal forecasts of the uncertain event, trades in the market in order to represent this forecast and updates his forecast and market portfolio in case s/he receives new information.

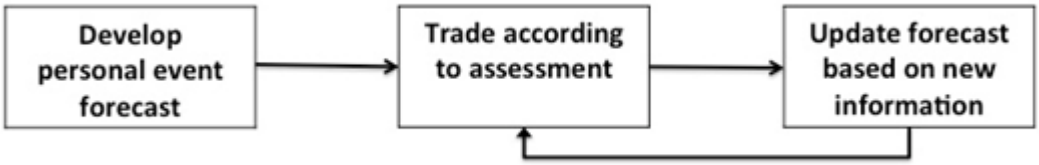

Figure 24: Behaviour model for prediction markets (adopted from Leutenmayr et al., 2013)

Applications of such markets can be political elections, sports events, sales of products (in such cases prediction markets are deployed in enterprise settings) and others (see Luckner et al., 2012).

Recently the use of prediction markets for macro-economic forecasting has been proposed by Teschner et al. (2011). The authors setup a prediction market that allows traders to provide forecasts on the Exports, GDP, Inflation, Investments and Unemployment in Germany. Their work focuses on problems met in a prediction markets for macroeconomic forecasting, namely contract specification and market liquidity. They compare the results of the proposed prediction market to forecasts provided by Bloomberg and find that the prediction market setting provides better results.

Decision Support Markets aggregate the assessments of participants on the options of a pending decision and produce highlight the collectively selected option. In decision markets, participants buy shares of the decision options they approve of and sell shares of the options they do not favour. Contrary to prediction markets, decision markets offer rewards based on the influence participants have on the final decision. Figure 25 shows the behaviour in decision markets. A participant develops his own opinion on the given decision options, trades shares in order to represent this opinion in the market and potentially updates his opinion on the arrival of new information. In this case, participants are assumed to derive their utility from the influence they exert on the decision result and thus to maximize the realization of their personal favourite.

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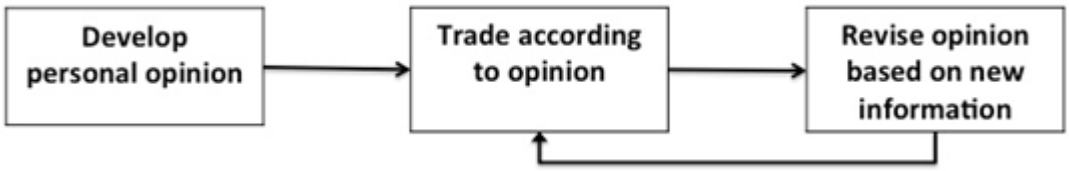

Figure 25: Behaviour model for decision markets (adopted from Leutenmayr et al., 2013)

Preference Aggregation Markets aggregate the preferences of a group of people on a given topic such as product features and provide a collective preference indication (Dahan et al., 2007). Ideally, participants buy shares of the preference options they favour and sell shares of the undesired ones. In such markets, however, an external event is missing for establishing the reward for the participants. Thus, participants are often rewarded based on a comparison of their preference ranking with the final market outcome. This type of rewards can lead to a Keynesian Beauty Contest[12] where participants guess the voting of others and adjust their voting to take advantage of it. Preference markets with such rewards aggregate individual forecasts on the group's preference ranking rather than individual preference rankings (Dahan et al., 2010 – see Figure 26).

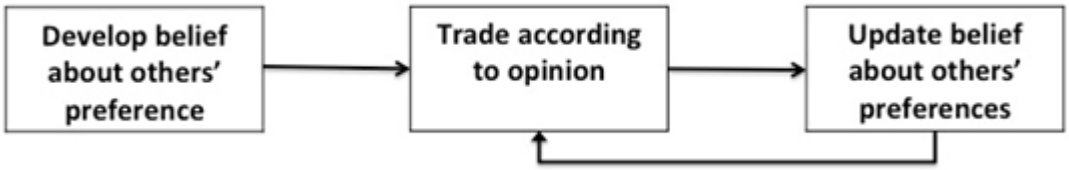

Figure 26: Behaviour model for preference markets (adopted from Leutenmayr et al., 2013)

Trading Mechanisms

Trading mechanisms define the rules of how to match demand and supply, influencing the price of the shares and therewith, predictions. In this section we provide a short description of the most common mechanisms.

Double auctions (DAs). In DAs, traders submit orders with a chosen fixed quantity of shares, usually with a price limit, into the order book. If no price limit is specified, the order is referred to as market order. Orders with a limit are called limit orders. If a matching order is found, then the price bid in the buy order is at least as high as the ask price of the sell order, and the order could be and is usually immediately executed. If no matching order is available, the order stays in the order book and remains there until it expires, is matched with a counteroffer, or is removed (Madhavan, 1992). The most common DA is the continuous DA or CDA, which clears immediately matching orders. This form of DA is suitable for liquid market where there are enough orders. In cases of low liquidity the alternative is to gather orders for a certain period of time, and then perform execution according to a

12 http://www.economicsnetwork.ac.uk/sites/default/files/Ashley/6%20References%20for%20KBC.pdf

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priority rule, e.g. the principle of the highest executable volume, at given points in time. This concept is known as call auctions (CAs).

Market Scoring Rules (MSR) are based on the concept of scoring rules (Hanson, 2002). The mechanisms rewards participants based on their forecasting accuracy and provides incentives to reveal subjectively accurate predictions. The basic idea of market scoring rules is that forecasters give successive predictions on one particular forecasting goal by adjusting the former most current prediction. The amount this forecaster receives for his prediction is the improvement of prediction, which can be negative, if it turns out the forecaster has moved the prediction in the "wrong" direction, i.e., farther away from the actual outcome than his predecessor has forecasted. This concept of moving probability estimates can be modelled by introducing shares of underlying events which can be traded. The market scoring rules function acts as an automated market maker (AMM) which means that participants' orders can be executed when submitted even if there are no matching order by other participants. Furthermore, although markets running a MSR have to be subsidized by e.g. the administrator, losses are limited, and an upper bound for losses can be determined.

Dynamic Pari-Mutuel Market (DPM) is based on the concept of standard pari-mutuel markets. There markets such as horse races, are known to be able to aggregate information efficiently at one point in time (Pennock, 2004). The algorithm extends standard pari-mutuel markets by allowing updates of predictions on the arrival of new information, such as news (Slamka et al., 2008) by introducing dynamic prices for shares of the final amount of money. The price of a share depends on the number of shares in the market and on the utilized continuous price function (Soukhoroukova et al., 2010). As in the standard pari-mutuel market, all money is redistributed over all winning shares and the price of a share does not directly correspond to actual probabilities, but has to be transformed into probabilities.

Dynamic Price Adjustment (DPA) offers an equal buy and sell price for up to a certain maximum quantity without implementing a continuous price function (Slamca et al., 2009). After the transaction, a new price is calculated depending on the last executed trades within a moving window. E.g., if a purchase occurred, the price will rise, and it will rise even more if the last transactions were also purchases, indicating an increase in the underlying true value. However, this mechanism is not arbitrage free, meaning that by skilful trading, traders could exploit the mechanism and use it as "cash cow". Thus, measures against this kind of behaviour, such as a limiting buy and sell orders, have to be implemented. Another side effect is that the maximum loss of this AMM is not limited.

Hollywood Stock Exchange Mechanism (HSX). This mechanism has not been publicly described in every single detail; however, the basic idea has been published in three subsequent patents (Spann and Skiera, 2003). In a certain time frame and for a specific stock, buy and sell orders are collected, comparable to call auctions in financial markets, which is called the sweep period. However, they are not immediately executed. At the end of the time frame, a net-movement balance is determined, which essentially is the

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difference of the number of shares of buy orders minus the number of shares of sell orders. Thus, if this number is positive, demand for the stock is higher than supply, indicating a higher "true value" of the underlying stock. Then, the net-movement balance is multiplied by a factor, resulting in the projected price movement. The price movement can potentially be attenuated by a "Virtual Specialist" function if the movement is found to be too strong. The new price is calculated as the old price plus the price movement. At this point, the final buy/sell price for the orders in the elapsed time frame is calculated and the user can be informed about the final buy or sell price.

Contracts

Information Market contracts define how the outcome of an event is mapped to the payoff and provide the rules of how the final values are specified when the event realizes and the market closes. There are several contract types and each one may serve different goals. The selection of the specific contract type depends on the goal of the IM designer. The main difference between contract types is the payoff which can be distinguished to the following three (Wolfers and Zitzewitz, 2004): Winner-takes-all contracts, Linear or index contracts, Spread contracts.

Furthermore, contracts can be "conditional" and rely, as the name states, on conditional outcomes. If we consider a measurable set of possible future outcomes denoted by V1, V2, . . . , Vn, i index on these outcomes and a second set of outcomes denoted by E1, E2, . . . , Em, then if the second outcome is measured at the same time or before the first, we can define a set of conditional outcomes by Vi | Ej. Iowa Electronic Markets (http://tippie.uiowa.edu/iem/) has ran markets for conditional contracts with liquidation values depending on conditional election outcomes. One set of contracts was based on the (two-party) vote share for the Democratic nominee (presumably Clinton) versus the share for the Republican nominee conditional on Lamar Alexander being the Republican nominee. There were similar sets of contracts conditional on Bob Dole, Steve Forbes, Phil Gramm or "any other Republican nominee." Values of these contracts are forecasts of vote shares conditional on various potential Republican nominees in advance of the actual nomination. Thus, voters could have used these markets to identify and vote for the strongest contender instead of their favorite among the field of potential nominees. Similarly, the Republican party could have chosen the strongest nominee for the general election instead of the one that was most popular within the party itself.

Table 4 provides a summary of these contracts types and a related example:

Table 4: Summary of Information Market contracts and related examples.

Type	Example	Reward	Goal
Winner-takes all	"Product X will beat last year's sales".	€100 if event happens, else €0.	Probability of event to occur.

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Linear or index	"Percentage of total market share of product X next year".	€1 for every underlying base value point.	Mean value of Outcome.
Spread	"Product X's sales next year" expressed by "Product X's sales will raise more than y % next year".	Contract costs certain fixed amount. Pays off at twice the value, if spread is true, else €0.	Median value of outcome.
Conditional	€1 × the % of votes received by a nominee conditional on a specific person being the nominee.	Payoff is the percentage of votes received by the nominee conditional on the event that a specific person will be the nominee.	Probability of conditional outcomes.

Rewards

In IM the main types of rewards are performance based and outcome based.

Performance based rewards are suitable in contexts which can profit from obtaining a forecast on a given variable from a large group of people. Rewarding the forecast of the group's opinion as in the preferences markets described by Dahan et al. (2010) may also be the goal for a market application. Performance based rewards may consist of an in-market payment, a leaderboard ranking, and an after-market payoff. The reward is determined by comparing the respective forecast with the actual outcome of the forecast variable. The better the forecast of a participant is, the higher the payment the participant receives or the higher up in the leaderboard he ranks. As participants are assumed to be utility maximizing, they should aim at maximizing their reward by providing an accurate forecast. Although the performance-based reward should contribute to the achievement of the forecasting goal it is likely to bias the achievement of an aggregation of individual opinions (Luckner et al., 2012).

Outcome based rewards are applied in contexts where the goal is to obtain an aggregation of the sincere opinions of the participants. In such contexts, the market organizer does not seek forecasts from participants and the reward should come from the actual outcome of the market.

Incentives

Incentives in IMs are the means to foster participation and user engagement. Incentives can be provided in terms of bragging rights (for example a leader board publicly displayed where users want to be ranked highly), prizes (e.g. prizes are given to the best performing participants or to those who participate strongly in the market), monetary incentives (e.g. participants buy contracts using their own money).

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Monetary incentives cannot be easily applied due to legislation issues. Prizes and other non-monetary incentives can be given and past research has provided evidence that they are equally effective as monetary incentives.

Participants

Information markets have been mostly used to aggregate predictions from humans. In such settings, normally a web application is setup, participants are invited and they perform the trading actions.

Nonetheless, there is no reason why the mechanism cannot be used to aggregate predictions from software agents. This kind of settings are beginning to emerge. Perols et al. (2009) used an information market to combine predictions from machine classifiers. In their experiment, depending on the setting, the market mechanism either outperformed or performed on par with other benchmark combination mechanisms including simple average, weighted average, and majority. Dasgupta et al. (2012) consider the problem of information fusion from multiple sensors of different types with the objective of improving the confidence of inference tasks, such as object classification, performed from the data collected by the sensors. Their technique is based on distributed belief aggregation and they use a multiagent IM to solve the information fusion problem. Bothos et al. (2010), have utilized IMs in order to aggregate user preferences expressed in social media. The proposed approach considers agents that process user generated content and subsequently make transactions in an IM whereas the market acts as an aggregator of user opinions.

Yiftach and Malone (2012) combine human and software agents in an IM for combining human and model predictions. Their approach combines the best features of humans and machines: computers can use vast amounts of data to make predictions that are often more accurate than those by human experts, yet humans are more adept at processing unstructured information and at recognizing unusual circumstances and their consequences.

Applications

There are a number of commercial information markets for short and medium term forecasting, which have been applied successfully in various fields. Economics, politics and sports are the most common subject of the prediction markets, as they are the main people's interests. However, a few prediction markets incorporate more than one domain.

Apart from commercial purposes, it is observed that during the latest years, information markets for business have been set up. The interest of the private companies to implement the «wisdom of the crowd» in order to take policy decisions, has been prominently increased.

In this section we attempt to collect and classify the totality of the information markets applications based on Tziralis & Tatsiopoulos (2012), Luckner et al. (2014) and our own research.

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Table 5 Fields of application of information markets

Political information markets: Aggregate community's opinion about future political events		
Market	Description	Reference
Iowa Electronic Markets	US elections. Non-US elections (Russia, France)	http://tippie.uiowa.edu/iem/
UBC Election Stock Market	Provincial and federal elections in Canada	http://esm.ubc.ca/
Swedish EU PSM	Swedish 1994 EU referendum	Bohm et al. (1999)
Ipredict	NZ, US, UK and European elections, International politics	https://www.ipredict.co.nz/
Predictious	US presidential elections, Worlds politics	https://www.predictious.com/
Sauder School of Business Prediction Markets	Provincial and federal elections in Canada	https://predictionmarkets.ca/
GEM 90, GEM 91, GEM 94, GEM 98	Federal and regional elections in Germany	Luckner et al. (2011)
Wahlstreet, Wahlboerse	State elections in Germany	http://www.zeit.de/2005/30/wahlstreet
PassauerWahlbörse	Federal elections in Germany	Beckmann and Werding (1996)
NP02, TE03	National assembly and regional elections in Austria	Huber and Hauser (2005)
Austrian Political Stock Market	Austria's membership in the EU, federal elections, governing coalition	http://www.ebweb.at/apsm/
Sports information markets: Gather punters' beliefs about the outcomes of games, tournaments or championships		
BettingIn	Worldwide sports e.g. soccer, tennis, basketball	http://bettingin.com/
Tradesports	Worldwide sports prediction market, e.g. baseball, soccer, football	http://www.tradesports.com/

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Betfair	Soccer, tennis, horse racing, etc.	http://www.betfair.com/
Predictious	Football, basketball, cricket, ice hockey etc.	https://www.predictious.com/
PredictWise	Football, baseball, hockey, basketball etc.	http://www.predictwise.com/
Stoccer	Soccer FIFA World Cup	http://www.stoccer.com/
Hubdub	Football, baseball, basketball, hockey	http://www.hubdub.com/
FriendBet	Football, Formula, Ice Hockey, Handeball, Basketball	http://friendbet.com/
Bundesligabörse	Soccer	http://www.bundesligaboerse.net/
Entertainment information markets: Trade stocks about social topics, such as movies, music, TV shows.		
Hollywood Stock Exchange	Box office performance of movies	http://www.hsx.com/
Pick.fm	Social bets in pop culture	http://pick.fm/
Predictious	Nobel peace prize 2014, Pistorius trial, Eurovision 2014	https://www.predictious.com/
FriendBet	Danish TV Shows, Danish News	http://friendbet.com/
Science & Technology information markets: Make forecasts about consumers tech, aviation, space, extreme science, energy, environment, web trends or automotive.		
Scicast	Agriculture, Computational Sciences, Engineered Technologies, Information Systems, Physics, Space Sciences, Biology & Medicine, Chemistry, Energy, Mathematics, Social Sciences, Transportation	https://scicast.org/
Intrade	Science, technology	https://www.intrade.com/

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Foresight Exchange	Future developments in science and technology	http://www.ideosphere.com/
Tech Buzz Game	High-tech products, concepts, and trends	http://en.wikipedia.org/wiki/Tech_Buzz
simExchange	Video games	http://www.simexchange.com/
Business information markets: Private sector companies that have implemented internal or external information markets.		
Microsoft	Anticipated release dates or the number of software patches	Luckner et al. (2011)
HP	Sales forecasts	O'Leary (2013)
Google	Various questions such as the number of Gmail users	Cowgill et al. (2009)
Motorola	Products to take to market	Lindič et al. (2011)
General Electric	Questions about technology investment and new product development	Matzler et al. (2013)
Other Fields		
Guess2give	Set personal bets for charity fundraising	https://www.guess2give.com/
Betable	Personal tailored bets	https://betable.com/
Blogshares	Weblogs evaluation	http://www.blogshares.com/
Hurlos	Hurricane risk landfall in US	http://www.weatherrisksolutions.com/

As the global political agenda has focused to find a way to overcome the economic and ecosystem crises, the information markets which deal with these subjects increasingly being developed. In this regards, Table 6 provides a summary of the information markets that handle global systems issues namely economics and climate.

Table 6: Information Markets for Global Systems Science

Financial stability: Predict economic and financial variables e.g. GDP, stocks, bonds,

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currencies, unemployment etc.		
Market	Description	Reference
The Good Judgment Project	Geopolitics, Finances	http://www.goodjudgmentproject.com/
Nadex	Stock indices, Forex, Commodities	http://www.nadex.com/
Scicast	Economics, Business of Science	https://scicast.org/
Predictious	Precious metals, Bond market, Bitcoin, Alternate crypto-currencies	https://www.predictious.com/
Ipredict	NZ and US Economics, Financial markets	https://www.ipredict.co.nz/
Sauder School of Business Prediction Markets	Monetary policy of the Bank of Canada.	https://predictionmarkets.ca/
Sustainability issues: Access and communicate the implications of global climate science, e.g. global average temperature or sea level in 2020		
The Potsdam Climate EXchange	Climate events	http://www.potsdamclimateexchange.org/
Copenhagen Prediction Market	Climate change	http://www.coppm.org/public/
Scicast	Global Change	https://scicast.org/

The majority of the applications for tasks about economics and climate are addressed to experts or relevant qualified persons, because of the specialized questions. For example, Scicast project inquires participant's personal background information in order to increase the outcomes accuracy.

Discussion

A large part of academic research has focused on the ability of the information markets to provide accurate forecasts of uncertain events. Specifically, Snowberg et al. (2012) conducted a number of case studies about prediction markets, which run on macroeconomics, politics and business. The results showed that the predictions of the

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information markets have smaller mean absolute error and mean squared error than the surveys, polls and company's official forecasts.

Moreover, Berg et al. (2008) attempt to show through numerous observations the predictive accuracy for election vote months in advance. Their work demonstrates the absolute accuracy not only in very short horizons, but the long run forecasting ability. Comparing market prices to polls, they conclude that information market prices aggregate data better than simple surveys where the results are interpreted using sampling theory.

Gjerstad et al. (2005) have also shown that information markets are very close to the mean belief of market participants if the agents are risk averse and the distribution of beliefs is spread out. On the other hand, Manski et al. (2006) show mathematically that under a few assumptions the predictions of an information market offering all-or-nothing contracts do not actually correspond to the mean participants' beliefs unless the prices are near zero or one. Results of a set of time series tests in the same mechanism but in different domains shows that sports game contracts are not so accurate than financial contracts. As Tetlock, P. (2004) states in his research, this inefficiency is mainly based on the fact that the financial information markets are not under investments or hedge.

4.3.2.3 Research focus in SYMPHONY

In SYMPHONY we will setup prediction markets for macroeconomic variables following Teschner et al. (2011). Furthermore we plan to design a combinatorial outcome space, which will provide traders with numerous outcomes to bet. To this direction we will rely on the work of Miroslav et al. (2013).

In addition to the above, we intend to establish prediction market settings for decision support and preference aggregation. These markets will focus on issues of sustainability transition and will provide a tool for users to aggregate information on issues like regulatory settings and environmental policy modelling. To this direction we will consider designs that use the market metaphor but do not resemble a stock market setting. A similar approach has been followed by Kneissl et al. (2012) in the platform Metropolitalia that is developed for linguistic field research on the Italian language. In this platform users can –amongst others– create so called assessments consisting of a phrase, its geographical region, and an estimation of how many other users agree to the user's assessment, i.e., choose the same, or a similar, geographical region. This estimation is a prediction of how other users characterize the phrase. The closer the estimation is to the real agreement proportion, the more money the assessment is worth (see Figure 5). As a consequence, success on Metropolitalia depends on how one is skilled at forecasting others' conceptions.

As regards the trading mechanism implementation, we will select the appropriate market type. Our intent is not necessarily to invent new mechanisms however, we will consider extending existing mechanisms if required in order to address the requirements specified in the project.

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Moreover, our intention in SYMPHONY is to establish a set of rules to assist policy makers in defining contracts, which will be able to aggregate information according to the question at hand. We will extend the work of Teschner et al. (2011) who identify bias issues when contracts for macro variables are defined. Furthermore we will examine the use of conditional contracts for preference aggregation and decision support in IM settings. Such types of contracts have not been explored but can generate insight regarding the opinions of the public and related stakeholders.

The reward that we intent to apply in SYMPHONY is a leaderboard. After the outcome to a question is known and made public, participants who answered correctly will be rewarded and move up on the leaderboard. Moreover, the more correct forecasts a participant makes, the more influence she/he will have in other forecasts. However, we will experiment with other available rewards and we will extend them, if needed.

Last but not least we aspire to will extend the work of Yiftach and Malone (2012) in order to combine information from human and software agents in an IM environment for policy makers.

Figure 27 summarizes our vision for the SYMPHONY IMs. The main component is an IM that contains all the required elements. The IM can support human and software agents who act as participants. Policy analysts and policy makers configure the IM in order to aggregate information for issues of Sustainability transition and financial Stability.

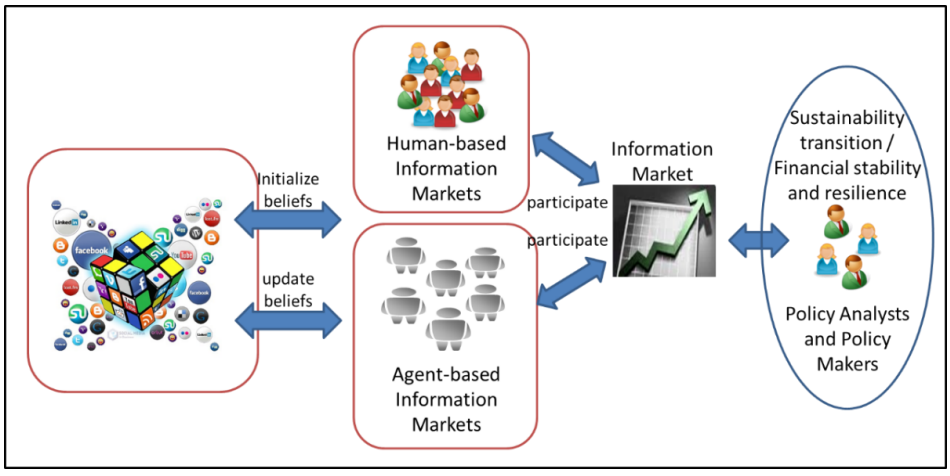

Figure 27: Our vision for the SYMPHONY Information Market.

Table 7 summarizes the elements of an Information Market and the proposed work for SYPMHONY.

Table 7: Overview of research directions for Information Markets in SYMPHONY

Information Market Design Aspects	Research vision for SYMPHONY

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Types of Information Markets	- Design and implement IMs for Macro Economic Variables and Financial Stability - Design and implement IMs for decision support and preference aggregation on issues of sustainability transition
Trading Mechanisms	Select appropriate trading mechanisms for the SYMPHONY use cases
Contracts	- Design contracts able to aggregate information for the SYMPHONY use cases - Specify guidelines for policy modellers and policy analysts in order to support the design of new contracts
Rewards	Experiment with alternative reward types and select those suitable for SYMPHONY
Incentives	- Gamify the user experience to foster participation - Consider approaches that use the market metaphor
Participants	Design and implement mixed IMs where participants are human and software agents

4.3.3 Agent-Based Engine

4.3.3.1 Overview of the Component

Agent based models (ABMs) are computerized simulations of a number of decision makers (agents) and institutions, which interact through prescribed rules (Farmer and Foley, 2009). The agents may represent various entities and institutions including consumers, policy-makers, banks and governments and act according to rules specifying their behaviour while considering their current situation and the stated of the - artificial - world where they live. ABMs do not rely on the assumption that the economy will move towards a predetermined equilibrium state, as other models do and can handle a wider range of nonlinear behaviour than conventional equilibrium models. Moreover, with the use of ABMs, policy-makers can simulate an artificial economy under different policy scenarios and quantitatively explore their consequences.

In SYMPHONY we will make use and extend the EURACE macro agent-based model (Cincotti et al., 2012a) which is a software platform where the economy is represented as a system of interacting agents. The agent-based model of the economy incorporates different economic models characterised by the following features: they are composed of interacting agents, these agents may have behavioural rules and the interaction among the agents means that aggregate phenomena are intrinsically different from individual behaviour. In this respect, the network which governs the interaction is crucial. With the software platform, large-scale

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agent-based simulations on high performance computer are performed and computational experiment with different macroeconomic policy scenarios are investigated.

The EURACE model represents a fully integrated macro-economy consisting of the real sector, the credit sector, the financial sector, the public sector, the foreign sector, the real estate sector and the environment in order to introduce sustainability aspects.

The real sector represents the production of consumption and capital goods with labour, the capital goods and energy as factors of production and relative markets, and the technological innovation, whereas the credit sector, the financing production plans of firms. The financial sector consists of the exchange of claims on the equity capital of producers as well as of governments' liabilities, whereas the public sector models the policy making, i.e., the fiscal policy made by Governments and the monetary policy set by the Central Bank. Finally the foreign sector introduces the possibility of exchanges between different country and thus the application of different economic policies, the real estate sector, the possibility to buy and sell house and the environment the sustainability aspects.

4.3.3.2 Current State of the Art and Practice

The last economic crisis has led to a lot of questioning about the economic theory and in particular about macroeconomics and economic policy. The mainstream macroeconomics, based on Dynamic Stochastic General Equilibrium - DSGE models, appear to be unable to deal with the Great Financial crisis we are facing. DSGE models entirely rely on very strong and unreal assumptions, e.g. rational expectations, representative agents, perfect markets etc., hence they are not able to include endogenous interplay between the real economy and financial markets. Moreover they only consider the finance as a friction or as an exogenous shock. Consequently due to very strong interactions between the financial market and the real economy, DSGE models were neither able to forecast the current crisis nor to provide any useful advice to policy makers in order to overcome the crisis. However in the last two decades many scholars have been developing a new paradigm called "Agent-Based Computational Economics" – ACE which provides strong and unreal assumptions imposed on agents' behaviour and brings more economic meaning to an economic model. The class of models used by ACE, called Agent Based Models – ABMs, is based on heterogeneous agent assumption, where each agent make a decision independently using the adaptive expectation approach and interact with other agents on a particular market. This kind of approach allows us to better understand interactions between agents, to model the different type of market structure as well as to perform the analysis out of equilibrium. Even though DSGE models have been developed more intensively than ABMs, the new approach already gave significant results in many macroeconomics policy areas such as fiscal policy, monetary policy, bank regulation and central bank independence. The remainder of the paper presents Agent Based and DSGE models in more details, discusses their theoretical, empirical and political-economy issues, provides the state of arts and concluding remarks.

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DSGE models

Current DSGE models are based on two business cycle theories – the Real Business Cycle (RBC) perspective (see King and Rebelo, 1999) as well as the New Keynesian Paradigm (Mankiw and Romer, 1991). Basically this is an augmented RBC-DSGE model with monopolistic competition, nominal imperfections and a monetary policy role called a New Neoclassical Synthesis – NNS (see Goodfriend and King, 1997). According to RBC theory the starting point of the models is a stochastic version of the standard neoclassical growth model with labour supply. The economy is populated by an infinitely lived representative household who maximize its utility function with respect to intertemporal budget constraint and by a large number of firms who maximize the profit and whose homogeneous production technology is affected by exogenous shocks. All agents make decisions based on rational expectation. On the top of RBC, the New Keynesian theory brings to the model money, monopolistic competition and sticky prices. However money usually has the function of unit of account and its impact on real variables in economy in the first place depend on how we define the household's utility function. In case of separable utility function where a change in money holding does not impact the marginal utility of consumption or leisure, the neutrality of money is guaranteed (see Novales, Fernandes and Ruiz, 2009). Recently, due to the strong interaction between financial markets and the real economy many authors tried to include the credit market into the model (see Curdia and Woodford, 2010, 2011; Christiano et al., 2011; Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011). From the theoretical perspective DSGE models are General Equilibrium models and their solution strongly depend on the representative agent assumption. Solving DSGE models means calculating the system of difference equations which requires checking whether the solution of the system of equilibrium conditions of a DSGE model exist and is determinate. Once the solution is found, one should access the empirical performance of the model and calibrate the parameters and then perform the policy exercise. DSGE models enable us to observe the response of variables to the exogenous shock, (e.g. monetary policy shock), assuming that the system will go back to the steady state after the certain period of time. From the empirical point of view, DSGE models totally failed to account for the current crisis. One reason for the big failure is that macroeconomics time series distributions are well approximated by fat tail densities (Fagiolo et al., 2008), however DSGE models usually assume Gaussian distributed shocks. Moreover, Ascari et al. (2012) shows that even if the fat-tailed Laplace shock is assumed, the distribution of the time series produced by DSGE models have thinner tails than distributions in real data. Furthermore DSGE models have many potential misspecifications of the statistical model (see Fukac and Pagan, 2006; Favero, 2007) due to many persistent shocks, employed standard maximum likelihood estimation, etc. Therefore miss specified statistical model are not able to produce significant policy analyses because these are carried by a Data Generating Process (DGP) which is very different from those observed in time-series data. In general the majority of critique of DSGE models (see Howitt, 2011, Stiglitz, 2011, Hendry and Minzon, 2010, Akerlof, 2002) is still addressed to the unrealistic framework, particularly: that agents perfectly know the model when they make decisions, agents are able to understand and solve any problem, and

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agents know that all other agents behave on the same way; which hampers us to study and better understand the market structures and agents' behaviour.

ABMs

In order to overcome unrealistic assumptions in DSGE models, AB approach bring new features into models and provide a much richer structure. Therefore the ABMs allow for better understanding the impact of agents' behaviour on the aggregate output. Fagiolo and Roventini (2012) point out the main ten ingredients that tend to characterize economic AB models: i) a bottom up perspective, ii) heterogeneity of agents, iii) the evolving complex system approach, iv) non-linearity, v) direct (endogenous) interactions, vi) bounded rationality, vii) the nature of learning, viii) true dynamics, ix) endogenous and persistent novelty and x) selection based market mechanism. Including all the above mentioned features, ABMs have shown to be able to investigate the link between the real economy and the financial aspect (see Riccetti et al. 2011, Delli Gatti et al. 2010, Cincotti et al. 2012, Riccetti et al. 2012, Teglio et al. 2012) which is the promising feature in the current financial crisis. Opposite to DSGE models, ABMs do not impose any strong theoretical requirement; therefore they do not require the analytical solution. Moreover ABMs allow us to replace assumptions in a modular way if the model does not perform as expected. From an empirical point of view, ABMs allow to validate the inputs by setting the assumptions about individual behaviours and interactions similar to the observed ones and to validate the output by setting the parameters, individual behaviours and interactions and initial conditions in order to replicate stylized fact of interests. Due to their flexibility, there is an increasing interest for ABMs which deal with policy issues. Particularly they are used for studding the macroeconomics policy areas such as fiscal policy, monetary policy, bank regulation and central bank independence. Two foremost models in the ABMs' literature are: one developed by Giovanni Dosi group (see Dosi et al., 2010, 2012) which brings Keynesian theory of demand-generation and Schumpeterian theories of technology-fuelled economic growth (the K+S model) and the EURACE model. As a current state of the art and ongoing research "SYMPHONY project" should be considered as well. The project aims to create richer expectation formation process among agents. In short the project will provide the empirical foundation of expectation formation using the social media mining and web-based information market outcomes. Once the expectations are defined, the project will employ a multi-country agent-based model simulator, run through a game like interface for participants to explore. Each individual will play one agent in an economy which will allow gathering real-time information from citizens-players connected to the game. This innovative feature will give to policy makers a ground breaking tool for simulating policy measures, taking into account their impact on citizens' expectations, and therefore refining their decisions accordingly. A virtuous cycle could be determined at the end, where citizens' expectations are aligned with policy makers' decisions and fulfilled. As a model simulator the project will engage existing EURACE model which will be extended for various features.

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A review of EURACE and K+S model

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), see Cincotti et al. (2012a). The agents behave in line with the standard agent-based framework i.e. they follow bounded rationality and adaptive expectation behaviour. Furthermore a key modelling paradigm which is followed in EURACE model is the balance-sheet approach and the stock flow consistency checks. All above mention features enable researches to use the model as an exceptional laboratory for performing policy exercises and policy design. In particular, EURACE shows the emergence of endogenous business cycles which are mainly due to the interplay between real economic activity and its financing through the credit market, thus shedding light on the relation between debt, leverage and main economic indicators (Raberto et al., 2012, Teglio et al. 2012). Furthermore EURACE shows that a quantitative easing monetary policy coupled with a loose fiscal policy generally provides better macroeconomic performance in terms of real variables, despite higher wage and inflation rates (see Cincotti et al., 2010). However EURACE model currently includes only one country, hence for the purposes of SYMPHONY project, the model will be extended to be able to provide multi-country agent-based framework. On the other hand K+S model, developed by Giovanni Dosi's group, is grounded on the Keynesian theory of demand generation and Schumpeterian theories of technology-fuelled economic growth. Hence the model enables for studying many properties of macroeconomic dynamics, the impact of public policies on supply, demand and the fundamentals of the economy (see Dosi et al., 2010). Moreover Dosi et al. (2012) shows the relationship between income distribution and monetary and fiscal policies using a credit-augmented version of the K+S model. Therefore Symphony project will consider inter alia including the technology innovation feature in current EURACE model as well.

Conclusion

The mainstream macroeconomics has been primarily focused on developing macroeconomics models within DSGE framework. Unfortunately during the Great Financial crisis those models were unable to give any explanation or advice to policy makers; in short they failed to predict and explain the crises. Although a lot of effort was put in developing appropriate DSGE models they are still unable to give the answer. Meanwhile, many scholars have been developing Agent Based models which are more real and able to explain many interesting features of the global economy environment. Nevertheless, the ABMs come with open issues that should be addressed, such as over-parameterization and calibration. However the ABMs stand as very promising approach regarding the explanation and solution to the Great Financial crisis.

4.3.3.3 Research focus in SYMPHONY

The research focus in SYMPHONY is to design and develop a large-scale agent-based model, grounded on the EURACE model, able to explain the functioning of a financial economy from

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the bottom-up, with a particular focus on modelling and investigating the interplay between the financial and real sectors of the economy. The ABM model, as a part of the SYMPHONY platform, will be also able to initialize agents' preferences and expectations according to inputs provided by information markets and social media outcomes.

The ABM model in the platform will be used as a valuable computational laboratory where to simulate different policy scenarios regarding financial, economic, and environmental issues under investigation. In this respect, particular attention will be devoted to investigate appropriate monetary, fiscal and regulatory policy able to recover an economy after collapse in assets values and a consequent severe financial crisis, to prevent new financial crises or mitigate their duration and effects by increasing the overall resilience of the economy, and finally to trigger a sustainability transition toward a financially and environmentally sustainable growth. Moreover, a multi-country version of the current agent-based model will be designed, implemented and calibrated on the European economic scenario characterized by a single currency. Figure 28 summarizes the enriched EURACE macro model. The circle represent the agents, the square the markets and the arrows the demand and supply. In particular the role of each building block is explained in the following.

Agents

Each agent is characterized by a double-entry balance sheet with a detailed account of all monetary and real assets as well as monetary liabilities. Monetary and real flows given by agents' behaviours and interactions determine the period by period balance sheet dynamics. A stock-flow model is then created and used to check that all monetary and real flows are accounted for, and that all changes to stock variables are consistent with these flows. This provides us with a solid and economically well-founded methodology to test the consistency of the model and it increases the credibility of results. The balance sheets of all agents is shown in Table 8.

Households

Households act as consumers and workers. Both the consumption goods and labor markets are decentralized with price and wage dispersion. Households buy homogeneous consumption goods from consumption goods producers according to their consumption budget and provide a homogeneous labour force to consumption goods producers, constructions firms and capital goods producers. Producers with a positive labour demand raise their wage offer in order to keep their present workers as well as to attract new ones, and post open job positions. Conversely, producers with a negative labour demand fire workers that are in excess of their need. The selection of fired workers is random. In the turnover phase, a set of employee is randomly selected to look for new and better paid positions at different employers. These employees decide to fill a new position if it is paid better than the present one. After the turnover phase is over, unemployed households are randomly queued in the market to look for the remaining open positions, if any, and to fill them.

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Households buy electricity and fossil fuels in their respective markets for lighting, transportation and heating. Households can invest in the stock and in the government bond markets and can own funds shares.

Generally speaking, households act according to rules that use backward looking expectations. In particular, in the financial market, the decisions are based on prospect theory, whereas the savings and consumption decisions are based on empirically-founded rules derived from the buffer-stock theory of consumption (Deaton (1991) and Carrol (1993)), finally the purchasing decisions of households are modelled using standard logit-models from the marketing literature.

Finally, households can invest in new housing units built by construction firms or they can buy or sell housing units in the housing market. The bulk of demand and supply of housing is made by households who are selected to enter the market as buyers or sellers. This models the trading activities driven not by speculative reasons but by different reasons, like family, needs, migration.

Producers

Different types of producers (or firms) will be considered in the enriched Eurace model, namely consumption goods producers (CGPs), capital goods producers (KGPs), construction firms and power producers. CGPs employ labour, capital goods, electricity and raw materials to produce a homogeneous consumption good according to their production plan. Construction firms employ labour, capital goods and raw materials to produce new housing units. Power producers employ capital goods and fossil fuels to produce electricity. Capital goods producers employ labour, electricity and raw materials to produce new investment goods for the other producers.

All producers act as price setters in their respective sale markets and supply their output following a short-term profit maximizing behaviour. Prices are set considering a mark-up on unit costs. Consumption goods producers and construction firms form backward looking expectations about demand, while both power and capital goods producers produce on order.

All producers can also borrow money from banks in order to pay production factors and make investments. All producers are modelled as corporations whose share are public and traded in the stock market. Producers can also issue new share to finance their activities if rationed in the credit market.

If producers end with a net worth (equity) below zero they are considered bankrupt. In this case the producer exits the economy, its employees are laid off, shareholders wiped-out, and its debt is partially written off causing a loss for the lending bank as well. However, a new producer of the same type enters the economy after a lag period with the physical capital inherited from the bankrupted one.

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Banks

Banks supply loans to all types of producers to finance their operations and provide mortgages to households to finance their purchase of housing units; banks also collect private sector deposits (i.e., the liquidity of all private agents) and may borrow from the central bank if in shortage of liquidity through a standing facility. Lending activity by banks is constrained by a minimum capital requirement and depends also on the evaluation of the balance sheet of the borrower.

In the market for loans, producers apply for credit first to their preferred bank, then if rationed to another selected bank. If the producers are rationed by both their preferred bank and by a second bank, they will be forced to cut their dividend payment. If this is not enough to cover the interest payment on loans the producers will look to the Equity Fund for additional equity to continue their operations

Finally, mortgages are the financial instruments that households use to borrow from banks for buying housing units. Households ask for a mortgage for the purchase of new housing units if they are not endowed with enough liquidity. Beside the equity ratio, households must satisfy an additional requirement to get a mortgage, i.e., households need to show to be able to pay the costs (interests and principal repayment) of all their mortgages, including the new one, given their present income and the present mortgage rate. Like for producers, any household has its preferred bank to whom asking for a mortgage. Waste and CO2 emissions are a by-product of production by all types of producers.

Policy makers: Central Bank and the Government

The Central Bank is responsible for the monetary policy and sets the interest rate, on a monthly basis according to a Taylor rule. The Taylor rule takes into account both the unemployment rate, as a proxy for the output gap, and the rate of inflation. The Central Bank acts as a liquidity provider for the banking sector. If the banks need liquidity they can draw upon the Central Bank credit line (standing facility) at any time and without limit. The central bank can also perform unconventional monetary policy based on bond purchases like quantitative easing.

The government is responsible of the fiscal policy that is determined adaptively on a yearly basis according to the budget and debt to GDP targets. The government can issue infinitely lived bonds to finance its budget deficit. Fiscal policy is implemented by setting tax rates on consumption (VAT), and on both labour and capital income. Tax revenues are paid back to households, both as general transfer benefits, distributed equally among all households, and as unemployment benefits, given to unemployed households. The government decides also the environmental policy by setting environmental taxes as well as fiscal incentives, and by setting the long-term targets about CO2 emission, share of renewable energy production and eco-efficiency.

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Funds

The role of funds in the EURACE ABM model is to invest in producers and bank stocks as well as in ABSs (Asset Backed Securities) in order to create and sell fund shares to the households. Fund shares should be created as a composition of different assets, with the aim of the risk diversification. The funds should link the financial and derivative market with the investment market. Shares sold to investor should spread the systemic risk to a big part of economy and an higher demand of derivative products such as ABSs, would influence the willing of the banks to lend money to households, amplifying the credit cycles.

Financial Vehicle Corporations (FVCs)

Financial Vehicle Corporations in the enriched EURACE model will purchase mortgages or loans from banks and will issue Asset Backed Securities. Those financial instruments can be used to pay banks loans or to be sold to funds, thus increasing investment markets. Therefore securitization market in EURACE passes through the FVCs. ABSs market influence the banks in their decision to retain or not those instruments, thus affecting the willing of the credit institutions to lend money.

Mining Company

The Mining Company is an agent inside the Eurace economy that extract the fossil fuels and raw materials from the environment and sell them in the relevant markets to households and different producers. Moreover they employ resources from the environment producing waste. The introduction of the environment let to take into account the sustainability aspects.

Foreign sector

The foreign sector introduces the possibility of exchanges of both real goods and financial assets with an external economy. It also provides fossil fuels and raw materials to all agents.

Markets

In the enriched Eurace ABM model, markets represent the place where agents interact. Markets are based on a decentralized exchange with pairwise trading and price dispersion, except for electricity, financial and fossil fuels markets where a centralized Walrasian auctioneer operates and a single price is set at the intersection of the demand and supply curves. In decentralized markets, prices are set by agents on the supply side, by considering a mark-up on unit costs.

In the consumption goods markets, consumption goods producer offer their products to households/consumers.

In the labour market, producers post job vacancies based on planned output. Searching workers send applications based on posted salaries. Firms rank applications based on skills and make offers. Workers rank offers (wage – commuting costs), compare best offer to their reservation wage and accept or reject the job.

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In the financial market, households trade stocks and bonds with a strategy based on the prospect theory. Firms issue or buyback stocks and the governments issue bonds when needed. The assets prices are set by a clearing house and the financial market is global. Funds and FVCs also operate in the financial markets with complex derivatives products.

In the credit market, the banks provide loans to households, all types of producers, and to the mining company.

In the capital goods market, the capital goods producers and the foreign sectors sell their product that are bought by constructions firms, power producers and consumption goods producers.

In the raw material market, the mining company and the foreign sector sell their productions that are bought by construction firms, consumption goods producers and capital goods producers.

In the fossil fuel market, the mining company and the foreign sector sell fossil fuels to power producers and households (for heating and transportation).

In the real estate market, households buy and sell housing units among them and can buy also the new ones produced by the construction firms.

In the electricity market, the power producers sell electricity to producers and households. The market is centralized and price is set on a monthly basis at the intersection of the demand and supply curves. The size of demand is given by the amount of production and by the number of households. Demand is then considered as inelastic. The price will then depend on the unit costs of the marginal power producer.

Finally, an important issue for the sustainability use case is to introduce carbon emissions and a price for carbon into the model. Carbon emissions can be considered as a waste product from production of all firms and also from households. For firms we are planning to introduce CO2 emissions in terms of tons of CO2 per output or per GDP (maybe differentiated by sector, such as electricity production, capital goods producers, consumption goods producers). For households the emissions can be introduced as tons of CO2 per unit of housing they own

As next step, we would introduce a price on carbon. This can be done in different ways:

1) As a tax, which is the current approach in most climate-economic models. Then we can either add a constraint to the model by setting a maximum amount of carbon which can be emitted. Actors will adapt their production and investment decisions accordingly and a certain price for carbon will result from this (which can be understood as the marginal price of the last ton of carbon that someone is willing to pay, in order to produce this amount of carbon). Or we can set a specific price per ton of carbon, then the result will be a certain amount of carbon, all actors would produce at this price (can be higher or lower than the

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target). The second approach is less useful, when we want to analyse a specific CO2 target, hence determine the amount of carbon emissions.

2) Via a market for carbon emissions, where producers receive a certain amount of allowances (which is in line with the overall emissions target). The allowances will be auctioned or sold by the government, which then has an additional revenue. If they emit less than their allowance level, they can sell certificates on the market, if they emit more, they have to buy certificates. The market price will be determined by supply and demand of emission certificates.

One of the two possibilities will be implemented in the course of the project. Another question then, is how the additional revenue from carbon will be reused by the government. Different options will be evaluated: it can be used to reduce labor taxes, or invested into additional energy efficiency measures or renewable energy (as a subsidy) or invested into research and technological development.

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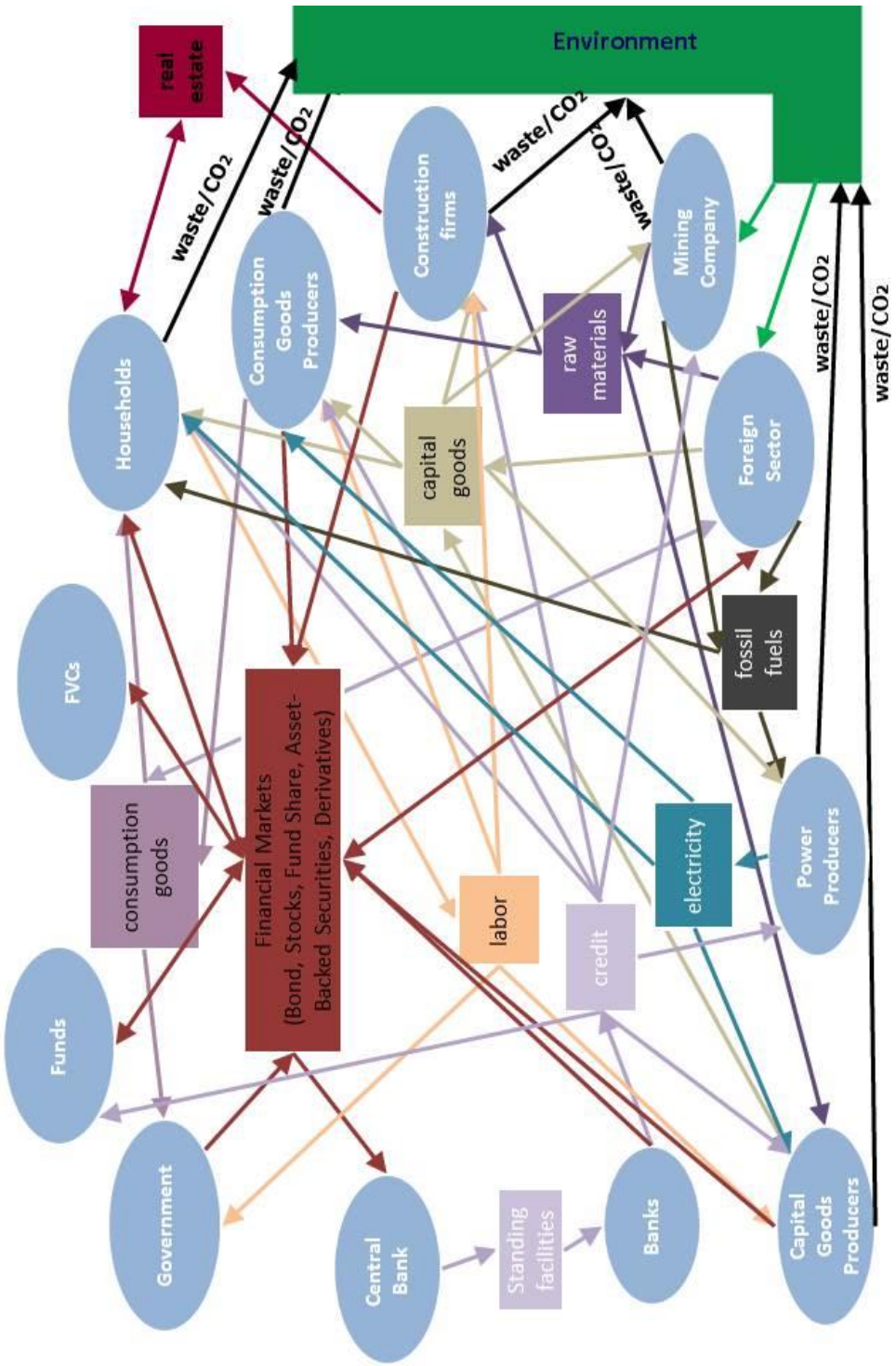

Figure 28: Overview of the enrich Eurace ABM model. The circles represent agents, the squares represent markets and the arrows represent demand and supply.

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Table 8: Balance Sheets of agents in the enrich EURACE model. Foreign Sector is a particular agent with no balance sheet constraint but with the purpose to record all financial assets and monetary flows of the EURACE economy with the outside. For this reason the Liabilities column is empty.

Agent	Assets	Liabilities
Household	Liquidity Equity Shares Gov Bonds Housing units Funds' shares	Mortgages Equity
Consumption Goods Producers (CGP)	Liquidity Capital goods Inventories	Loans Equity
Capital Goods Producers (KGP)	Liquidity	Equity
Construction firms	Liquidity Capital goods	Loans Equity
Power producers	Liquidity Capital goods	Loans Equity
Bank	Liquidity Loans Mortgages	Deposits (Liquidity of Hous. CGP and KGP) Standing facility with the CB Equity
Government	Liquidity	Bonds Equity
Central Bank	Liquidity Standing facility with Banks Gov bonds	Outstanding fiat money Deposits (Liquidity of Banks and the Gov) Equity
Funds	Liquidity Gov Bonds Stocks Derivatives	Loans Equity
Mining Company	Liquidity Capital goods	Equity
Financial Vehicle Corporations (FVCs)	Liquidity Loans Mortgages	Assets-backed debt securities Equity
Foreign Sector	Liquidity Stocks Gov Bond Derivatives	

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4.3.4 Policy Modelling Gamification

4.3.4.1 Overview of the Component

The Objective

Our outline objective is to provide an enhanced user experience through a gamification layer that enables policy makers and citizens to engage with SYMPHONY's macro-economic engine in an easy to grasp, more meaningful and visually appealing way.

Through reducing the complexity of engaging with the agent-based model (ABM) to a set of simple and intuitive graphical interfaces supported by gaming mechanisms, we will guide the user through different scenario sets. These scenarios are created by key stakeholders using SYMPHONY's Admin Dashboards.

We aim to provide a playful experience that increases users' propensity for exploration and experimentation with monetary policy ideas and economic roles and decisions, helping to further insight.

Policy Game Introduction

Policy games can provide a safe environment where people can play key roles in confronting major issues and bring their knowledge and skills to the forefront of the strategic debate. Economic policy modelling and analysis is a complex process. The ability to grasp a complete understanding or experimenting with macro-economy of multiple countries and economic actors is a difficult process for which a number of economy modelling tools exist. Economy modelling tools are however rife with complexity in terms of usability and users' ability to comprehend what is being presented on screen. These tools require specialized skills and expert-level knowledge which can often only be gained through expertise and experience in the field.

The SYMPHONY game provides a user friendly interface to engage with the ABM, reducing data noise and clutter to prevent overwhelming players. It provides meta-games through goals and scores to encourage evaluation of a broad set of policy options and economic actions. We use game design methodology to translate complex financial data into a set of playful user interface patterns which the user can easily grasp and extract decision critical information from.

The SYMPHONY game offers a new experience for policy decision making. In particular, we will be focusing on providing playful interfaces for which both citizens and policy makers can experiment with new policy ideas and take a variety of roles within the simulated economy in order to gain deeper insights into the potential macro level and micro level impacts of their decisions.

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Data Driven Gameplay

Data Driven Games can be seen as any game that separates the game code from its content. In the SYMPHONY the game will be driven by the ABM where a connector provides information feeding the game visualisation and feedback through the interface is sent back to the ABM. The meta-games which incorporate goals and encourage exploration and experimentations however sit within the gaming environment with no impact on the simulation.

The ABM has hundreds of variables, most of which are entirely hidden from the players whilst in game. Our approach is to only display decision critical values, and to incorporate only those variables which can be manipulated, thereby considerably reducing the complexity of interacting with the ABM from the players' perspective.

Although the ABM drives the economic simulation it does not provide a playful experience, this is provided by a set of game mechanics within the SYMPHONY game. These mechanics define the rules and processes which together form the gameplay. The game mechanics we utilise in the design of the experience will react and report the data provided by the ABM and form a framework for feedback to the player which provides a meta-level goal-based gameplay. Using key performance indicators from the ABM as goals and objectives to explore, achieve and discuss.

Thus the key game mechanisms utilised are Goals, Score and Risk-Reward, these are framed in a competitive dynamic.

Goals are a sequence of actions which give the player structure and motivation to progress forward exploring different areas and options in the game. In SYMPHONY there are two types of goal structures;

(i) Predefined goals are primary aimed at new players and citizens. These are pre-sets defined by the game designer, arranged in a hierarchy, and increasing difficulty.

(ii) Player defined goals defined by policy makers, allowing them to set the goals they wish to achieve. I.e. reduce unemployment rate by 4% over five years.

Victory conditions of a goal are dependent on specific variable values in the ABM, for the example above the variable in the ABM would be unemployment_rate from the Eurostat agent.

Score – A measured quantity of achievement associated with a player or team, often score is a key indicator of how well the player has progressed in the game. In SYMPHONY there will be scores for each of the different player roles, i.e. the Government player may have unemployment rate and GDP where as a Firm may have profit as a score.

Risk-Reward – Risk can be defined as the potential to lose game progress or assets. I.e. time, experience and score could all be lost through the element of risk. Reward is the positive

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result of overcoming risk which could include the gain of new assets, experience and score. Striking a fine balance between the two creates the Risk-Reward mechanic; the chance for receiving a reward in the game which is linked to some risk which will induce a penalty if the player fails to acquire the reward. Many of the decisions made while playing the game will have some low and some high economic risk associated with them. I.e. trading in the capital markets has substantial risk and reward, stock traders can put a lot of their capital on the line in order to gain big rewards, sometimes they win and sometimes they lose.

Human Controlled Agents

The ABM contains multiple agent types which all interact and cause consequences for each other; however in the game the human player can only take control of a selection of these agents. These agents are key economic players, through which allowing a human player to take control will provide more realistic results to the Policy maker when the game is running. We refer to these agents as 'Player Roles'.

Each player role requires the user to work towards achieving a set of goals; for Household players goals may consist maximising their financial gain through investing in stocks and bonds in the markets, Firms to produce successful products, Banks to make profit on financing Firms and Households, Central Banks to keep the economy stable through raising/lowering interest rates and Government to ensure the correct polices are enacted in order to benefit growth of the economy as whole. Decisions made by Government and Central Bank players can have dramatic effects on other player roles; Households, Firms and Banks. Vice-versa if Households and Firms aren't able to financially sustain themselves they can cause Banks to go under causing recession, depression and even a country defaulting on its own loans. Each player role is closely interlinked, creating a network where every decision taken by each of the player roles can have serious consequences for the others. A balancing act must be struck between playing it safe and taking risk in order to survive.

In APPENDIX IV we have constructed a fact sheet for each of the playable roles; the reader can find a brief description of the player role, what it can control and what other player roles have a positive/ negative effect on it. Note that it is not a full technical description of the agents and should be taken into consideration when reading; it is more to shown the each role from the player's point of view.

4.3.4.2 User Interfaces

Interface complexity is a serious issue for sophisticated financial and economic applications. As increasing complexity of interface can drastically reduce utility, dramatically increase the learning curve of the application, and cause users to feel intimidated and overwhelmed, leading to lack of engagement.

Well-designed games however have an innate ability to reduce complex information into simple, easy to digest interface patterns; recurring design solutions that solve common

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interaction problems. Resource management games such as Civilization[13], have a very complex game structure with many elements to the interface. Civilization uses a step-by-step in-game tutorial which forms the first campaigns by the player in order to guide them through the range of interactions and options. By adopting a common theme and recurring interfaces and using a step by step process to introduce the user to the interface, Civilization succeeds in solving the complexity issues.

Figure 29: Interface of Civilization V

Below we compare an interface from Minsky[14], a macro-economic modelling application on the left and, Diplomacy 3[15], a game which simulates the political economy of UK based loosely on data from real-world figures, on the right.

[13] http://www.civilization.com/
[14] Minksy - System dynamics program with additional features for economics http://sourceforge.net/projects/minsky/
[15] http://www.positech.co.uk/democracy3/index.php?src=positech

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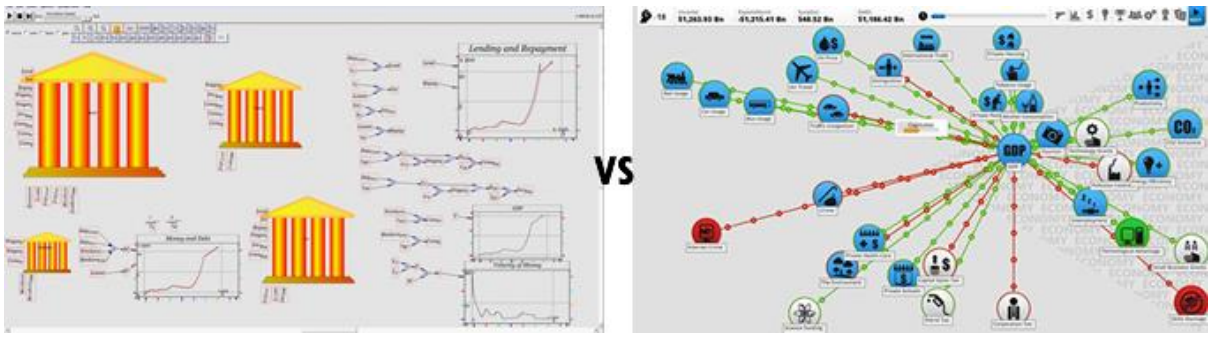

Figure 30: Minsky macro-economic modelling tool (on the left) vs Diplomacy 3 game (on the right) which simulates political economy.

Whilst Democracy 3's interface appears to be much more accessible to unfamiliar users, Minsky appears to provide more utility and fine grained detail. Within the SYMPHONY game we will aim to strike a balance between accessibility and utility, enabling non-expert users to engage and contribute whilst experts experiment with options and gain useful insights.

In order to achieve this balance we introduce a set of user experience techniques to be utilised when designing the interface for the game, these are;

- **Progressive Disclosure**[16] – Reducing cognitive overhead to help maintain the focus of the users' attention by minimising visual and information clutter. This is achieved through moving less frequently used elements behind a secondary of interaction, mostly commonly through additional popups or screens through a mouse roll-over, mouse click or keyboard shortcut. We prioritise variable and interactive values in order to achieve this.

- **Contextual Actions** – This form of progressive disclosure provides contextually appropriate controls for a particular object only under the relevant conditions. In the SYMPHONY game, player roles will dictate contextual actions.

- **Alignment & Visual Hierarchy** – By using a consistent visual structure, through hierarchy and alignment we will reduce complexity further in the interface. Use alignment and a well thought out grid to turn the interface from a chaotic experience to a harmonious and appealing one.

- **Visual Noise & Contrast** – The amount of visual noise in a user interface can greatly impact the perceived complexity, contrast can also influence visual noise. By using lower contrasted user interface elements, visual noise can be reduced which often reduces complexity.

- **Use of Iconography** – Interfaces which are regarded as complex with steep learning curves are often found to include an abundance of icons that lack descriptive labels.

[16] http://www.nngroup.com/articles/progressive-disclosure/

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When users jump into an application experience for the first time with an interface saturated in label-less icons, it can be intimidating and potentially cause decision paralysis through choice overload. Icons should be used to help characterize some actions and should be labelled appropriately and sit within a container which will help provide context. I.e. Icons denoting income and expenditure should sit inside a container which includes the income and expenditure financial data.

- **Charts, Infographics and Visual language** – There are times when charts are essential to extract decision critical information, however there are many chart types used within the financial services industry and some can be daunting and hard to decode, the rise of infographics has given way to a new design language around the visual communication of data stories. Where possible infographics should be used instead of traditional diagrams in order to convey information in the best visual way possible.

4.3.4.3 Current State of the Art and Practice

The majority of games that provide an experimental playground for policy modelling provide a single perspective on the macro economy. Internet based economic strategy games have been running online for many years. One of the most notable of these games is Nation States[17], which is a nations simulation game based on the popular novel 'Jennifer Government'[18]. Player's signup and take control of their very own country, dictating their own policies and devising economic strategy. However Nation States only provides the user with the perspective of the government and no other economic players.

Similarly Capitalism 2[19], a game with a fully simulated economy where a player takes the role of a firm and tests their entrepreneur skills in a dynamic environment. Despite enabling players to play the stock market within the game, and influence business policy (when big enough) and experience the economic downfall such as recession, players still only play from one perspective.

[17] http://www.nationstates.net/
[18] http://maxbarry.com/jennifergovernment/
[19] http://www.enlight.com/capitalism2/

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Figure 31: Capitalism 2

Considering further examples such as Geo Political Simulator 3[20] and Democracy 3; players take the role a Government where their choices affect economic prosperity, relationships between their people or neighbouring countries. Whilst these types of games are great to understand at a high level how these factors affect each other, they still only provide the user one view into the economy.

Figure 32: Geo Political Simulator 3

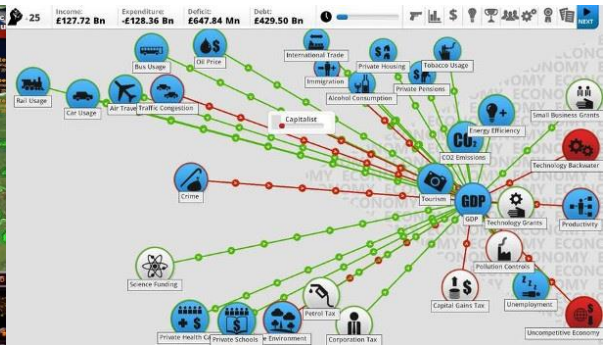

Figure 33: Democracy 3

A recent game which is closer in line with SYMPHONY is EA Games franchise, SimCity[21]. The 2013 release introduced a simulator engine known as GlassBox[22], where gameplay was derived from an agent based modelling system, although the amount of variables and complexity was kept minimal to cater for entertainment value to a wider audience. This is a good example of an ABM being used to create game-play, although Simcity only allows the player to become a mayor of a city. What is unique is as the mayor you can pull up information on each individual agent as well as high level information of all agents in a specific group. These are referred to as data maps which appear as overlays on top of the 3D world. This methodology is a good example of using an ABM to help create game-play, showing that it is possible to provide an engaging game experience in this way. Although

[20] http://www.masters-of-the-world.com/
[21] http://www.simcity.com/
[22] http://www.andrewwillmott.com/talks/inside-glassbox

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given the expenditure of tens of millions of dollars on development, coupled with scores of less than 50% from most game critics, it could be argued that the ABM perhaps got in the way of pure fun and entertainment. Figure 34 and Figure 35 are an outline slides explaining the transport agent system as well as a screenshot from the game where a car collision run through the agent system is creating traffic disruption.

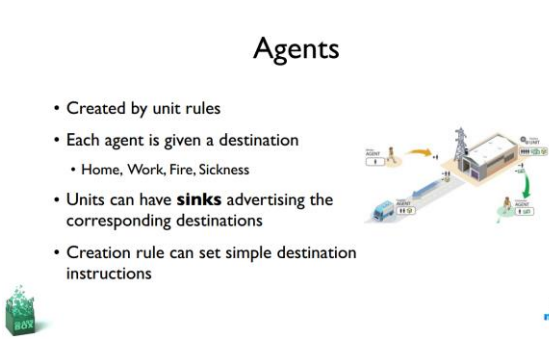

Figure 34: GlassBox Engine Slides from GDC 2012 **Figure 35: Simcity 2013**

The SYMPHONY game will allow players to take on a variety of roles within the simulated macro-economic world. In this way it shares some of the same qualities as Multiplayer Online Role Play Games (MORPG), which often contains a virtual economy.

4.3.4.4 Research focus in SYMPHONY

Our focus is to research and develop a gamified solution driven by the SYMPHONY ABM system in order to provide a safe environment where policy makers can experiment and test new monetary policy ideas in a playful and meaningful way. Where citizens interested in macro-economics, carbon emissions and the modern monetary system can engage to make their mark to explore about the bigger picture.

Our main challenge will be to provide an interface that reduces the complexity and amount of data presented on screen in order for users to extract and make decisions easily without being overwhelmed. We will explore alternative methods and approaches for this user experience in order to maximise utility and usability when exploring the macro-economic simulator.

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4.4 User Scenarios

Design methods such as sketching, prototyping, and storyboards are all used throughout the design process to develop and demonstrate the potential of a product or service. The use of storyboards can be used to define and explain a future service or the experience of a new service whereas stories help explain, engage imagination, spark new ideas, create a shared understanding, and communicate a vision to external stakeholders (Quesenbery and Brooks, 2010). In SYMPHONY we followed a storyboarding approach in order to understand and agree on the details of our integrated system. The process involved the definition of a problem space, the personas or users associated with the defined problems and a visual representation with related narratives that connect the pieces and offer a holistic view of how SYMPHONY will be used in policy modelling scenarios. Our aim is to present how the stakeholders will experience the SYMPHONY system through a set of indicative, yet inclusive, user scenarios.

In the following sections we describe four user scenarios which we collectively decided, each providing answers the following questions:

1. What story is to be told?

2. What SYMPHONY components are needed? Some components play leading roles in the story while other objects will be used to provide background scenery.

3. What actions are to take place? The actions in the story will eventually become the requirements for the SYMPHONY platform.

The first scenario describes how SYMPHONY senses the views of the TechnoSociety by observing and processing social media information as well as by aggregating expectations through information markets. The second scenario shows how experts and policy makers can use the gamified ABM simulation environment. The third presents how citizens can participate in the simulation by undertaking different roles. Last but not least the fourth scenario describes other uses of the SYMPHONY platform where i) the agents beliefs in the simulation can be initialized using social formed expectations from social media or information markets and ii) SYMPHONY can be used as a platform to perform research on how expectations are formed by combining the ABM simulation with information markets.

4.4.1 The Voice of the Crowd: Sensing the Views of the TechnoSociety

Policy makers and policy modellers can use the SYMPHONY Social Media Mining and Information markets to monitor expectations on key policy variables in near real time. These expectations reflect the beliefs of citizens about the real world economy.

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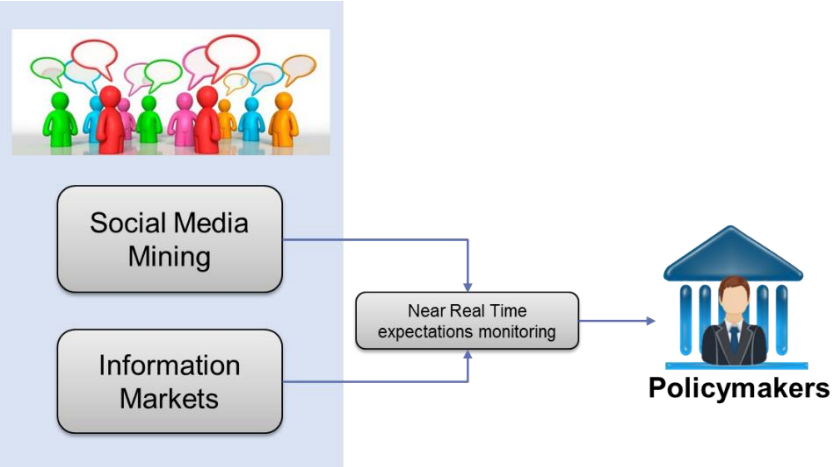
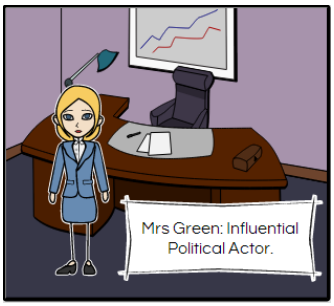


Figure 36: Overview of User Scenario 1.

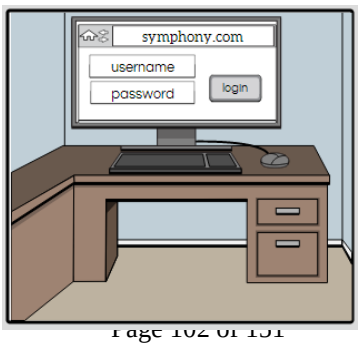
The user scenario comprises of three sections. We set the scene in section 'Background'. Then we show what it means to monitor Social Media in the context of SYMPHONY. Section three describes the set up and monitoring of the SYMPHONY Information Markets.

1. Background

Roles: **Mr Smith** is an executive at the European Central Bank. In order to make financial policy related decisions, he has to observe real world expectation on issues of the real world economy. More specifically he wants to have access to near real time expectations on variables such as unemployment rates. **Mrs Green** is an important and influential political actor in the government. In order to make climate and energy policy related decisions, she needs to understand the expectations and trends of energy prices.



Starting SYMHPONY: Mr. Smith and Mrs Green open their web-browsers and enter the SYMPHONY platform url. SYMPHONY is offered as a software-as-a-service and can be accessed by all employees who wish to use the SYMHPONY toolset.



Administrators for the SYMPHONY platform have been appointed by the Central Bank and the technical department of the

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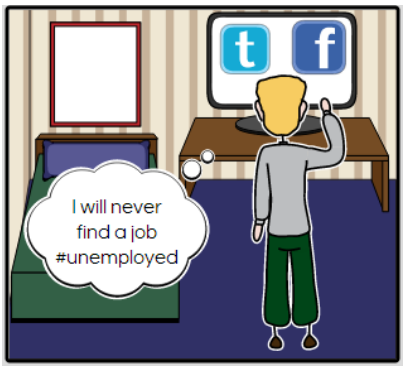
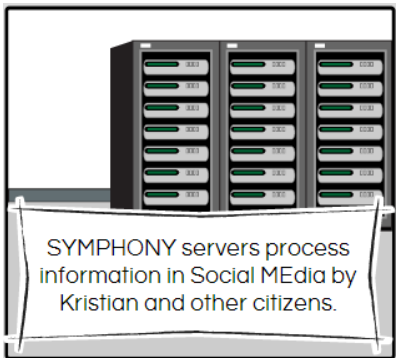
government. The administrators have already setup the proper access rights.

2. Mining Social Media for Expectations

2.a Kristian is a sales assistant in Hamburg that he finds it hard to find a job. He tweets "I will never find a job … #unemployed".



The SYMPHONY Social Media Mining platform processes information shared in social media by Kristian and other people from all around the world in order to collect citizens' expectations on job finding.



The platform analyses the text and sentiment of the social media information and derives beliefs and expectations regarding the economy. **Expectations and trends** about key variables of the economy include employment rates, inflation rates, interest rates and expected growth rates.

By selecting **different keywords**, Mr. Smith can view **the trends** related to key variables of the economy with respect to time (how the beliefs of social media users varied in time). By selecting different **social media mining features** (sentiment, frequency etc.) the policy maker can visualize social media data in different perspectives.

Mr. Smith can also visualize **different features of social media data** related to **future events** connected to key variables of economy.

Figure 37: Indicative visualization of social media data.

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2.b Mrs Green wants to get in depth information about the decisions and behaviour of firms and households in reaction to her envisaged energy policies policy.

She has the possibility to create extract (passive) data from social media mining on citizens' beliefs and expectations about energy prices, policy impacts and the share of renewable energy. She can also analyse the general sentiment regarding certain topics or reactions to specific events (e.g. large scale oil spill, nuclear accidents etc.).

She can select from different key words or add new keywords e.g. "Carbon prices".

3. Betting in Information Markets

Mr Smith creates a new information market (Figure 38) and places some questions on which he would like to have the opinion of other stakeholders including:

- The state of Households Liquidity
- The state of Bank Loans and Mortgages
- The capital goods of mining companies
- Government debts and GDP in the next quarter

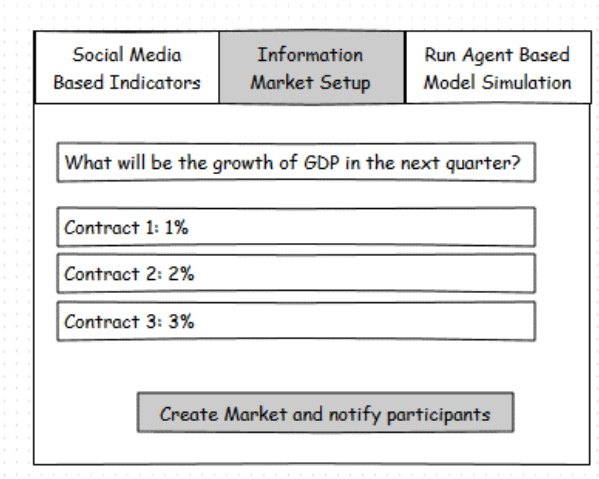

Figure 38: Indicative view of the Information Market setup interface.

He invites participants inlcuding (co-workers, executives from other organizations etc.). The SYMPHONY Information Market has been running for the last month and the financial policy experts whom Mr Smith has invited provide insights and expectations by trading information contracts. Contract prices represent the current expectations on the questions Mr Smith set.

Participants of the Information Market login and buy or sell contracts according to their expectations (see Figure 39).

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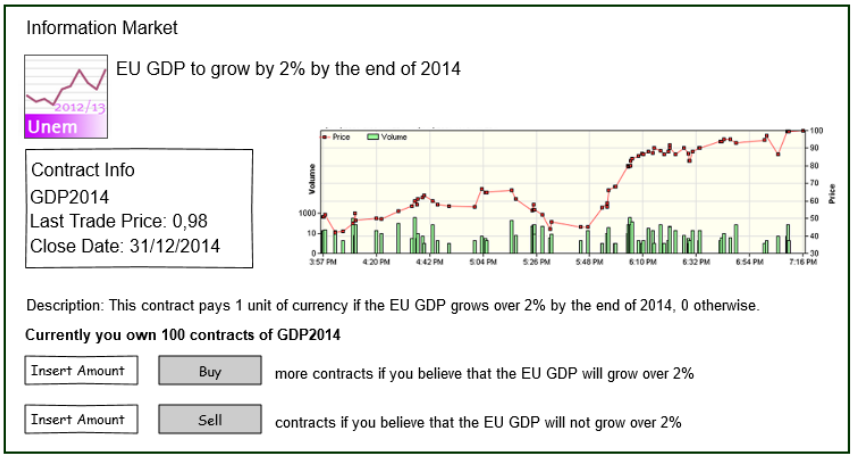

Figure 39: Indicative view of the Information Market participants' trading screen.

Mr Smith regularly visits the IM and from a graphical representation of the IM contracts he acquires an overview of the expectations of the participants.

4.4.2 To Model is to Play: Modelling Policies using the SYMPHONY Gamified Artificial Economy

The SYMPHONY ABM reflects a large-scale multi-country macro economy able to explain the functioning of a financial economy from the bottom-up. It is a fully-specified agent-based model of a complete economy that includes different types of agents and integrates different types of markets. Agents include households which act as consumers, workers and financial investors, consumption goods producers as well as capital goods producers, banks, a government and a central bank. Agents interact in different types of markets, namely markets for consumption goods and capital goods, a labour market, a credit market and a financial market for stocks and government bonds. Except for the financial market, all markets are characterized by decentralized exchange with price setting behaviour on the supply side. Agents' decision processes are characterized by bounded rationality and limited information gathering and computational capabilities; thus, agents' behaviour follows adaptive rules derived from the management literature about firms and banks, and from experimental and behavioural economics of consumers and financial investors.

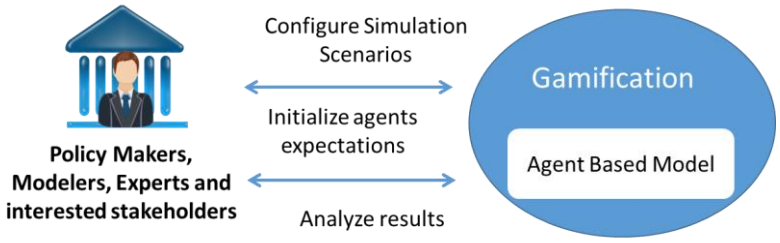

Figure 40: Overview of User Scenario 2

With the help of the SYMHPONY ABM policy makers and policy modellers are able to investigate:

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- Financial Policies, including:
  - the interplay between the financial and real sectors of the economy,
  - the financialization phenomenon
  - the financial stability
- Climate & energy policies, including sustainability issues

A gamified interface and usage process helps experts explore and understand the effects of alternative policies in a user friendly and engaging manner. The low level elements of the model which are difficult to readily understand in an interconnected environment are delivered as intuitive and straightforward options to the players.

This user scenario shows how the two policy makers we introduced in User Scenario 1, Mr Smith and Mrs Green, can use the SYMPHONY gamified ABM in order to run simulations that reveal the impact of the policy alternatives they have in mind. Using insights gained through the interaction with the ABM policy makers can then proceed into taking informed decisions.

The user scenario comprises of five parts, these are: Setting the scene the 'Background', a description of how the model is configured, what it means to run the model, finally concluding with description of how the simulation results are analysed by the policy maker.

1. Background

Mr Smith wants to understand if there is a need for extra prudence during economic expansions associated with financial booms and if the potential output and growth tend to be overestimated. Current models he uses are representative agent models and do not incorporate the credit and financial markets. This is a major limitation to their predictive power. Furthermore related tools are cumbersome to use.

In order for **Mrs Green** to make climate and energy policy related decisions, she has to investigate the impact of the available options. More specifically she wants to understand the effects of GHG emission reduction targets of 30%, 40% or 50% until 2030 on unemployment, economic growth and business cycles. Mrs Green is interested in investigating the economic effects of specific policies. These policies are implemented in the ABM so that she can select them and thus set the values for GHG emissions reduction targets and other variables and parameters. Mrs Green aims to apply ambitious emission reduction targets which lead to a preferably significant reduction of emissions as an optimization problem. Her additional targets are stable economic growth and no rise of unemployment. An optimal solution would imply an ambitious GHG emission reduction target leading to further economic growth while creating jobs and thus combating unemployment. As an instrument to trigger the desired emission reductions, Mrs Green introduces a price of carbon which she can set via her political decisions. Furthermore, she can decide how to use the revenue from the carbon price to stimulate the economy in other ways, e.g. by reducing labour taxes. Other models she has used so far have not given her the

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necessary information regarding the potential effect of her policy decisions on business cycles and related cyclical unemployment.

Starting SYMPHONY

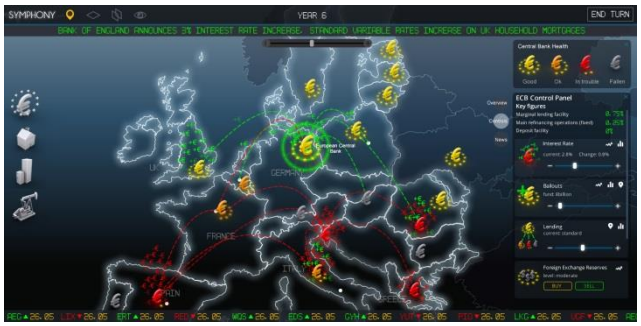
Mr. Smith and Mrs Green open their browsers and enter the SYMPHONY platform url. The web page informs them that they can log in to be able to play the game in all its features. The administrators has already setup the policies that are available in the game and relevant for the Central Bank and the government.

Indicative policy scenarios include different prices of energy taxes but also other taxes, such as labour taxes. Additionally several other policy instruments are conceivable:

- tax incentives (or subsidies) for energy related renovations of building
- renewable energy production subsidies
- quantitative easing program by the Central Bank directed at green investments (renewable energy, infrastructure, efficiency)
- expanding the use of green bonds by the Investment Bank (which is not directly a governmental agent either)
- subsidies in the transport sector, e.g. for trains and electric cars, and in transport infrastructure

2. Configuring the Model

Once logged in, Mr Smith and Mrs Green are presented with a graphical view of the European economy.



Mr Smith has to configure the economy before starting the ABM simulation. The process guides him, in order to review or set a number of elements in the artificial economy:

- Real estate market durable goods, construction firms and mortgages
- Derivatives market investment firms and hedge funds, shadow banking and derivatives securities
- Foreign sector
- Funds

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- Mining Companies
- Construction Firms
- Raw Materials and Waste

The model allows Mr Smith to initialize agents' expectations on the economy with values X_0^e.

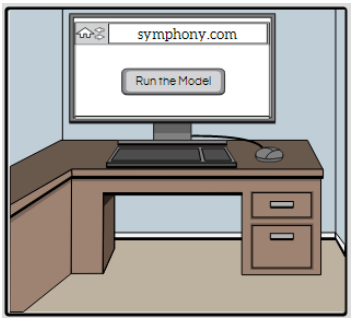
Mrs Green has to configure the economy's energy mix before starting the ABM simulation. The process guides her, in order to set a number of elements in the artificial economy:

- amount of renewable energy used in the country's energy mix
- energy intensity of households
- energy intensity of firms
- number and output of domestic energy production companies (renewable energy)
- amount of imports concerning the three different types of energy

The model allows Mrs Green to initialize agents' expectations on the economy with values.

3. Running the Simulation

Pressing the 'Execute Model' button, the ABM starts and the artificial economy begins to evolve.



As the ABM progresses, it remains to be seen how decisions made on key variables have affected the artificial economy. After two hours (in real time), Mr. Smith and Mrs.Green have data of the economy for a period of 10 years (in simulation time).

4. Analysing the Simulation Results

Mr. Smith and Mrs Green can delve into the available data from the simulation and understand why the economy evolved as it did; as well as scrutinize the impact of the initial conditions they set.

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Figure 41: Mockup of the simulation results.

4.4.3 Let's Play Together: Citizens and Policymakers Collaborative Exploring Policies with the SYMPHONY Gamification environment

1. Background

The SYPHONY Gamification environment provides dynamic data-driven games that lets policy makers and citizens, interested in economics and monetary policies, come together to interact with SYMPHONY's agent-based artificial economic world. Where all players' decisions impact the in-game virtual economy, and every player is made to feel the repercussions of financial decisions made by everyone taking part.

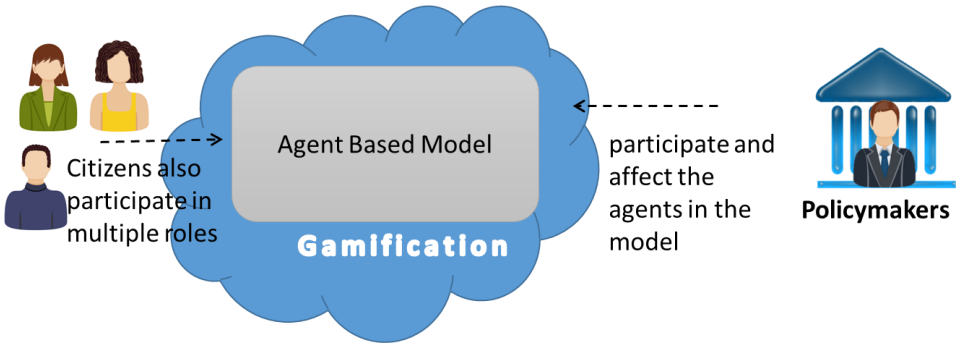

Figure 42: Overview of User Scenario 3.

Within the game there are five roles players can take charge of, these are: household, firm (CGP - Consumer goods producers), commercial bank, central bank, government, Retail sellers (malls) and Investment goods producers (IGP). Each role requires the player to work to a set of objectives: for household players it consists of being able to survive on a budget, firms to produce a successful business, central bank to keep interest rates down and government to ensure the correct policies are enacted. Decisions made by government and central bank players can have dramatic effects on households and firms, vice-versa if households and firms aren't making enough output they can affect central bank and government players. Each role has certain effects on each other, allowing players to feel connected to each other within the games environment.

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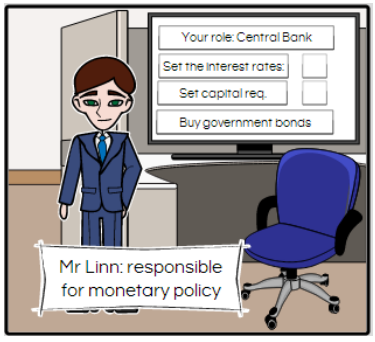
A chat room function is also available to allow players to communicate with each other which will help provide a space where players can share game strategies, help each other out and economic tips about playing the game.

What sets the SYMPHONY Gamification environment apart from other solutions is the game's ability to provide a different experience every time the game is played based on the underlying ABM simulation.

A general game scenario will run over a course of a week. Where policy makers/stakeholders are able to set the scenario conditions and invite users to join. Potential players can sign up to a game scenario by visiting the games website; they will be informed when the scenario begins through email.

2. Roles in the Game

Mr Linn is an executive at a European central bank, responsible for monetary policy issues. He has been recently informed about the SYMPHONY game in a conference he attended and decides to participate. He creates an account and selects the role of central bank from the available options.



He can now control a set of variables and takes actions associated with the role of central bank and affect the course of the game. Variables and related actions include:

- Set the monetary policy (e.g. interest rates in %).
- Set capital requirements for banks (the maximum ratio between total weighted assets of a bank and its equity capital).
- Decide to perform unconventional policies (as quantitative easing by buying government bonds)
- Set new regulation frameworks (including the acquisition of bonds from the government)

Marta is a dentist in Ljubljana. She saw the SYMPHONY game being mentioned in a post in facebook and has decided to participate. She creates an account and selects the role of household from the available options. The options she can set and are associated with the household role include:

- How much to consume, how much to save
- Marta can decide the quality of the good to buy
- How much to invest in the financial market. Portfolio decisions: which assets (firms' stocks and government bonds) to buy and which to sell.
- Marta can apply for a job and assess different job offers in the labour market

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Mark is a member of the parliament in Germany. He has been informed of the SYMPHONY game from an email newsletter and decides to join. From the available roles he select the one of a *Prime Minister* which allows him to take fiscal policy decisions. Indicative examples include:

- Setting tax rates on corporate profits, household labour and capital income
- Setting public expenditure, e.g.: unemployment benefits, household's transfers, and public wages
- Issuing government bonds to finance public deficit

Giancarlo owns a small business in Italy. A local newspaper had an article on the SYMPHONY game which sounded interesting. He accessed the provided url and decided to join. He selects the role of *firm* manager. Among the available actions of his role in the game are:

- How much to produce
- How many people to hire
- How much to invest
- Financial decisions: issuing new stocks in the financial market? Asking for one or more loans to commercial banks?
- Price setting (at the current state the mark up is fixed but we can relax this hypothesis for the game)
- Dividends payment decision: paying dividends to shareholders? How much?

Pedro works in a bank in Spain. An internal newsletter mentioned the SYMPHONY game and he decides to participate. He opts to play as a *commercial bank.* With this role he will be able to:

- Analysing loan requests from firms and deciding according to an internal evaluation based on firm's balance sheet (risk analysis and so on…)
- Examining mortgage requests from households (not yet in the model but there will be), taking again adequate decisions
- Setting the loans and mortgage rates, with a spread with respect to the policy rate set by the central bank, that is also bank's borrowing rate.

3. Playing the Game

The games starts and users are notified with an email that they should make their actions.

- Mr Linn sets the interest rates at 2%

- Marta decides to buy more goods and invest in stocks part of the income she receives within the game

- Mark allocates more money to public expenditure for unemployment,

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- Giancarlo decides to hire more employees in his firm and request a loan that is evaluated positively from Pedro's bank.

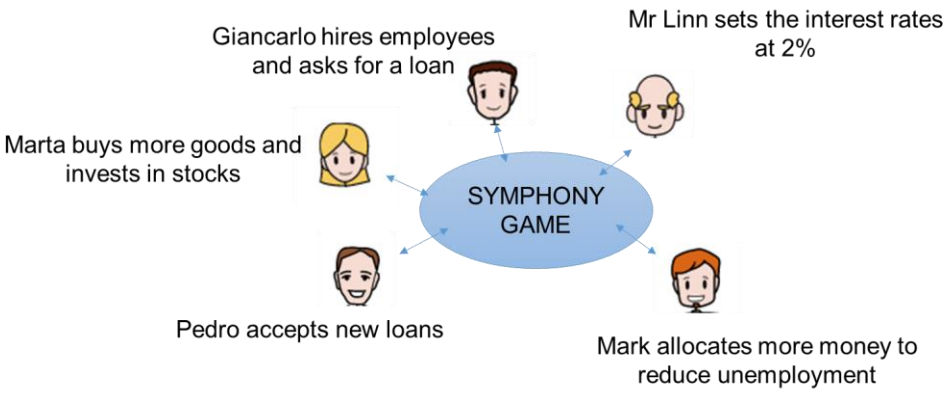

Figure 43: Indicative Player Actions.

4.4.4 Socially-formed Expectations

1. Running the SYMPHONY Artificial Economy with Expectations from Social Media and Information Markets

The initial state of the agents in the ABM is based on the beliefs and expectations of the public coming from the Social Media Mining and the SYMPHONY Information Market.

Mr. Smith configures the ABM using the dashboard (see User Scenario 1) but now he can rely on SYMPHONY to get the expectations of the real world in real time and initialize the artificial agents. This means that the credibility of the results of the artificial economy can be enhanced as the initial conditions are based on nowcasted information.

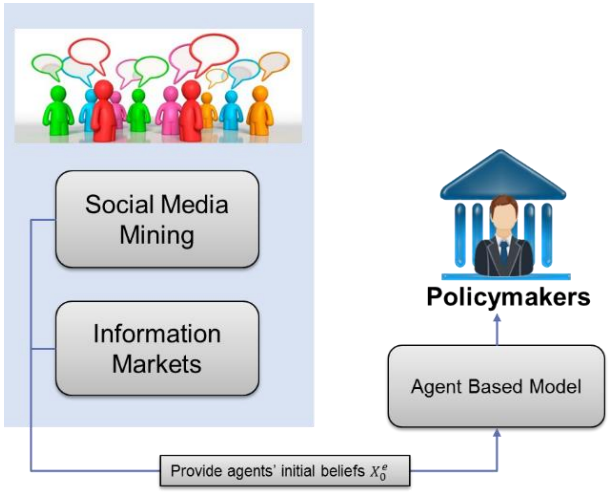

Figure 44: Overview of User Scenario 4.1.

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The platform supports agent's expectations initialization through a Social Media Mining infrastructure and a global Information Market, both tailored for the purpose of feeding agents' expectations. The Social Media Mining infrastructure provides continuous updates on a number of variables that are directly mapped to agent's beliefs. The tailored version of the Information Market which is used to initialize agents beliefs within the game has been deployed and runs continusously on a global level. We have attracted participants from all around the world who continuously provide their insights on a set of specific contracts that can be used to initialize model variables that represent agents expectations. Indicative Information Market contracts and Social Media Mining indicators which will be used to initialize agents' expectations include:

- Inflation representing Harmonised Indices of Consumer Prices (HICPs)
- Residential property prices
- Brent crude oil price
- Gross domestic product at market price
- Unemployment rates
- Euribor 3-month
- Euro area 10-year Government Bonds
- Equity/index - Dow Jones Euro Stoxx Price Index

2. A Virtual Information Market within the SYMPHONY Artificial Economy

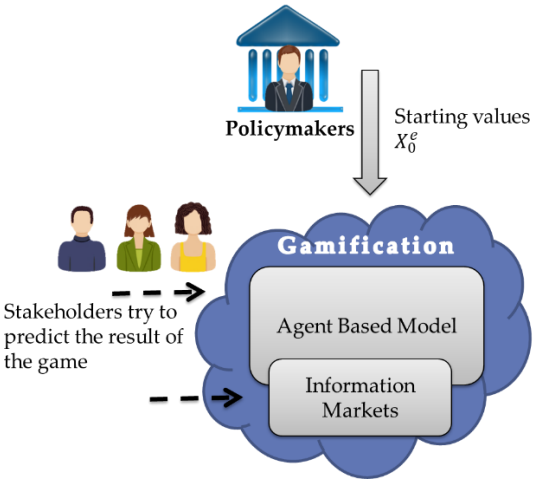

Figure 45: Overview of User Scenario 4.2.

The SYMPHONY virtual Information Market lives within the artificial economy. Participants of the market predict events related to the artificial economy and express expectations on

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related variables. It serves as a platform to perform research on how expectations are formed.

Mr Smith, the responsible for financial stability in the European Central Bank wants to combine the SYMPHONY tools in order to:

- Collect expectations
- Adopt an economic policy strategy
- Verify the effect of economic policy on the artificial economy
- Verify how the chosen policy modifies expectation

He logs in the SYMPHONY gamified ABM and configures a new simulation with the policies he has in mind. He starts the simulation and suspends it after 5 years (in simulation time). He then accesses the SYMPHONY Information Market and creates a set of contracts that deal with certain variables of the simulation.

He wants to find out what are the expectations of his colleagues on the evolution of these variables within the simulation and invites them in the Information Market.

Mr Smith's colleagues accept the invitation. The log in the game and check what has happened in the simulation during the last 5 years (of simulation time). Then they submit their expectations on the evolution of the selected variables.

Mr Smith understands the expectations of his colleagues. Then he resumes the simulation to check if these expectations match the outcome of the simulation.

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5 Conclusions and Further Work

This deliverable documented the work performed in WP1 of the SYMHPONY project. The main objective of the work package was to identify user and stakeholder requirements and define the conceptual architecture of the project.

With the use of a Design Thinking approach the consortium was able to map and analyse the problem space of the project and identify a set of key policy issues which will be supported by the SYMPHONY platform. Namely supporting the modelling and exploration of policy issues related to financial stability and sustainability transition is the focus of SYMPHONY. Through an ideation and prototyping phase the project partners were able to specify and describe the SYMPHONY conceptual architecture that glues together the research work and individual components that are currently being specified and implemented in WP2, WP3 and WP4. Furthermore within WP1 we defined a set of user scenarios that present our envisaged use of the platform. The scenarios have been refined and validated by our target users. In parallel the project partners have identified the key research directions which they will be pursuing in the remainder of the project, inline with the envisaged architecture.

The work described in this deliverable provides the basis for the rest of the SYMPHONY work packages. Besides WP2, 3 and 4, the system architecture which is being specified within WP5 is based on the presented conceptual architecture. In WP5 we are going to describe all the technical details required in order to integrate the various components in a consolidated system. Moreover in WP6 the proposed architecture will be evaluated and we will validate its adequacy for defining and conducting the use cases.

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7 APPENDIX I: SYMPHONY Design Thinking Questions

This document consolidates the questions and available answers provided by all partners during the 'Research' phase of the SYMPHONY Design Thinking. Please go through the list, identify the questions which you can answer and prepare your answers which will discussed during our consortium meeting in Athens.

Our aim is to clarify open issues and reach a common understanding on what SYMPHONY is about in order to create the project's Conceptual Architecture.

To ICCS:

1. From JSI: Task 2.4 Design and development of SYMPHONY Information Markets should be based on outputs from Task 2.3 Definition and Development of the SYMPHONY social media based expectations indicators. The connectors between two tasks should be set and aligned (in which format the outputs are provided, how frequent the updates are provided etc).

To JSI:

1. From ICCS: Could you provide an indicative list of policy indicators you plan to develop using social media information?
2. From ICCS: Besides markets with human participants, we aim to develop an information market in which the participants will be artificial agents. These agents will use the policy indicators that you will develop by mining social media data. How often do you expect to provide updates on these policy indicators (e.g. hourly, daily, weekly)?
3. From ICCS: Could you provide a description of the value of the policy indicators? Will these be binary, an index, something else?

To UNIVPM, UJI:

1. From JSI: In order to match micro-signals from social media with macro trends we would be interested to obtain a list of variables expressed in agent based model.
2. From JSI: In general, any available macro-economic data (or knowledge about possibilities of obtaining the relevant data) connected to agent based model representation would be useful for social media mining.
3. From JSI: Indicators and models for indicators extracted from social media will be aligned with agent based model. How often do you expect to update the relevant models?
4. From JSI: Since Task 2.2 of WP2 involves tracking cross-lingual information and opinion diffusion, would it be possible to incorporate diversity elements into the agent based model?
5. From ICCS: The Information market will aggregate the expectations of the market participants on certain macroeconomic variables (e.g. unemployment rate, consumer prices, etc). Could you give some examples of such variables?

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6. From ICCS: The Information Market contracts are futures contracts and should be related to a future event. When the event occurs, participants are rewarded. How far in the future will be the realization of these events: in the short term (e.g. some days or weeks), in the long term (e.g. some months or years)?
7. From ICCS: How many contracts do you expect to have in the information market which will be relevant for the agent based model?
8. From ICCS: Will you specify a predefined set of contracts for the Information Market? Or there will be updates (i.e. new contracts) in the duration of the market?
9. From ICCS: Expectations gathered in the information Market will be given as input to the agent based models. How often do you expect to feed Information Market data into the agent based model (e.g. hourly, daily, weekly)?
10. From UNIGE: How could the agent expectations be modeled and integrated in the Macro Agent-based engine?
11. From UNIGE: How can we calibrate Macro Agent-based model? And how can we validate the Symphony simulation results?

To PLAYGEN:

1. From JSI: Do you plan to include social media as part of the game?
2. From ICCS: Do you consider the information market as part of the game?
   PLAYGEN: Possibly. It rather depends on whether inclusion of this type of game would add to the ability of various users to better understand and be able to explore policy options. If it's possible to add this type of mechanism and be able to glean useful information from it, we will look to incorporating it.
   a. If yes, do you envisage an 'Information Market view' within the game where participants will be able to trade on policy related contracts related to the game?
      PLAYGEN: Right now we are not at all sure about the notion of 'buying contracts' in the way that you've described this, because unlike the stock exchange where there is an intrinsic desire to make money by making bets on how things will happen – moving this to extrinsic motivation to a policy area, for example to bet on the percentage of unemployed people and to be rewarded financially (all be it in a virtual currency) – may have a negative impact on engagement and alter the perception of the user about the game.
      What seems quite important/useful is gathering user opinion. In this case opinion of users on future changes / potential of specific metrics/values.
      What is not clear is the best mechanism with which to gather this information.
      It's possible that a betting option (as in a stock exchange game) carries with it connotations of gambling which may seem inappropriate in a public policy game.
      I would like for us to first define what we want the outcome to be – i.e. what are the metrics / elements which we would like users to predict the direction of. Based on this, we would explore potential gaming mechanisms

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which allow us to achieve the end goals. This might be in a betting type game, but we may frame it in an entirely different setting so it's not seen as gambling or even stock exchange play – potentially as consensus building or an auction, etc.

3. From ICCS: Do you consider developing an information market interface within the SYMPHONY game as part of your work?
   PLAYGEN: We see our task as incorporating gamification and a more refined user experience to encourage greater use. If information markets can be reduced to the key components which help the process of exploring options and better understanding repercussions of decisions we will seek to incorporate them. If however they are a simple addition on top with no real impact on exploration or deeper insight then no, we will not include them.

To ATC:

1. From JSI: The indicators and models for indicators should be aligned with agent based model. Are you going to develop connectors that will allow the interoperability of the agent based model and models developed within WP2, or will you provide specifications of APIs to which we should conform?
2. From ICCS: The Information Market data should be given as input to the agent based model. Are you going to develop connectors that will allow the interoperability of the agent based model and the Information Market, or will you provide specifications of APIs to which we should conform?

To USERS:

1. From JSI: For social media mining we would also be interested in several indicative problems in your area which require aggregation of information / opinions from stakeholders?
2. From ICCS: Could you state two indicative problems in your area which require aggregation of information / opinions from many stakeholders?
   Possible Answer:
   - Expectations on future electricity prices (reveals information about consumer and industry expectations)
   - Expectations on future economic growth
3. From ICCS: How many users do you expect to participate in an Information Market (a setting as described above)?
4. From ICCS: The market will offer a 'hall of fame'. This means that the best performing participants will be shown first and recognized by the community of traders. We consider the 'hall of fame' as a means to incentivize participation. Do you consider this kind of incentives sufficient? If not, which kind of incentives would you consider to participate in an information market?
5. From ICCS: In other similar projects in the past we have developed environments which included functionalities like forums and discussion boards, besides the

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market. This means that participants, in addition to trading, could verbally express opinions and ideas. Do you consider such functionalities interesting or necessary?

From USERS:

To ICCS, JSI:

Citizens/Society (delivering input for the agent---based model via social media mining and via information markets)

1. How do stakeholders think about multiple equilibria: do they think it is possible to reach a different state of the economy?
2. Do they think that a coordination of expectations and actions can deliver this?

Which groups of stakeholders?

consumers: Find out what are consumer decisions based on? What are important factors why consumers would chose for more sustainable products?

investors: What is the current investment portfolio strategy? What needs to change that environmental and social criteria get a larger weight?

producers: How can supply-chain management (social and environmental criteria) be improved? Which influence do consumers have on the production practices?

To PLAYGEN, ATC:

The purpose of the game is to provide a tool for policy makers to better judge the possible impact of a policy to be introduced and to test sensitivities & to simulate macroeconomic impacts/relevance of policies for a sustainability transition at European level.

The tool should be understandable and easily accessible to policy makers, clear input and output variables and assumptions need to be stated clearly. Think about an expert modus of the model: maybe not the game but a good user interface of the model (where more parameters can be adjusted).

- It might not be appealing to policy makers to develop scenarios and to justify their decisions using a game, there is a possible credibility problem.

This can be tested with different stakeholders once a prototype of the game is available.

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8 APPENDIX II: Citizens' questionnaire

QUESTIONNAIRE

"For Policy Design and Regulation of a Resilient and Sustainable Global Economy"

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Thank you for participating in this online study!

SYMPHONY ("Orchestrating Information Technologies and Global Systems Science for Policy Design and Regulation of a Resilient and Sustainable Global Economy") is an international research project with partners including universities, research organizations and policy makers. The project is co-funded by the "ICT for Governance and Policy Modelling" Programme of the European Commission.

The project aims to provide a set of tools in order for policy makers and citizens to collaboratively identify the transition to sustainable patterns of production and consumption leading to an economically and ecologically sustainable growth path.

The end result of SYMPHONY will automatically sense your opinions as they are expressed in social media, e.g. through twitter, facebook and blog posts, process them and produce a set of indicators which are then presented to policy makers in order to assist them in taking decisions. A simple example is that if you post an article stating that unemployment is raising, and many citizens post similar items, SYMPHONY will sense that this is an issue of concern and may adjust the unemployment indicator. Policy makers can see this and adjust their policies.

In addition, SYMPHONY develops a gamification environment where policy makers and citizens come together and interact in an agent-based artificial economic world. In this world, every decision impacts the virtual economy in a manner analogous to the real world economy!

As a player you can select a role and affect the decisions of that role. Namely you can be a household, a firm, a commercial bank, the central bank of a country or even the government of a country. Each role requires that you work for a set of objectives:

- If you are a household, you should be able to survive on a budget;

- If you are a firm you have to run a successful business;

- If you are a central bank you have to apply monetary policies to keep the economy stable; and

- If you are a government you have to ensure that the correct policies are enacted.

Government and central bank players can have dramatic effects on households and firms; vice-versa if households and firms aren't making enough output, they

PART A: Respondent's Details

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To help us evaluate your answers, please indicate:

A1. Profession:

A2. Country:

A3. Type of organization you belong to:

- ☐ Academic/Educational organisation
- ☐ Private sector company
- ☐ Public sector/Government organization
- ☐ Non-Governmental Organisation
- ☐ Other - please specify:

A4. Your Age Group:

- ☐ 18-25
- ☐ 25-35
- ☐ 35-50
- ☐ Over 50

A5. Your Gender

- ☐ Male
- ☐ Female

A6. Your educational level

- ☐ High school
- ☐ Bachelor / College degree
- ☐ Master degree
- ☐ PhD/Post-grad research degree
- ☐ Other - please specify:

PART B: General Questions

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B1) Are you interested/involved in public policies?

- ☐ yes
- ☐ no
- ☐ sometimes

B2) Have you ever participated in an online political forum / debate?

- ☐ Yes
- ☐ No

B3) If yes, why did you participate?

- ☐ A friend recommended it
- ☐ I was interested in the issue being discussed
- ☐ It was an opportunity to influence a decision maker
- ☐ I wanted to meet like-minded people
- ☐ To learn more about politics
- ☐ Other (please specify)

B4) If no, why not?

- ☐ I don't have enough time to post
- ☐ I am shy about public posting
- ☐ I don't know enough about the topic
- ☐ I want my activities to remain completely untraceable and preserve my privacy and safety
- ☐ Most forum messages are irrelevant or have little information value
- ☐ The discussion has too many posts to deal with
- ☐ There wasn't enough discussion

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- ☐ I don't like the tone of the discussions
- ☐ Other (please specify)

B5) Do you think social media is a good way for citizens to get involved in policy making process?

- ☐ yes
- ☐ no

B6) Which of the following online applications do you use to express opinions and get engaged in conversations?

- ☐ Discussion Forums
- ☐ Blogs
- ☐ Social Networks
- ☐ e-Petitioning systems
- ☐ Instant Messaging
- ☐ Polls
- ☐ Others (please state)

B7) What kind of comments would you like to provide in social media? (Tick all that apply)

- ☐ Views and opinions
- ☐ Suggestions
- ☐ Criticisms
- ☐ None
- ☐ Other (please specify)

B8) Do you think citizens' comments in social media about public policies are taken into account by policy makers?

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- ☐ yes
- ☐ no

B9) Do you think that "gamification" is a good way for citizens to get involved in policy making process?

- ☐ yes
- ☐ no

Please indicate why:……

B10) Could a suggestion intrigue you to use a game application for policy-making? If yes, from whom? (Tick all that apply)

- ☐ friends, users you trust
- ☐ 3rd party internet site recommendations
- ☐ from someone in your extended social network
- ☐ advertisement
- ☐ other - please specify:

B11) Would you be interested in participating in a policy making process through a game?

- ☐ yes
- ☐ no

Please justify your answer……

B12) Would you be interested to participate in a game in which you select a role (i.e. government, bank, household), and test different options (decisions) for preventing and mitigating economic and financial crises?

- ☐ yes
- ☐ no

Please justify your answer……

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B13) If you knew that your actions in the 'game' are being used for getting input on how to create the best policy, would you be willing to provide your input?

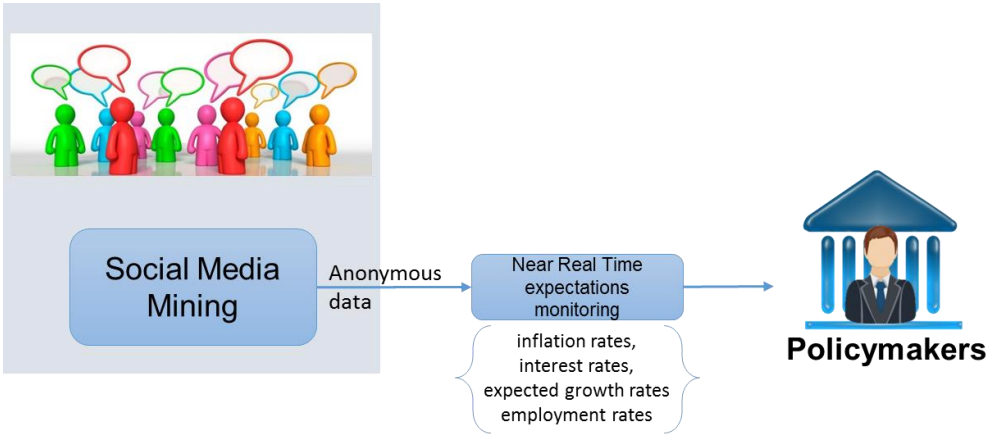
- ☐ yes
- ☐ no

Please justify your answer……

PART C: Indicative Scenarios

C1. How would you validate the following scenario?

Scenario 1: The Voice of the Crowd: Observing Expectations through Social Media and Information Markets



Overview:

Kristian is a sales assistant in Hamburg that he finds it hard to find a job. He tweets "I will never find a job … #unemployed".

The SYMPHONY Social Media Mining platform processes information shared in social media by Kristian and other people from all around the world in order to collect citizens' expectations on job finding. The platform analyzes the text and sentiment of the social media information and derives beliefs and expectations regarding the economy. Expectations and trends about key variables of the economy, include inflation rates, interest rates, expected growth rates and employment rates.

All the gathered information is anonymous and only aggregate indicators are produced by the SYMPHONY system.

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By selecting different keywords, Policy Makers can view the trends related to key variables of the economy with respect to time (how the beliefs of social media users varied in time). By selecting different social media mining features (sentiment, frequency etc.) Policy Makers can visualize social media data in different perspectives.

Your opinion is implicitly considered by Policy Makers when they take policy related decisions using the SYMPHONY platform.

How would you characterize this use case scenario?

- ☐ Very interesting
- ☐ Rather interesting
- ☐ Interesting
- ☐ Little interesting
- ☐ Not interesting at all

Please justify your answer……

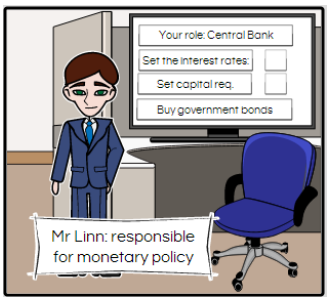
C2. How would you validate the following scenario?

Scenario 2: Let's Play Together: Citizens and Policymakers Collaborative Exploring Policies with the SYMPHONY Gamification environment

Overview:

The SYPHONY Gamification environment is a dynamic data-driven game that lets policy makers and citizens interested in economics and monetary policies to come together to interact with SYMPHONY's agent-based artificial economic world – where every decision made impacts the in-game virtual economy, where each player is made to feel the repercussions of financial decisions made by everyone taking part.

Mr Linn is an executive at a European central bank, responsible for monetary policy issues. He has been recently informed about the SYMPHONY game in a conference he attended and decides to participate. He creates an account and selects the role of central bank from the available options.



He can now control a set of variables and takes actions associated with the role of central bank and affect the course of the game. Variables and related actions include:

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- Set the monetary policy (e.g. interest rates in %).
- Set capital requirements for banks (the maximum ratio between total weighted assets of a bank and its equity capital).
- Decide to perform unconventional policies (as quantitative easing by buying government bonds)
- Set new regulation frameworks (including the acquisition of bonds from the government)

Marta is a dentist in Ljubljana. She saw the SYMPHONY game being mentioned in a post in facebook and has decided to participate. She creates an account and selects the role of household from the available options. The options she can, and associated with the household role include:

- How much to consume, how much to save
- How much to invest in the financial market. Portfolio decisions: which assets (firms' stocks and government bonds) to buy and which to sell.

Mark is a member of the parliament in Germany. He has been informed of the SYMPHONY game from an email newsletter and decides to join. From the available roles he select the one of a *Prime Minister* which allows him to take fiscal policy decisions. Indicative examples include:

- Setting tax rates on corporate profits, household labor and capital income
- Setting public expenditure, e.g.: unemployment benefits, household's transfers, and public wages
- Issuing government bonds to finance public deficit

Giancarlo owns a small business in Italy. A local newspaper had an article on the SYMPHONY game which sounded interesting. He accessed the provided url and decided to join. He selects the role of *firm* manager. Among the available actions of his role in the game are:

- How much to produce
- How many people to hire
- How much to invest
- Financial decisions: issuing new stocks in the financial market? Asking for one or more loans to commercial banks?
- Price setting (at the current state the mark up is fixed but we can relax this hypothesis for the game)
- Dividends payment decision: paying dividends to shareholders? How much?

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Pedro works in a bank in Spain. An internal newsletter mentioned the SYMPHONY game and he decides to participate. He opts to play as a *commercial bank.* With this role he will be able to:

- Analysing loan requests from firms and deciding according to an internal evaluation based on firm's balance sheet (risk analysis and so on…)
- Examining mortgage requests from households (not yet in the model but there will be), taking again adequate decisions
- Setting the loans and mortgage rates, with a spread with respect to the policy rate set by the central bank, that is also bank's borrowing rate.

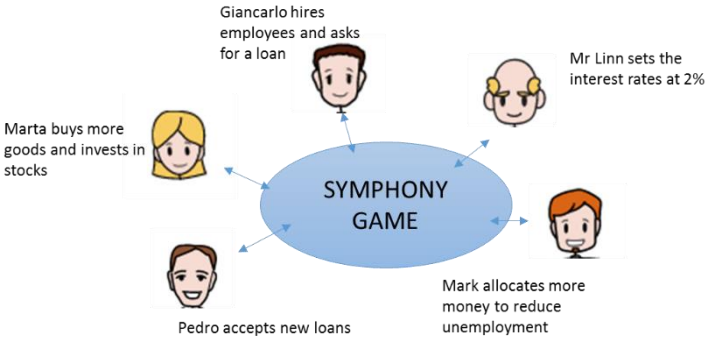
The games starts and users are notified with an email that they should make their actions.

- Mr Linn sets the interest rates at 2%

- Marta decides to buy more goods and invest in stocks part of the income she receives within the game

- Mark allocates more money to public expenditure for unemployment,

- Giancarlo decides to hire more employees in his firm and request a loan that is evaluated positively from Pedro's bank.



As the virtual economy evolves, through the players actions, a growth is observed. Unemployment drops, new jobs are created and companies produce profits. Policy Makers observe the actions of the players and can use this information in their real-life decisions.

How would you characterize this use case scenario?

- ☐ Very interesting
- ☐ Rather interesting
- ☐ Interesting
- ☐ Little interesting

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☐ Not interesting at all

Please justify your answer……

Briefly, what do you expect from projects like SYMPHONY? Please let us know if we have left anything out or if there are any important subjects that are not covered.

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9 APPENDIX III: Photos from the Focus Groups

In Athens

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In Italy

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10 APPENDIX IV: Fact sheet for each of the playable game roles

In the following we present a fact sheet for each of the playable roles; the reader can find a brief description of the player role, what it can control and what other player roles have a positive/ negative effect on it. Note that it is not a full technical description of the agents and should be taken into consideration when reading; it is more to shown the each role from the player's point of view.

<table>
<tr><td colspan="4">HOUSEHOLD PLAYER FACT SHEET</td></tr>
<tr><td rowspan="2">  </td><td colspan="3">ABOUT</td></tr>
<tr><td colspan="3">Playing a Household puts the player in the shoes of a home owner in the simulated economy. Household player's main ability is being able to play the capital markets, giving them the opportunity to take the role of a trader/investor in order to maximise their financial position and climb the societal wealth ladder.</td></tr>
<tr><td>CONTROLS</td><td colspan="3">INTERACTIONS</td></tr>
<tr><td rowspan="3"></td><td>PLAYER ROLE</td><td>POSITIVE</td><td>NEGATIVE</td></tr>
<tr><td> 
Household</td><td>Households who are employed and pay their tax provide a better financial economy for the rest of the Household players.</td><td>Other Household players may compete for job openings, real estate or investment opportunities on the capital markets.</td></tr>
<tr><td> 
Firm</td><td>Firms that are doing well employee more people which means more jobs in the labour market, also drives competition between firms to produce more products which requires more skilled Households on higher wages.</td><td>If a Firm doesn't make good profits they may want to cut costs by making employed Households redundant.</td></tr>
</table>

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	 Bank	A Bank provides the Household player with a loan (most likely a mortgage).	A Bank may raise interest rates on a loan to a Household from the consequences of Central Bank raising interest rates, causing the Household to pay more interest on the loan.
	 Central Bank	Central Bank may lower interest rates making buying a new/bigger home more affordable.	May raise interest rates in order to stabilize unforeseen events; i.e. real estate market bubble, in the economy. Causing loan interest payments to increase.
	 Government	Government provides subsidies and job for Households. If a household becomes unemployed an unemployment subsidy can be gained from Government to help support the Household.	Government requires tax to be paid. Government may raise tax to increase its spending power having a negative impact on the Household player's income.

FIRM PLAYER FACT SHEET	
	**ABOUT**
	Players who take control of a Capital Goods Firm are able to play the role of a business owner. They can develop new products to take to market, hire employees (Households) and purchase new machinery from Investment Good firms to increase production. Firm players will also need to make difficult decisions such as downsizing when profits aren't good, applying for a loan from a Bank when it's needed for new product innovation or to keep the firm afloat.

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CONTROLS	INTERACTIONS		
	PLAYER ROLE	**POSITIVE**	**NEGATIVE**
	 Household	Households provide Firm players with labour in exchange for a wage. Households also purchase products created by a Firm which has a positive effect on the Firms profits.	Households may not consume the Firms products, causing profit to decrease which could cause the Firm to downsize or even shut down.
	 Firm	Firms invest in each other as well as purchase products from each other.	Competition between firms to sell products could prove costly, prices rise for new product innovation and skilled labour can experience a shortfall.
	 Bank	Banks provide loans to Firms which enables them to take on new product innovations in order to increase profits.	A Bank player could raise interest rates on loans which could have negative effects on profits or worse cause the Firm to default on the Loan causing the firm to spiral into debt and out of business.
	 Central Bank	Central Bank doesn't directly impact a Firm however it does effect Government and Bank players which do have positive and negative effects on a Firm.	Central Bank could raise the interest rates causing the Bank player to raise interest rates on a loan to the Firm having a negative effect on the Firms profits.

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	 Government	Government may reduce corporation tax allowing a Firm to increase spending in other areas of its business.	Government may also increase corporation tax which will have a negative effect on profit.

BANK PLAYER FACT SHEET			
	**ABOUT**		
	A Bank player's primary goal is to maximise their profit by providing loans to firms or households. Banks enable Firms and Households to increase their financial position, they allow for new possibilities for both of these roles. However there is a fine balance between making profit and taking on risk, the riskier the loan the better the reward; however there is a chance the loan may default causing the Bank to lose money or in the worst case go insolvent. **Lending** - to Firms and Households, as well as setting the interest rate for these loans.		
CONTROLS	**INTERACTIONS**		
Lending - to Firms and Households, as well as setting the interest rate for these loans.	**PLAYER ROLE**	**POSITIVE**	**NEGATIVE**
	 Household	Households pay their mortgage with added interest which the Bank can use to lend out to other Firms or Households.	Households may default on their mortgage payments; in the worst case they may spiral into debt, causing the mortgage to turn toxic. Meaning it's not profitable for the Bank. Unless quantitative easing is activated by the Central Bank player.

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	 Firm	Firms apply for loans for new ventures; these loans have the benefit of being paid with added interest which the Bank can then use for other activities.	Firms which aren't doing too well can default on their loan payments, the Bank will lose money.
	 Bank	Banks don't directly have an effect on each other however they do have an indirect effect through the credit market, where they compete to match the demand of lending to Firms/Households.	
	 Central Bank	If a Bank gets into trouble it can go to the Central Bank for loan to help it stay afloat. The money is created as Fiat money; the money is not taken from the Central Banks cash reserves/liquidity.	Central Bank could raise interest rates which causes the Bank to raise loan rates to make up for the shortfall, but this puts more Firms and Households at risk of defaulting on their loan repayments.
	 Government	Government doesn't have any direct influence over a Bank; however it does directly affect other player roles which do.	

CENTRAL BANK PLAYER FACT SHEET	
	ABOUT
	A Central Bank's primary goal is to keep the economy in check; the player can do this by utilising the interest rate. Lowering the interest rate floods the financial market with extra liquidity, which influences

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	the rate of which Banks can lend to firms and households or Raising the interest rates which has the opposite effect. If Quantitative easing is active the Central Bank can buy up bonds and bad assets from banks to help ease lending. **Interest Rate** - Central bank can reduce interest rate (flood the market with extra liquidity), which influences the rate of which banks lend to each other and that in turn influences the rate that effects the rate of loans to households and firms.		
CONTROLS	**INTERACTIONS**		
Interest Rate - Central bank can reduce interest rate (flood the market with extra liquidity), which influences the rate of which banks lend to each other and that in turn influences the rate that effects the rate of loans to households and firms.	**PLAYER ROLE**	**POSITIVE**	**NEGATIVE**
	 Household	Households don't have any direct affect however if households are in good economic health it will allow interest rates to slowly rise.	If Households aren't spending much in the mall (agent) it can cause GDP to slow down, causing the Central Bank to take action such as lowering interest rates to increase liquidity in the economy.
	 Firm	Firms don't directly affect Central bank players however they do have effects on economic indicators such as GDP, the same as a Household.	If Firms aren't spending much in the mall (agent) it can cause GDP to slow down. (Same as Households)
	 Bank	Banks that take loans from the Central Bank have to pay them back with interest which is then turned into a dividend and distributed to the Government player(s).	If Bank players take on too much risk they pose the threat of going under, once they do they need to be bailed out by the Central Bank with a loan. However the loan is not provided from the Central Banks liquidity/cash reserves but from the creation of

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			fiat money.
	 Central Bank	Central Bank – Another Central bank does not have an effect on the Central Bank player.	
	 Government	When Government needs money it goes to the Central Bank and asks it to buy Treasury Bonds. The Government essentially asks for a loan (with interest).	Central Bank is not allowed to make a profit, instead the money is given as a dividend to Government - in case of multiple Governments the dividend is equally split between all Governments.

GOVERNMENT PLAYER FACT SHEET			
	**ABOUT**		
	A Government player takes the role of the prime minister of a country. Where they affect economic policy such as tax and subsidies. The player's main goal is to increase GDP, reduce the countries deficit and ensure social indicators such as unemployment rate are kept low. **Bonds** – Government can issue bonds in order to gain more spending power. **Tax** – Government can increase and decrease tax payments made by Firms and Households. **Subsidies** – Government can increase and decrease subsidy hand-outs such as unemployment benefit for Households.		
CONTROLS	**INTERACTIONS**		
Bonds – Government can issue bonds in	**PLAYER ROLE**	**POSITIVE**	**NEGATIVE**

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order to gain more spending power. **Tax** – Government can increase and decrease tax payments made by Firms and Households. **Subsidies** – Government can increase and decrease subsidy hand-outs such as unemployment benefit for Households.	 Household	Households which are employed are able to pay tax which allows the Government player to increase spending in other areas or reduce the countries deficit.	Unemployed Households have a negative effect on Government, requiring more subsidies to support them; they also have little spending power which can have adverse effects on tax income, a countries deficit and GDP.
	 Firm	Firms which are doing well provide the Government player income from corporation tax. They are also key players in stimulating GDP growth.	Firms which fail have negative effects on Banks but also Government as the income from the corporation tax doesn't come in, causing the Government income to be reduced.
	 Bank	Banks pay Central Bank when they take out loans with interest. The interest is turned into a dividend which is then paid to the Government Player.	When a Bank collapses it turns to Central Bank for a bailout loan, which is created from fiat money which creates more debt increasing the Governments deficit.
	 Central Bank	Central Bank issues loans to Government through buying treasury bonds. Increasing the Governments spending power.	However these loans come with added interest which increases the Governments deficit. Also if Central Bank isn't careful when raising interest rates the economy could slide causing massive consequences to income, subsidies and tax.

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