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Abstract

In the aftermath of the financial crisis, attention concerning inequality as a risk factor has risen. Nevertheless studies, focusing on the implications of inequality as a collective risk, remain seldom. Therefore the following paper will discuss why inequality is indeed a collective risk, leading to a social dilemma as known from game theory. The first section examines the collective risks that emerge of disproportionate income distribution and social immobility - as two dimensions of inequality. The second section investigates how these inequalities and their resulting collective risks can remain persistent. Climate change as a risk factor, shares several features with the dynamics of inequality. This will be demonstrated, by applying the results of an experimental study on climate change on the afore mentioned discussion and analysing the implications of additional aspects as unequal initial endowments and strong reciprocity. The paper concludes that the contribution of individuals to lower inequality is highly dependent on the expected probability of risk. If the risk probability is not close to one, contributions are low and cannot reduce inequality substantially while risks remain persistent.

Keywords: Inequality, Social Mobility, Collective Risk, Snow Drift Game
JEL classification: C71, D81, H41, Z13

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1 Introduction

The belief in markets has been shaken long before the financial crisis of 2008. However, since then the question arose, if individuals bear costs and consequences, too large to be taken care of by themselves. Risk like the real crisis of 2008 call for arrangements where risks can be shared within a collective. Apart from exogenous risks such as climate change, there is the question if there are endogenous risks calling for a collective solution. In the case of inequality, classical market economics explain that inequality is related to the individual capabilities of people and their efforts to exploit these. Possible risks emerging from inequality are therefore idiosyncratic and possibly short-termed. In the aftermath of the financial crisis this point of view has been shaken by two prominent explanations of the financial crisis focusing on inequality as one of the major reasons for the outbreak of the financial crisis. The important question emerging in this context is whether inequality is only a temporary issue or a collective and persistent risk and why this is the case.

Answering this question becomes more difficult, as inequality is not a single issue. It rather is a huge agglomeration of factors whose distribution might be unequal. Although a multidimensional perspective on inequality is highly desirable, a clear framework how to handle this issue is still missing. Therefore, there will be a focus on collective risks, which may be a result of two dimensions of inequality: income and social mobility. Income inequality is the important factor for Rajan (2010) and Reich (2010) to explain the recent financial crisis and the macroeconomic risks of general instability, resulting from high-income inequality. The focus on social mobility as a second dimension of inequality follows the question if risks of inequality are only restricted to macroeconomic stability or if further risks emerge like a persistent segregation of society, less equity of opportunities, fewer chances to escape poverty or other forms of discrimination.

If the risks related to inequality are indeed a collective risk, collective action is necessary to prevent them. However, once risks cannot be included in a usual market the problem may be beyond the market's invisible hand to solve. This leads to the question, if the necessity to cooperate leads to a certain solution or if people will end up in a social dilemma, as known from public good games.

The first part of Chapter 2 will explain the connection of inequality and the recent financial crisis as Rajan and Reich did and present a formal model, supporting their view on the risk of inequality. The second part will add another risk of inequality with the dimension of social mobility and thereby extend the definition of risk. Chapter 3 will show why the prevention of inequalities and their respective risks is a public good. With the help of an experiment on the prevention of climate change, the problem of public goods will be explored and with the help of an n-person public goods game it will be shown that the prevention of inequality may indeed end up in a collective risk social dilemma.

2 The Aggregate Risks of Inequality

Inequality is a main topic in social sciences and economics, but until recently, standard economics did not expect income inequality to be a greater aggregate risk for the economy or the society in general. As the characteristics of risk may be lost in single discipline-research, which generalizes and decontextualizes the phenomena from one single perspective (Horlick-Jones and Sime, 2004, p.445), two perspectives on the risk of inequality shall be presented in order to give an idea of the wide range of related risks caused by inequality. One perspective shows the risk of macroeconomic instability, which can be explained by the massive increase in income inequality in the U.S.. The second perspective will show why social immobility is a form of inequality and which risks emerge in this context.

2.1 Income Inequality and Leverage

Income inequality is usually measured through two different methods. The first and most common is the Gini-Coefficient, which consolidates the information over distribution of household income in one single coefficient and ranges between zero and one [1] Is the Gini one, all incomes belong to one household, is the Gini-coefficient zero, income is equally distributed over all households. The simplicity is also the greatest disadvantage of this method as information about the distribution of income between different groups gets lost.[2] This can be described by the 90/10 Differential, as it shows a ratio of the income between the 1th decile and the 10st decile of the population, which is the difference from the lowest 10% to the highest 10% of income groups. Together with the 50/10 Differential and the 95/5 Differential, it may give a better insight in distributional changes within the population (Rajan, 2010, p.24).

2.1.1 Historical Development

In the U.S. income inequality among households has risen steadily. Since the mid 1980's the share of income of 5% of the richest households increased from 22% in 1983 to 34%

[1] The Gini-Coefficient is defined as a ratio of the area between the line of perfect equality (the 45° line) and the Lorenz curve, which plots the cumulative share of population against the cumulative income the households receive in a triangle. This area and therefore the Gini is 0 when the Lorenz curve equals the 45° curve and becomes greater as the inequality in income between households become greater (OECD, 2008, p.39).

[2] Further important disadvantages of the Gini-Coefficient include the difficulty to compare between to states of inequality measured by the Gini-Coefficient (Atkinson, 1970).

in 2007. Wages, generally contributing the greatest part to household income, show the same trend. Between 1975 and 2005 the wages of the 10th decile increased by 65% more than the wages of the 1st decile (Rajan, 2010, p.24). Looking merely at the richest 1% of the households, the effect of widening incomes is even greater. The share of the highest first percentage of total incomes has increased from 10-14% in the 1980's to more than 23% in 2007 after a relative steady fraction of approximately 10% in the period from 1950 to 1980 (Reich, 2010, p.21, figure 1). A closer look shows not only the general trend of a widening distribution of incomes and wages in the U.S but also steady incomes of the so-called middle class, which contributed to the increasing inequality. Male hourly wages of the 10th decile increased until 2005 by cumulative 70% while the wages of the first decile, which represents the lowest income group, decreased by 60%. During these 38 years, wages for the 5th decile, corresponding to what could be described as white-collar workers with basic college education, decreased by cumulative 5% (Heathcote et al., 2010 in: Kumhof and Rancière, 2010a, p.6). Since the distribution effect of tax policy on incomes in the U.S only had a limited effect between 1995 and 2000, pre-tax income inequality does not differ very much from after-tax income inequality (OECD, 2008, p.33).

If the relative increase in consumption compared to income inequality of households is less, one could assume those households substitute their relative income loss with credit. As a result, the debt-to-income ratios of households at the bottom of the income distribution would increase more than debt-to-income ratios of households with higher incomes than the median household (Kumhof and Rancière, 2010b, p.7f.). When comparing the dept-to-income ratios of the wealthiest 5% of households with the rest of the households, this hypothesis can graphically be accepted for the last 20 years (see figure 1). In 1983, the wealthy 5% had higher debt than the average of the 95% group, since 1986, however, debt-to-income ratios of the average households became much higher than these of the wealthiest 5%. In addition to this growing difference between income groups, liabilities of private households compared to GDP have also increased. In 1995 liabilities of private households amounted to 65.7% of total GDP and increased to 96.4% until 2009 with a peak at 99.2% in 2007 (see table 1). This indicates once again that large groups of low-income households have compensated their relative income loss with higher liabilities, especially since 2003.

In several European countries, a somehow similar trend in income distribution and debt of households can be distinguished. The average Gini for income inequality of households in 19 European countries has increased from 0,276 in the mid 1980's to 0,296 in the mid 2000's. In the mid 2000's it ranges from 0,232 (Denmark) to 0,385 (Portugal), which is slightly more than in the U.S. at that same time (0,381). Whereas inequality increased in two-thirds of the European countries, only in France, Greece, Ireland and Spain the dispersion of household income decreased over the whole period (see table 2). To show how the middle class was affected by these changes in the distribution of disposable household incomes a mean-to-median income ratio can be calculated.[3] In all European countries where data is available, this ratio has decreased, except Greece, France and the Netherlands. This means that households at the median income have suffered a relative income loss, just as households of the U.S. middleclass, but to a lesser extent (see figure 2). The distributional effects on after-tax incomes compared to pre-tax incomes have decreased in most of the European countries with the result that the Gini of pre- and after tax income distribution is almost equivalent. Only in Denmark, Greece, Italy and the UK (since 2005) the Gini for disposable incomes is lower than for market incomes (OECD, 2008, p31.ff). The average level of the Debt-to-GDP ratios for the same 19 European countries is about 0.2 point lower than in the US, the growth rates, however, between 1995 and 2006 are much the same. Since 2007 the ratio for the European countries sharply decreased while the growth of the U.S. debt-to-GDP ratio only slowed down for two years (see figure 3). This may be related to the a fast GDP drop while long term liabilities prevented absolute liabilities of private households to decrease as massively as the GDP. Despite the similar empirical findings in European countries, the connection between leverage and income inequality found in the U.S. cannot simply be transferred to Europe because of the different financial systems.

The parallel development of income inequality and household leverage in the U.S. is not casual, neither in economic nor in political terms. Due to a lack of other political measures to fight growing relative income losses of a huge part of the U.S. working population, politicians were afraid to extend distributional policies and to enforce the wage bargaining power of workers (Reich, 2010, p.50ff.). Instead, they promoted private housing as the American way of live, financed by state managed companies regardless of the financial solvency of the households. Consequently, loans, and therefore aggregate household leverage was increasing as well as overall riskiness of financial assets including household loans. Intentionally or not, the U.S. administrations of Clinton and Bush increased this risk taking of lenders by cutting the regulation authorities, which might have prevented such an extensive sup-prime credit provision and the included risks (Rajan, 2010, p.34ff.). The precise but descriptive work of Rajan and Reich about policies and distribution is supported by the theory of political science, which point out the difficulties to maintain or reduce inequality in a democratic market society (McCarty and Pontusson, 2011, p.687f.).

[3] Median income refers to the income at the middle of the distribution whereas mean income refers to the average income of the hole distribution. Show as a ratio between both, means that the incomes of the so called middle class (median income) have fallen relative to the people in society that are in the upper tail of the distribution (OECD, 2008, p.29).

2.1.2 A formal model

The development of a formal model may not only confirm the historical argument made by Reich and Rajan. Most importantly, it highlights macroeconomic risks possibly associated with growing income inequality to the disadvantage of low and middle-income groups. The model of Kumhof and Rancière (KR-Model), which is presented on the following pages, is an explicit attempt to make a formally consistent case for the argument of Rajan and Reich (Kumhof and Rancière, 2010a, p.4). Because the formal model integrates the demand side for credits as well as the supply side, in can indicate if other interpretations of the financial crisis that focus on the supply side of the credit market (the so called "savings glut") might do a better job (cf. Bernanke, 2005; Levitin and Wachter, 2010).

The Background for the stylized facts is the historical development as laid out in chapter 2.1.1 from which (Kumhof and Rancière, 2010b, p.5ff) derive stylized facts to build the general equilibrium model. The central mechanism is being built with two groups, which are referred to as workers and investors. As social mobility is expected to be insignificant in this model, membership of both groups is fixed. 95% of the population is supposed to be workers, with the real wage as their only income source. The rest of the population (5%), are supposed to be investors, owning the complete capital stock of the economy and their sources of income are the return of physical capital and the interest of financial investments. Consumption of workers is supposed to be heavily persistent because of a subsistence consumption level. In case of income losses, a certain consumption level always remains independent from the income development. The real wages are determined by a bargaining process between workers and investors. As bargaining power is assumed to be an autoregressive function, power is persistent and in the event of a crisis workers remain in a situation with little bargaining power for a long time. As specified by Carroll (1998) investors have a "capitalist spirit" and derive utility not only from consumption but also from wealth. Possible motives are diverse and include for example less precautionary savings or the social prestige resulting of wealth. Wealth can take two forms, physical capital and financial assets. The investors income gains will be reinvested in financial assets, helping workers to maintain their consumption level despite the lower income as well as supporting the production function. They stylized facts are completed by the assumption that the financial sector will grow as the inequality rises because of the greater demand for financial intermediation between workers and investors. In equilibrium, under the assumption that both actors maximize their lifetime utility, markets for goods and financial claims are always cleared.

The overall risk of a macroeconomic crisis is integrated in the model by a coefficient reflecting the probability of a crisis. The probability of a crisis in the next period is endogenously determined by the ratio between the outstanding loans of workers and their real income in the actual period. If incomes are decreasing, loans rise and reduce income once more due to the interest obligations of the workers in future periods. Probability of a financial debt crisis increases and shifts the economy towards a positive risk zone. The impact of a financial crisis is defined by the reduction of output, defined as 10% of capital and assets that collapse. The collapse of capital and assets in turn leads to a crisis, affecting as well the financial as the real sector. This is supposed to be a collective risk as it is affecting all individuals.

In the baseline scenario (see figure 4), workers bargaining powers declined by 7.5% in the first ten years. In year 30 after start, a crisis takes place. Note that this crisis is not an endogenous result of the increasing crisis probability, but exogenously defined. As bargaining power of workers decreases in the first ten years, real wages decrease by 6%. The consumption of workers declines only by two thirds relative to their income, leading to an increase in loans to workers and a dept-to-income ratio increasing from 64% to 140% in 30 years. Despite a slow recovery of bargaining power and real wage gains of workers after the first ten years, dept-to-income ratio is still as high as after the first ten years due to the increasing loans. The return to capital (e.g. the income of investors) rises by 2% and because of arbitrage interest for loans to workers rises by 2% too. Income inequality is increasing as investors' income share rises from 30% to 35%. The predetermined crisis in year 30 of the model is characterized by household debt defaults (-10% of financial assets) and a sharp contraction in output (-10% of capital stock). As a reaction, real wages drop by 10%, debt service of workers raise from 3% to 9% due to lower incomes and increasing interest rates. This outcome is determined by a made assumption of which percentage of household debt collapses in the event of a crisis. The higher the household debt defaults, the lower the burden for a household after the crisis (Kumhof and Rancière, 2010a, p.15f).

In the baseline scenario, income inequality after the ten year bargaining power drop is reduced by the increase of real wages resulting from higher capital investments. Should the model expect investors to prefer financial investments rather than capital investments, real wages would rise considerably less while income inequality and crisis probability would be worse. In this framework, the development of income inequality and crisis probability is critically dependent from the fact of how investors use their additional income and in this context a so-called financialization is definitely could be quite costly. Additionally, if workers do not see any perspective to restore their original bargaining power or if the subsistence consumption level is higher, the economy remains in an almost constant state of high-income inequality and crisis probability (Kumhof and Rancière, 2010a, p.18).

The means to reduce the probability of a crisis presented by Kumhof and Rancière are promising. An orderly reduction of household debt managed by state intervention without a drop in output of the real economy reduces the dept-to-income ratio as workers' incomes will not decline as much as if a real crisis would occur. However, as long as bargaining power is not restored, household debt keeps increasing and converges to the pre-crisis leverage level (Kumhof and Rancière, 2010a, p.36, figure 14). Once the bargaining powers of workers are restored to the initial level at the crisis, income inequality will almost reach the initial level, loans and therefore household leverage and crisis probability follow a declining trend (see figure 5). To restore the workers bargaining power will result in higher real wages reducing the return to capital and investments on the long run. Despite these possible problems, reestablishing workers' bargaining power is more convenient than a stock adjustment inasmuch as leverage and therefore crisis probability can be reduced sustainable.

Other solutions such as tax driven redistribution or taxing of returns of financial assets may be promising to reduce inequality and the risk of macroeconomic crises but their impact is hard to determine with this model. Nevertheless, as the use of investors' income has turned out to be very important, taxes might give an impulse to reduce leverage of low-income households and raise real wages by directing investments to the real sector.

There might also be a case for a self-enforcing process, driven by the relation of income inequality, leverage and macroeconomic risk of a crisis. If the impact of a financial crisis is supposed to be higher on small and middle-income households than on high-income households (Torres, 2008, p.47ff.), the destruction of real wages enlarges the gap between consumption and income and therefore advocates higher leverage of households. This raises the probability of a crisis as shown in the model and may lead to a spiral of rising income inequality at the expense of macroeconomic stability. Nevertheless, additional research is needed to highlight the driving factors of this possible process.

2.2 Persistent Social Mobility and Inequality

2.2.1 Risk definition

Until now, the term of risk has been treated under the assumption that there would be only a single well-defined meaning of the term. Economics, technical sciences and implicitly the KR-Model define risk as "the statistical expectation value of unwanted events, which may or may not occur" (Hansson, 2005, p.8). In opposition to the "subjective risk" or "risk perception" which focuses on individuals rather than an aggregate expectation value, risk is supposed to be an objective risk (Hansson, 2005, p.8f.). This view takes only two variables into account in order to measure the aggregate severity of risk: probability and utility. This may fit perfectly into economic models, but the simplicity leaves beside the fact that risk is inextricably connected with interpersonal relationships (Hansson 2005, p.9). Examples of other factors could be Agency, Consent, Rights, Institutions, Intentions or Equity (cf Hansson, 2005, p.9, figure 2). In addition to this problem, the objective risk definition has a utilitarian background as they expect values to be independent from the individuals who carry them. Under this assumption total risks can be outweighed by the total benefits of an action (Hansson, 2005, p.10f.). The KR-Model for example calculates risk as a probability for a macroeconomic crisis that leads to collapses in loans and capital stock, with different outcomes for workers and investors. Within the groups of workers and investors, however, results are aggregated although it is clear that risk exposure within the workers' group may differ to a great extend. The narrow definition of risk in economic and technical sciences might be one of the reasons for the difficulty of augmenting with a crisis probability in communication with and within the public.

In contrast to the technical risk definition for social constructivism "the categories we use to understand and describe the world to each other are socially negotiated" (Horlick-Jones and Sime, 2004, p.447). From this point of view, risk is hardly universal. Whether risk is real or true, threatening or challenging may be different amongst societies and subcultures. The social construction of risk is dynamic because it is derived by the link between values and facts in our understanding of the world. Therefore, from a constructivists view, the dynamic makes it impossible to develop a universal perspective of risk. A solution for an aggregate perspective is to address the specificity of problem situations and thereby overcoming the discipline based borders (Horlick-Jones and Sime, 2004, p.448). As the majority of modern society's favor fair accesses to opportunities and therefore social mobility (Kaufmann et al., 2004, p.747), social immobility could be such a problem situation. This constructivist perspective on risk will not and cannot outweigh the problems of the technical definition of risk as mentioned above. On one side, it is an intention to reduce the epistemological divide. On the other side, the focus on social mobility follows the idea that inequality cannot be fully understood when looking at just one point in time. The mobility of individuals and groups, their prospect for advancement or failure is critical for the assessment of inequality (Stiglitz, 2000, p.36f.). By further developing the theoretical frame of social mobility, other than just macroeconomic risks because of inequality will become clear.

2.2.2 Social mobility and motility

Social mobility is a broader concept describing "any transition of individual or social object of value – anything that has been created or modified by human activity – from one social position to another" (Sorokin, 1927; Ohnmacht, 2009, p.133) and consists of several dimensions of mobility. Most common is the distinction between vertical and horizontal mobility, which describes the transition between or within a social hierarchy. A further distinction is made between intergenerational and intragenerational mobility that refers to the time horizon in which the transition is made or not.[4] Social mobility must not be limited to actual or past movements. It can also refer to possible mobility that does not necessarily need to happen. This capacity for mobility of individuals as well as groups is called motility:

> “Motility can be defined as the capacity of entities (e.g. goods, information or persons) to be mobile in social and geographic space, or as the way in which entities access and appropriate the capacity for socio-spatial mobility according to their circumstances.” (Kaufmann et al., 2004, p.750)

The term motility merges the three elements access, competence and appropriation into a single theoretical framework in order to analyze the relation of social mobility and inequality in economic and sociological terms. According to Kaufmann et al. the first element of motility is the access to different forms and degrees of mobility. On one side agents like individuals, groups or networks have certain possibilities that determine social motility as for example the actual income, wealth or available communication and transportation. On the other side, the same motility is limited by conditions such as class hierarchy or location-specific costs (Kaufmann et al., 2004, p.750). One example, where economics take into account the element of access is the Stiglitz-Model with pareto-efficient markets including wealth and income to explain persistent inequality between generations. Since the wealth of the last generation is transmitted to the actual generation, total inequality is always higher than income inequality[5]. Persistence of total inequality is even higher, when the wealth of the actual generation is supposed to be an increasing function of the income of the previous generation. On the long run, total inequality can disappear because labor earnings slowly reduce the effect of intergenerational wealth transmission until a steady-state (Stiglitz-Model), but this holds only under strict assumptions such as equal saving functions and fertility rates between the rich and the poor (Piketty, 2000, p.440ff.). This independence of total income and saving or reproduction behavior, however, should be questioned, not only from a sociological perspective. As a result, the Stiglitz-Model tends to underline the persistence of inequality and motility as presented in this sociological theory, if the strong assumptions are released.

[4]The dimensions of social mobility mention here are only a selection, for a complete overview over possible dimensions see (Ohnmacht, 2009)

[5]Under the additional assumptions that labor productivity (e.g. the ability of individuals) is constant, independent from previous generations and not negatively correlated to wealth (Piketty, 2000, p.437).

The second element that determinates motility is *competence*. To recognize and make use of the given access, different skills and abilities are necessary. This *competence* can be a physical skill or another personal ability owing to social and cultural capital such as education, knowledge or organization skills for acquisition and transformation of information. Competence is neither independent from *access* nor the last element *appropriation*. Acquisition of knowledge for example relies on the access to capital in most of the cases but also on the motivation to use provided resources, even if there are no direct costs for the agent. Due to its interconnected form, it is supposed to be highly correlated to the competence of older family members. Distribution of *competence* is not only related to access to resources and a given state of ability. As several empirical studies reveal, the distribution of cognitive and non-cognitive skills, seen as one operationalization of *competence*, are highly correlated to the family background. Before schooling this effect is the strongest, but to a lesser extent family background determinates post-compulsory education as well (Machin, 2011, p.407f.). These cycles of disadvantage can run for generations and generate persistent inequality.

The third element (*appropriation*) includes motives, strategies and understandings of agents like individuals, groups or networks. *Appropriation* describes how agents collect, specify and select their options for mobility. This implicates a definite decision of the agent for or against mobility given the level of *access* and *competence* for mobility.

2.2.3 Interim Conclusion

It is difficult to say how motility or social mobility are "connected" to inequality, they are types of social inequality, highly connected to other forms of social inequality (Kaufmann et al., 2004, p.754). Due to the interwoven character of social inequality with other forms of inequality as presented in the KR-Model or in education (cf. Machin, 2011) and gender (cf. Gregory, 2011), the risk of inequality emerges between the connections of the different types that form a persistent social hierarchy or class with low opportunities of advancement neither for individuals nor for groups. This stands in contrast to many modern social theories that favor equity of opportunities for all individuals and social mobility as a prerequisite for a just, stable and efficient society (Kaufmann et al., 2004, p.747). It is therefore legitimate to define persistent social inequality as a risk to society, leaving open to which extend social inequality is risky because of its normative and not universal definition and emphasize that this is not an idiosyncratic risk associated to individuals. It is a collective risk because of its ubiquitous outreach to affect the fundamental values of a modern society such a justice, efficiency and stability.

3 The collective risk social dilemma

When inequality remains heavily persistent in pure economic models as well as in sociological theories despite the collective risks emerging from it, the question arises why there is no action taken against it. This might be the case for a social dilemma, where people defect to contribute in order to reach a common goal because the individual benefits seem to be greater, although in the case of cooperation the collective benefits would be higher. The following chapter will explore the question if the theory of social dilemmas and respective games as the public goods games and the snow drift game can explain why collective action against inequality is hard to achieve.

3.1 Inequality, public goods and game theory

The link between the theory of public goods and inequality is not unobvious. Reducing the collective risk can be assumed to be a public good as there is no rivalry of consumption nor could someone be excluded from the benefits of a lower collective risk. The idea of income distribution or international distribution justice as a public good have been developed before (Thurow, 1971, p.327f.;Kapstein, 1999), but not in the context of a public goods dilemma. Equity per se does not need to be a public good, but if inequality is the cause of collective risks as presented in chapter 2, a fair equity level is a public good as on the one hand no one can be excluded from its benefits while on the other hand no individual suffers as another individual "consumes" the favors of lower risks. To reduce or preserve a particular distribution level is an investment in a public good, to which the social dilemma of public goods can be applied.

Social dilemmas are sometimes referred to as a kind of "social trap" or "social fence" that incorporate a reinforcing course leading to negative outcomes in the long term. To resolve such a trap, individuals need to overcome their short-term interests in favor of positive long-term consequences for society and individuals. The focus on this kind of social dilemma is somehow misleading because other problems such as the model of the prisoners dilemma result in a social dilemma even without the conflict of short- and long-term decisions (Beckenkamp, 2006, p.338f.). Following the definition of economic game theory "social dilemmas are multi-persons decision-making problems in which individual interests are at odds with collective interests" (Colman, 1995, p.201) and their abstract solution is usually called the *N-person Prisoner's Dilemma* (NPD). As the name suggests the basis is a model of social interaction with more than two players (n-person). The NPD game is characterized by three common properties. First, every player has the choice between two or more decisions, that are *cooperate* and *defect* in the baseline scenario. Second, because *defect* has the higher payoff, it is the dominant strategy for every player, irrespective of the decisions of the others. Third, if all players choose the dominant strategy of defecting, the result is a Nash-equilibrium that is not pareto-efficient. In other words, should all players choose to cooperate, the payoff is higher for everyone than if all choose to defect or any other possible combination of decisions. The third property grasps the social dilemma, as all players are trapped in a pareto-inefficient state although they could reach a pareto-efficient equilibrium if all would cooperate. This social dilemma is ubiquitous for all players because as long as there is no interventional mechanism that guaranties for cooperation of the other players, rational individuals choose to defect (cf. Colman, 1995, p.205f.). When a threshold is included in the game, there is no longer only one Nash-equilibrium. The payoff for single self-regarding players depends on the probability of cooperation of the other players. As a result, multiple Nash-equilibriums exist where no strategy is dominant and the critical fact is the probability for cooperation of the others. Without cooperation or cheap talk, information about the others is scarce and the dilemma remains the same because players will choose to defect (Ledyard, 1995, p.144f.).

The game theory of social dilemmas (NPG) has been investigated in different experimental framings. Apart from the *resource dilemma*[6], the framing that gained most attention from researchers is the public goods dilemma (Colman, 1995, p.212). In this experiment the subjects can contribute a part of their personal goods (c) to a public fund that yields a benefit (b) for all subjects of the experiment where $b > c > 0$ (Doebeli and Hauert, 2005, p.749). Because subjects that defect to cooperate do not face the costs of contribution (c), their payoff (b) is higher than the payoff for contributors ($b - c$). The dominant strategy of the self-regarding subject would be to defect as in all NPD games (Gintis, 2009a, p.46). These economic experiments show that subjects cooperate under certain circumstances contrasting with the predictions of a self-regarding subject. When public goods experiments are repeated with decision rounds held one after another, the level of contributions is declining over the rounds and subjects who started with altruistic contributions change to a self-regarding behavior (Gintis, 2009a, p.64f.). The so-called free riders who did not contribute from the beginning can change the behaviour of the former contributors. With their violation of norms such as fairness, fair sharers may find it unfair to contribute to their burden and to the gain of the free riders and reduce contribution at the end of the game (Fehr and Schmidt, 1999 in: Milinski et al., 2008, p.2294). However, subjects can sustain a more cooperative level if they have tools like communication or sanction at disposal. If groups have the power to punish defectors for example with fines, contribution increases. When subjects are allowed to communicate without making binding agreements (cheap talk), the increase in

[6]Resource dilemmas present a social dilemma experiment that is used to show the "tragedy of the commons" as described by Hardin (1968) and simulate the shared use of public resources. The important difference is that individuals "take-some" instead "give-some" as in public goods experiments (Colman, 1995, p.214).

contributions is even more significant while sanctioning decreases (Ostrom et al., 1992 in: Gintis, 2009a, p.65). Other factors that determine outcome in contribution level of such public good experiments are the size of the decision group, individual differences between subjects, attribution of intent to other subjects and the framing of the game (Colman, 1995, p.215).

The approaches to the public goods dilemma are diverse just as public goods are in reality and so are the designs of public goods games and respective experiments. To describe the possible dilemma emerging from the collective risks of inequality, the negative effects of climate change will give a basis for analysis of the social dilemma.

3.2 The game for climate change

The experiment designed and carried out by Milinski et al. (2008) is a useful basis because three central characteristics are comparable to the inequality topic. First, the negative effects of climate change are assumed ubiquitous because all subjects of the game are affected in the same way. Second, the occurrence of the negative event is defined by an assumed probability and not certain. Third, to prevent the negative event successfully, collective action (e.g. cooperation) is needed to reach the threshold. In other words, only by cooperation the players of the game can reach the goal as the effects of individual action are very limited. The three characteristics only include a simplified version of the risks discussed in chapter 2 but for a start, they are useful to show the nature of the social dilemma.

The game of Milinski et al. consisted of thirty groups with six players each.[7] Every player had an endowment of € 40 at the beginning, knowing that he could spend € 0, € 2 or € 4 in each of the 10 rounds the game would last. The results of every round were immediately reported to the members of the group and groups kept unchanged. As the results were reported anonymously, reputation could not be accumulated. Only the strategies and changes in strategies could be observed by the players. If the sum of all contributions would reach or surpass € 120 all players would gain what is left from their initial endowments minus their contributions. All players knew that if the threshold would not be reached, there personal goods would be lost by the probability of 0.9. In two other treatments with ten groups each, the personal goods would be lost by the probability of 0.5 and 0.1. The public fund for the prevention of climate change was definitely lost, even if the threshold was reached (Milinski et al., 2008, p.2292). To lose the investment in the public fund and to only gain a benefit from the prevention of

[7]The participants of the computerized experiment where German undergraduate students. The participants knew that personal payoffs would be given in Euros while the sum of the public account would be spend for a press advertisement on climate protection in a daily German newspaper (Milinski et al., 2008, p.2294).

negative effects stands in contrast to usual public good games that assume a collective benefit for all, for example by building bridges or dikes. Milinski et al. (2008) therefore expect players to be risk-avers.

It is assumed that free riders contribute nothing, fair sharers € 2 and Altruists € 4 each round. Under the assumption that all subjects keep to the same strategy for the whole experiment, the average account values that a subject can expect at the end of the game are the following. If all subjects are fair sharers and contribute € 2 each round, their payoff would be € 20 irrespective of the loss probability because the threshold would be reached in any case. If the probability of a crisis is 0.9, the self-regarding subject would choose to cooperate by providing a fair share of € 2 each round because the average payoff (€20) is much higher than with a free rider strategy (€ 4). In the 0.5 case, average payoff is the same for the fair sharer and the free rider strategy, but in the case of 0.1 crisis probability free riding results in a higher payoff (€ 36) than a cooperation with a fair share (€ 20) would do. As the expected payoffs show, one could suggest that at least in the 0.9 scenario players on average choose to cooperate while in the 0.1 and 0.5 scenarios reaching the threshold is doubtful. The 0.9 case results in a Nash-Equilibrium because if just one of the players refuses to choose the rational strategy to contribute a fair share this would lower the personal expected payoff and therefore be irrational. Assuming that other players keep by their strategy, a strategy change to free riding would result in not reaching the threshold and thus lowering the expected personal payoff by 90% while altruism would reduce the personal payoff due to unnecessary contributions to the public fund that are lost anyway (Milinski et al., 2008, p.2ff. (SI Annex)). Other players could change their strategy in order to reach the threshold by changing to altruism or free riding and cut the losses. As reducing losses by free riding has a lower payoff than altruism, as long as only a few players defect, any self-regarding individuals would favor altruism.

3.2.1 Snow drift game and fairness

The situation, where cooperation is favorable even if other players defect, is a special version of the NPD called the "snow drift game" (SDG). The initial 2-player SDG describes the situation of two cars on the road, blocked by a snow drift. To get home, both drivers have the option to do nothing and no one gets home with the payoff 0. If one of the drifters removes the snow, both get the benefit of going home (b) while the payoff of one of the drivers is reduced by the burden of removing the snow (c) resulting in the payoff ($b - c$). If the drivers cooperate, everyone has half the share ($c/2$) but the full benefit (Souza et al., 2009, p.581). In an N-person game, where N drivers are blocked and remove the snow all together, everyone gets the payoff $b - c/N$. If only k remove the snow, the payoff is reduced to $b - c/k$ for the drivers that shovel snow because $N > k$ while the other drivers get payoff b. The crucial difference to NPG games is that a self-regarding player would cooperate, even if the others defect as long as $b > c > 0$ (Doebeli and Hauert, 2005, p.749). In the N-person SDG, this leads to a stable state of contributors and defectors. Assuming a necessary threshold of people needed to shovel the snow, to produce a public good or to prevent a crisis leads to a social dilemma as long as there are not enough contributors (Souza et al., 2009, p.582f.). Note that in the game design of Milinski et al. (2008) the social dilemma of a SDG only evolves in the case of the scenario of 0.9 crisis probability. In the other two scenarios, the expected benefits (b) are lower than the costs of cooperation (c) via altruism or a fair share. The condition of $b > c > 0$ is therefore not satisfied in the other scenarios.

Because of the repeated game decisions, dynamics may arise, especially at the end of the game when one would suspect that in the 0.9 scenario, self-regarding players struggle to reach the threshold. Contributing a fair share and altruism would be rational in order to reach the threshold but because of a sense of fairness players may act irrationally. If one player defects and others see the possibility that this subject would benefit from free riding, they might find this unfair and refuse to cooperate even at their one disadvantage (Fehr and Schmidt, 1999 in: Milinski et al., 2008, p.2292).

3.2.2 Results of Milinski et al.

The results of Milinski et al. (2008) report, that in the scenarios of 0.1 and 0.5 crisis probability, players started with a fair share contribution of € 2 in almost all groups, despite the fact that the rational strategy would have been to defect from the beginning. Over the rounds contributions declined and the threshold was reach in almost no group. Average contributions still reached € 92.2 and € 73.0 respectively, which is significantly higher than 50% of the threshold. A possible explanation for this behavior is the framing of the game. Because facing a risk instead of contribution to a public fond to build infrastructure for example, the risk-aversion of the player increased the contributions away from a Nash-Equilibrium (Goeree et al., 2003 in: Milinski et al., 2008, p.2293). In the 0.9 scenario 5 out of 10 groups reached the threshold. Groups that did not reach the threshold collected on average € 112.8 and had therefore the smallest expected benefit due to high contributions, lost investments and high probability to lose the remaining personal goods.

As predicted, the contributions of fair sharers where highest in the 0.9 and lowest in the 0.1 scenario but the strategies of the players changed significantly during the game (see figure 6). In the 0.9 scenario the number of free riders as well as the number fair sharers decreased during the first five rounds compared to the last five rounds while the number of altruists, which contributed all of their personal goods, increased at the end. The amount of fair sharers decreased also in the other scenarios, but instead of altruism, free rider strategies increased massively. It is extremely interesting, that in the 0.9 scenario in the last round, when many contributions would have been needed to reach the threshold, contributions decreased irrationally. This might be a matter of the fairness argument as made before. Some players had not contributed anything, which led other players to irrationally contribute nothing as well despite the probable loss of all benefits (Milinski et al., 2008, p.2293f.).

Despite the rational solution of contributing a fair share to the public fund in the 0.9 crisis probability scenario, half of the groups failed to reach the threshold, necessary to prevent a probable outbreak of the crisis. The failure to reach a pareto-efficient solution in half of the cases makes the social dilemma under a collective risk evident.

3.3 Adaptation on inequality

Despite the similarities mentioned in chapter 3.2, the adaptation of the climate change game of Milinski et al. (2008) to inequality is not only a change of the framing of the experiment. With the risk of inequality, possible counteractions against the risk, the costs of contribution and the payoffs for individuals change the nature of the game. The following questions need to be answered to conclude if there is still a possible SNG that results in a collective risk social dilemma.

- Which counteractions are needed to prevent the collective risk?
- What are the costs of cooperation, compared to the losses when defecting?
- Does the different initial position of heterogeneous subjects change their behavior?
- Are individuals able to handle the uncertainty of a risk, captured by probabilities and their respective expected payoff values?

This subchapter will address the first four questions and try to analyze their impact on the nature of the experiment. The last question refers to a wider discussion about uncertainty and risk perception in game theory an experimental economics. This question, together with the work of bringing together all the questions in one experiment will be deferred to future work.

3.3.1 Cost and benefits of contributions – a zero-sum game?

Counteractions against inequality can be diverse. Possible examples include a progressive income tax, which has a direct redistributive effect or incentive schemes in the area of education, which can change inequality indirectly on the long run. No matter if they are direct or indirect, reducing inequality always requires a form of redistribution as inequality is very persistent and respective distributions levels will remain unchanged. As in the climate change experiment, we will not take up the discussion about measures to reduce inequality and simply assume that a certain level of redistribution is necessary to reduce inequality. This effort cannot be achieved by single contributions making collective action imminent to reach a threshold that implies a stable or decreasing inequality.

In the SDG of climate change, all players who would contribute to climate change faced the same costs. In the inequality case, as redistribution is needed, everyone can contribute to redistribution but only a part will face a cost that will be transferred to subjects of the lower tail of the distribution, which therefore have a benefit, by contributing. In game theory the situation of redistribution can be modeled as a zero sum game (Mueller, 1982, p.155). The assumption is that the benefits for the individuals receiving the contributions outweigh the costs for individuals, which contribute. In the end the sum of the payoffs is zero and as long as there is no higher payoff possible, a Nash-Equilibrium exists (Gintis, 2009b, p.143f.).

Including the insights from chapter 2, lower inequality would result in a lower crisis probability and therefore in higher expected outcomes. The game would not be any longer a zero-sum game because every subject would gain a benefit when the threshold is reached. In this case, a self-regarding subject would only contribute when the expected benefits are greater than the given cost of cooperation. Because subjects cannot be sure of the cooperation of others, the dominant strategy is defect. Interestingly enough, even if all cooperate this might not result in the best payoff for every subject because the costs of contribution for the subjects at the upper tail of the distribution (e.g. the richest) might exceed the expected benefits under a lower risk. The event of reaching the threshold via cooperation is therefore not necessarily pareto-efficient, even if it is more efficient from a collective perspective. Under the assumption of a given risk of inequality and the necessary threshold to prevent this risk, one critical factor that determines if this inequality risk game leads into a collective risk social dilemma is the mode of redistribution. If the burden of contribution for rich people exceeds the benefits when reaching the threshold, the Nash-Equilibrium is lower than the pareto-efficient solution. In other words, if the risk of inequality is high enough and the costs of prevention reasonable, the probability of a collective risk social dilemma is given.

3.3.2 Strong reciprocity and redistribution

Until now it has been assumed, that the subjects from the lower tail of the distribution have no costs of contribution because they receive the contributions, made by the subjects from the upper tail of the distribution. The idea that receivers only have a negative cost of contribution is questionable. Fong et al. (2006) question the usual explanations for the existence of actual welfare states. The voluntary and egalitarian support of redistribution among strangers can hardly be explained by the median voter model with rational individuals. With the alternative concept of *strong reciprocity*[8] they explain forms of redistribution to a broader extend (Fong et al., 2006, p.1441). For a collection of empirical studies, Fong et al. conclude that attitudes towards redistribution depend to a great extend on the belief that the “poor” work hard. Individuals have a predetermination to contribute to redistribution even at their own cost, but “they withdraw support when they perceive that the poor may cheat of fail to cooperate by not trying hard enough to be self-sufficient and morally upstanding” (Fong et al., 2006, p.1442). Note that this attitude to contribute is in contrast to altruism. Under the assumption of altruism, contributions of altruists are negatively correlated to the contributions of others. If one contributes more than the others do, incentives for free riding increase (Croson, 2008, p.784).

When assuming strong reciprocity, individual contributions can lead to higher contributions of all others. In terms of wealth or income, the costs of contribution for poor subjects are negative as they are receivers and their non-material contributions could be ignored in the game, but the concept of strong reciprocity shows that but their contributions have a value that could be the reason for others to maintain their support even at costs.

3.3.3 Initial endowments and behavioral consequences

The game for public goods as well as the SNG has assumed that the initial endowments of every single player are the same. Also in the experiment of Milinski et al. (2008) each subject was given the same amount of € 40 at the beginning. When inequality is the risk factor that calls for collective counteractions, the assumption is not an equal distribution but exactly the opposite. The assumption of equal initial endowments for all of the players is therefore wrong and the question arises if a different framing of the experiment will lead to different outcomes.

An experiment of Chan et al. (2008) analyses the differences in voluntary contributions to public goods in two different settings. In both experiments three subjects of a group are repeatedly asked to contribute voluntarily for a public good. In the case of equal distributed endowments, subjects almost reach a pareto-efficient level of contributions despite a lower Nash-equilibrium. The experiment is repeated under the same conditions, but with different endowments for each of the three group members. As the inequality rises between the group members, one would expect that richer subjects compensate the loss in contributions of poorer group members. But this is only

[8]The concept of strong reciprocity refers to the idea of and can be defined as “a propensity to cooperate and share with others similarly disposed, even at personal cots, and a willingness to punish those who violate cooperative and other social norms, even when punishing is personally costly and cannot be expected to entail net personal gains in the future” (Fong et al., 2006, p.1441).

true to a limited extend because contributions of rich subjects always remain under the predicted level of equity theory while poor subjects always contribute more than predicted (Chan et al., 2008, p.834, figure 2).

If these results are adapted to the inequality game, the probability of contributions will decrease and therefore the chance to reach the threshold in order to prevent the risk of inequality will decrease. The collective risk social dilemma of inequality as developed above is likely to be reinforced if the inconsistent assumption of equal initial endowments is released.

4 Conclusion

The multidimensional perspective on inequality with the examples of income and social mobility not only greatly increases the possible collective risks in comparison to a single-discipline perspective. The broad view also incorporates diverse solution strategies. One opportunity lies in the special characteristic of risk in contrast to usual public goods. When the perception or risk aversion against risk of inequality increases, expected benefits rise and make individuals contributions more likely, irrespective of the personal endowments.

With more feedback on individual contributions against collective risks, the discourse about risk may change and solution strategies become legitimate. The actual discourse about risks of nuclear energy plants in Germany is an excellent example how the opinion of a public majority about risks and acceptable costs to prevent them can change rapidly.

With the inequality tax, Robert Shiller has presented a concept that can form public discourse and at the same time reduce inequality. The inequality tax is a two-step process. First, the public has to define a desirable inequality level according to current inequality. Second, each year taxes need to be adjusted according to the defined inequality goal (Shiller, 2003, p.149ff.). Despite the real world problems of tax collection and the fact that this proposal only refers to income inequality, with the necessary public debate about inequality goals it could form public discourse about inequality risks, legitimate collective actions and prevention of the otherwise possible social dilemma.

In order to develop and evaluate possible solutions to collective risks of inequality some questions still need to be answered. What is the mathematical solution for the inequality game and can uncertainty in the collective risk social dilemma be designed as something different than a certain probability value?

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Appendix

Figure 1: Dept-to-income ratios for the U.S.(Kumhof and Rancière, 2010a, p.29, figure 5)

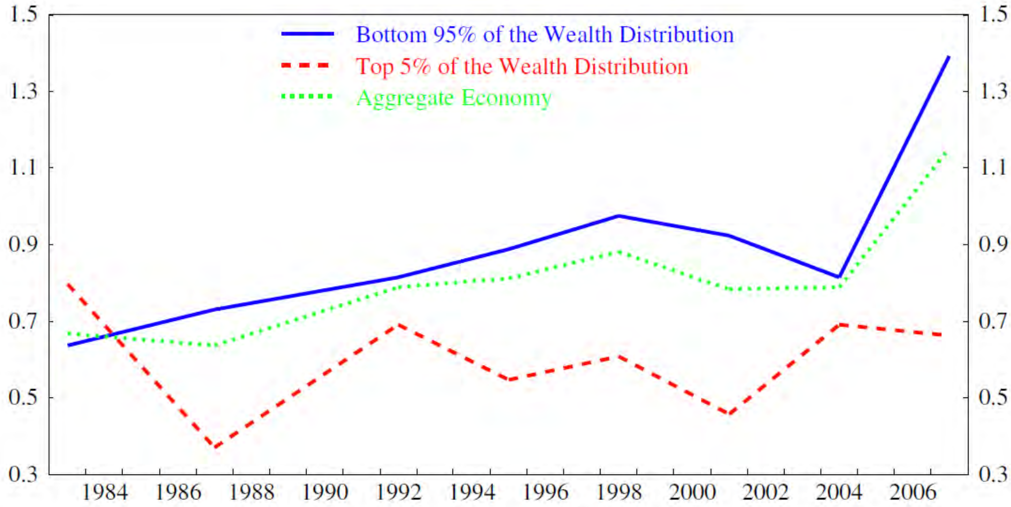

Figure 2: Changes in the ratio of median to mean household disposable income in European countries and the U.S. (OECD, 2008, p.30)

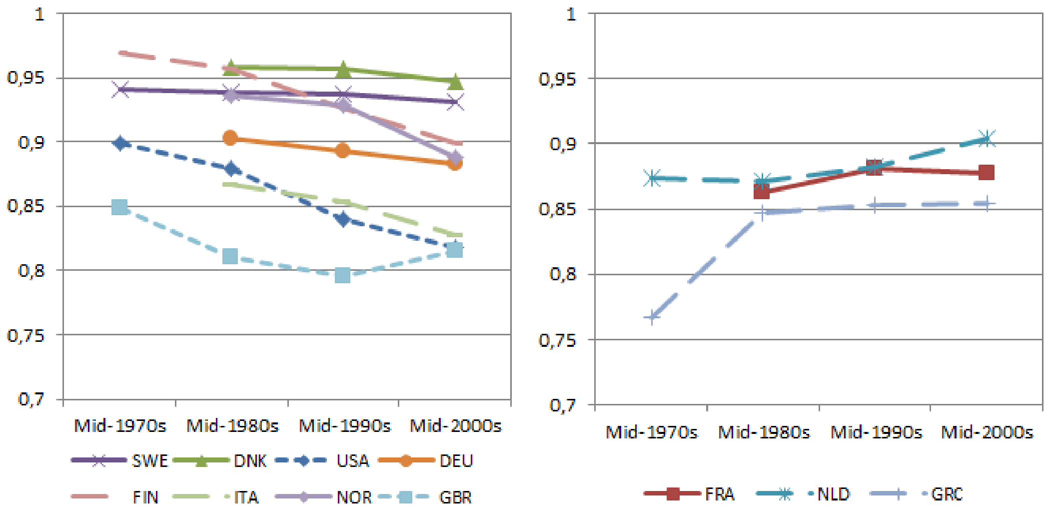

Figure 3: Ratio of GDP to liabilities of private households (debt-to-GDP ratio) (OECD, 2011)

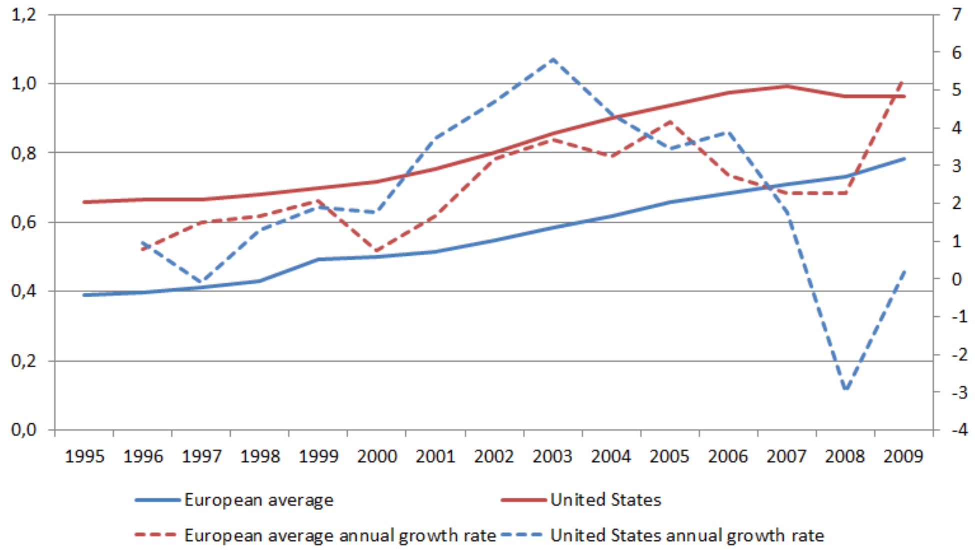

Figure 4: IRF's for Base Line Scenario of General Equilibrium Model (Kumhof and Rancière, 2010a, p.32)

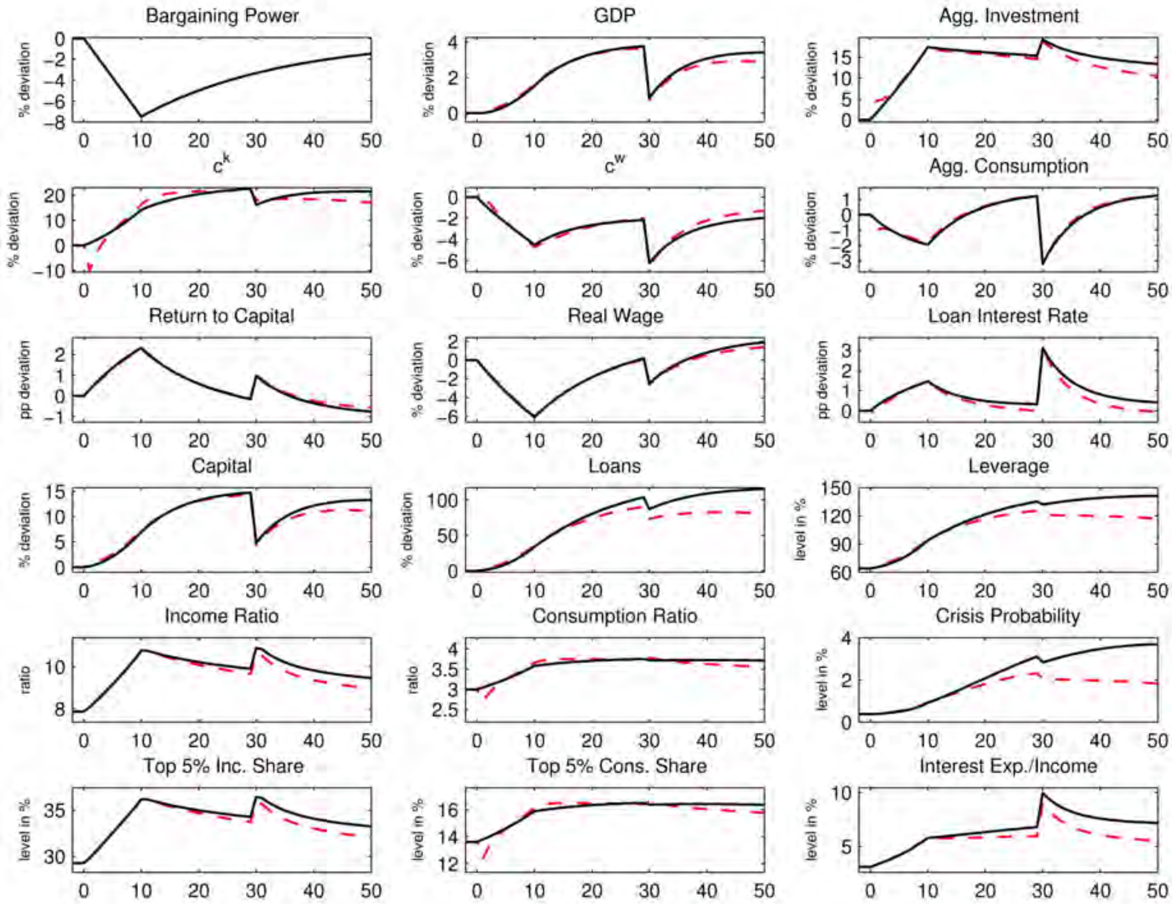

Figure 5: IRF's for Restoration of Workers' Bargaining Power (Kumhof and Rancière, 2010a, p.37)

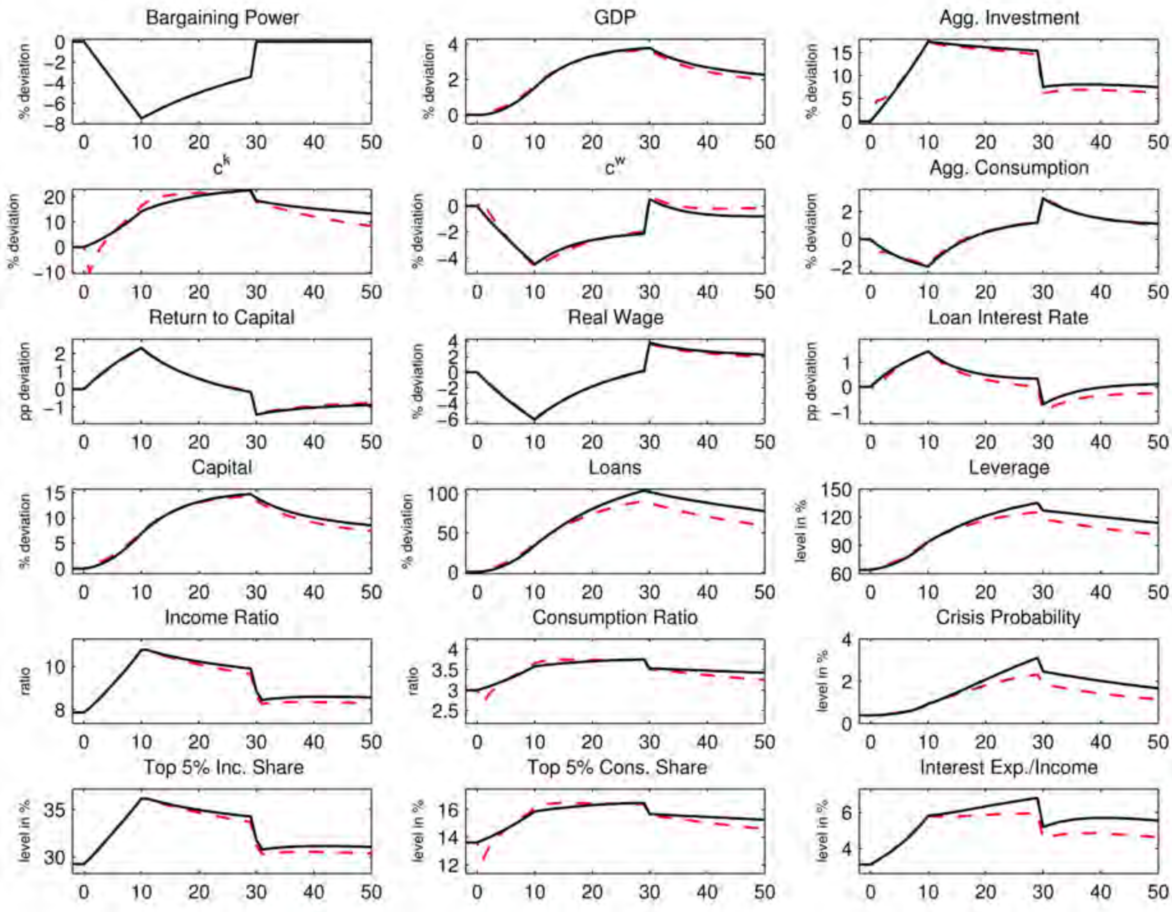

Figure 6: Decision changes over ten rounds for different crisis probabilities (Milinski et al., 2008, p.2293, Figure 3)

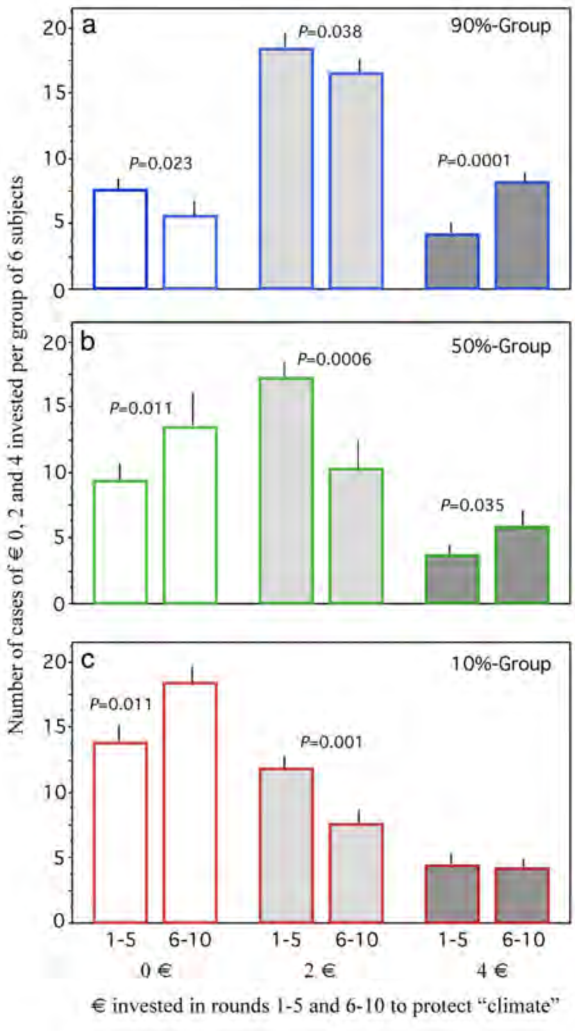

Table 1: Loans-to-GDP ratio for European countries and the U.S. (OECD, 2011)

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Austria	0,422	0,433	0,445	0,439	0,462	0,471	0,478	0,486	0,49	0,512	0,545	0,55	0,542	0,545	0,565
Belgium	0,366	0,379	0,387	0,405	0,409	0,397	0,38	0,385	0,399	0,405	0,431	0,452	0,468	0,494	0,537
Czech Republic	0,076	0,07	0,07	0,064	0,07	0,074	0,083	0,098	0,116	0,138	0,179	0,194	0,247	0,279	0,3
Denmark	0,796	0,831	0,864	0,91	0,905	0,909	0,937	0,983	1,031	1,081	1,159	1,21	1,274	1,33	1,458
Finland	0,341	0,319	0,299	0,296	0,314	0,318	0,321	0,345	0,386	0,422	0,468	0,502	0,515	0,538	0,612
France	0,346	0,348	0,348	0,343	0,355	0,353	0,359	0,367	0,381	0,4	0,431	0,455	0,48	0,498	0,526
Germany	0,615	0,648	0,668	0,689	0,722	0,728	0,72	0,718	0,718	0,705	0,693	0,669	0,632	0,613	0,634
Greece	0,058	0,068	0,076	0,087	0,102	0,128	0,168	0,209	0,245	0,298	0,364	0,418	0,472	0,509	0,524
Hungary	0,06	0,046	0,043	0,038	0,044	0,057	0,076	0,112	0,167	0,197	0,234	0,261	0,297	0,362	0,374
Ireland							0,5	0,552	0,618	0,713	0,842	0,93	0,989	1,105	1,208
Italy	0,182	0,182	0,186	0,195	0,216	0,223	0,225	0,267	0,289	0,315	0,348	0,371	0,39	0,395	0,422
Netherlands	0,591	0,64	0,694	0,761	0,831	0,87	0,897	0,952	1,03	1,078	1,141	1,176	1,181	1,188	1,279
Norway	0,602	0,58	0,575	0,607	0,602	0,56	0,601	0,664	0,709	0,721	0,731	0,739	0,784	0,762	0,858
Portugal	0,261	0,308	0,409	0,47	0,549	0,597	0,631	0,676	0,727	0,772	0,824	0,873	0,901	0,925	0,965
Sweden	0,459	0,459	0,466	0,472	0,486	0,502	0,526	0,545	0,571	0,604	0,643	0,669	0,69	0,728	0,819
Switzerland					1,146	1,122	1,128	1,159	1,213	1,214	1,228	1,213	1,176	1,146	1,209
United Kingdom	0,657	0,64	0,643	0,649	0,666	0,69	0,733	0,788	0,843	0,91	0,929	0,971	0,997	1,004	1,035
European average	0,389	0,397	0,412	0,428	0,492	0,5	0,516	0,547	0,584	0,617	0,658	0,685	0,708	0,731	0,784
United States	0,657	0,667	0,666	0,679	0,698	0,716	0,753	0,8	0,858	0,901	0,936	0,975	0,992	0,962	0,964

Table 2: Trends in Gini coefficients of income inequality in European countries and the U.S. (OECD, 2008, p.27)

	Mid-70s	**Mid-80s**	**1990**	**Mid-90s**	**2000**	**Mid-2000s**
Austria		0,236		0,238	0,252	0,265
Belgium		0,274		0,287	0,289	0,271
Czech Republic		0,232	0,232	0,257	0,26	0,268
Denmark		0,221		0,215	0,226	0,232
Finland	0,235	0,207		0,228	0,261	0,269
France		0,3	0,29	0,27	0,27	0,27
Germany		0,257	0,258	0,272	0,27	0,298
Greece	0,413	0,336		0,336	0,345	0,321
Hungary		0,273	0,273	0,294	0,293	0,291
Ireland		0,331		0,324	0,304	0,328
Italy		0,309	0,297	0,348	0,343	0,352
Netherlands	0,251	0,259	0,278	0,282	0,278	0,271
Norway		0,234		0,256	0,261	0,276
Poland					0,316	0,372
Portugal	0,354	0,329	0,329	0,359	0,385	0,385
Spain		0,371	0,337	0,343	0,342	0,319
Sweden	0,212	0,198	0,209	0,211	0,243	0,234
Switzerland					0,279	0,276
United Kingdom	0,282	0,325	0,373	0,354	0,37	0,335
EU average	**0,291**	**0,276**	**0,287**	**0,287**	**0,294**	**0,296**
United States	0,316	0,338	0,349	0,361	0,357	0,381

Notes: In the first panel, data refer to changes from around 1990 to the mid-1990s for the Czech Republic, Hungary and Portugal (no data are available for Australia, Poland and Switzerland). In the second panel, data refer to changes from the mid-1990s to around 2000 for Austria, the Czech Republic, Belgium, Ireland, Portugal and Spain (where 2005 data, based on EU-SILC, are not deemed to be comparable with those for earlier years).