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Fairness, Efficiency, Risk, and Time

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Nr. 281/2007

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ISSN 0930-8334

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Abstract

We present a model of a 2-person-2-period-economy with specific (human) capital. Although the individuals are purely selfish, the outcome is seemingly guided by pro-social behavior. We find in our model economy that fairness and efficiency are positively related whereas risk aversion seems to have no major impact on the seemingly fair behavior. A rise in the time preference increases the disadvantaged subject's aspiration for equal outcomes but reduces the advantaged subject's willingness to accept them.

Keywords: Pro-social behavior, utility maximization, time preference, risk attitudes.

JEL classifications: D 63, C 78, D6

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[1] I would like to thank Björn Frank, Heinz-Peter Spahn, and Mei Wang for helpful comments and discussions.

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1. Introduction

Traditional economic theory mainly relies on the assumption of utility-maximizing behavior of individuals. In contrast, a vast literature of empirical, especially experimental studies shows that economic theories only based on this principle are too narrow. Data indicate that individuals do in specific situations take the utility of other individuals into account. This deviation from textbook theory may, of course, lead to markedly different economic predictions and policy advice.

In order to refine predictions and policy success, experimental economists claim to use empirical findings to improve economic theory and support alternative theoretical approaches. Theorists, however, strongly tend to resist to such claims. As experimental and behavioral economists up to now cannot present one *general* theory, capturing all behavioral deviations from standard theory, theorists bother to which extent behaviorally modified theories may be applicable. Consequently, they reject any changes in the utility function and call for an endogenous modeling of behavioral aspects.

Therefore, we present a model of human economic behavior which shall contribute to the solution of three economic problems: Firstly, the model can explain why it might be rational also for purely self-centered individuals to treat other subjects in a way which is seemingly more in line with concepts of 'fairness' than it should be expected under utility-maximization behavior. Hereby, we use 'fairness' as a generic term for the seemingly kind behavior and abstain from detailed motivational distinctions (e.g., altruism (Andreoni and Miller 2002, Cox et al. 2002), reciprocity (Rabin 1993, Dufwenberg and Kirchsteiger 2004, Falk and Fischbacher 2006), inequality aversion (Fehr and Schmidt 1999, Bolton and Ockenfels 2000), envy/spite (Brennan 1973, Kirchsteiger 1994, Dufwenberg and Güth 2000)), as individuals in our model act for selfish reasons.

Secondly, and probably even more importantly, the presented model will refer to fair behavior in an intertemporal perspective. As optimization in respect of future production opportunities is at the core of the model and future production is the driving force behind the seemingly fair behavior, the model just naturally gives insights into the relationship and interaction of fairness and time preference. Insofar, the presented model goes further than models of other-regarding preferences in a sequential perspective (Dufwenberg and Kirchsteiger 2004, Battigalli and Dufwenberg 2005, Falk and Fischbacher 2006).

Thirdly, with the proposed model we are able to study the general relationship between fairness, risk and efficiency. Although we consider our model as plausible, we do not claim that it perfectly maps the actual reasoning behind human decision-making and the current economic environment. Instead, it refers to the hard and primitive world which our early ancestors have been faced to millennia ago and which has coined our decision heuristics in the process of human evolution (Gintis 2006). In other words: We do not state that modern economies are best described by our model but that we fairly approach reality by assuming that individuals behave *as if* they lived in such conditions.

Our model is related to the theory of reciprocal altruism (Trivers 1971, Axelrod and Hamilton 1981), which predicts that selfish individuals provide costly benefits to others if they can expect them to reciprocate in future periods. The specific characteristics of our approach are that giving is one-sided, not dependent on others' behavior, that we model technology and preferences explicitly and, therefore, are able to study with one single model the influences of time and risk preferences and (relative) productivity on the (seemingly) fair behavior.

The remainder of the paper is organized as follows: In the next section, we describe our model. In section 3, we explain how we calibrate the model and how we are going to evaluate it. Section 4 shows the results which are discussed in section 5. Section 6 concludes.

2. The Model

2.1 General Structure

For simplicity, and in order to stress the main driving forces we present a model economy that exists of two people making decisions in two periods. The two individuals A and B, to whom we also may refer to as Robinson and Friday, live for possibly two periods on an island. Period 1 represents present time and period 2 stands for the future.

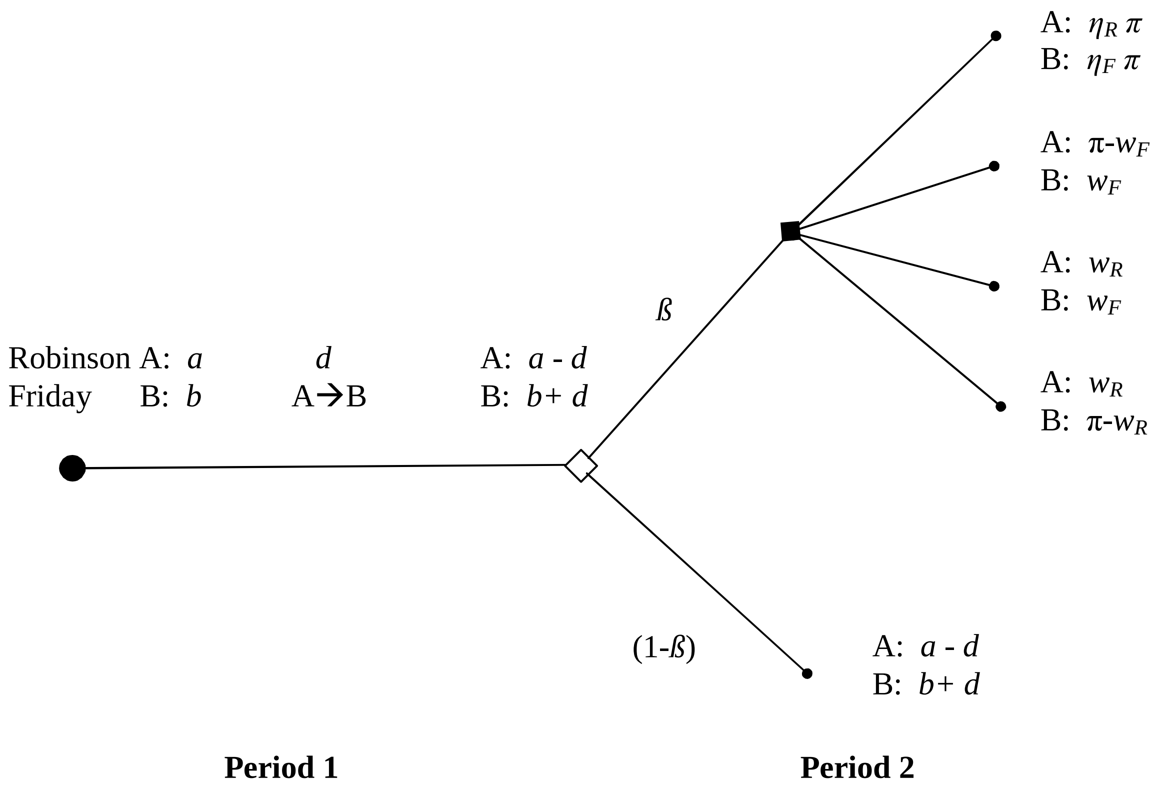

Figure 1: Structure of the Model

In period 1, Robinson and Friday meet for the first time and are (already) endowed with resources. Robinson is endowed with goods of the amount *a*, Friday with the amount of *b*. In period 1, Robinson is able to give an amount *d* of his resources to Friday. At the end of period 1, Robinson and Friday carry over their resources, (*a*-*d*) and (*b*+*d*), to period 2.

In period 2, Robinson and Friday are possibly able to agree on the common production, for which they need to use their resources. The division of the goods is determined before their production via alternating-offer bargaining (Ståhl 1972, Rubinstein 1982). The bargaining solution is characterized by four possible cases, which will be explained later on. As "future is … uncertain" (Keynes 1937, p. 213), it is not sure whether Robinson and Friday will remain together on the island and be able to jointly produce in period 2. This will only be true with probability β. With probability (1-β), (at least) one of the two individuals will leave the common place on the island so that production is not possible and both will just stay with their endowments (increased or decreased by the donation *d*). In any case, at the end of period 2 Robinson and Friday consume their goods, which originate from pure storage or from production in period 2.[3]

With our model, we mainly focus on the causal relationship of fairness and time preference. Therefore, we do not exogenously impose pro-social attitudes on the utility function but model an economic environment that – under standard utility maximization - endogenously leads to a (seemingly) fair outcome. Main element of this environment is the opportunity of common production in period 2, which may serve as an incentive for one individual to donate to the other one in period 1. This donation *d* we take as a measure of a (seemingly) pro-social behavior.

Similar to fairness, we model the issue of time preference endogenously. Following Rae (1834, p. 57), who identified the general uncertainty of life as a main source of time discounting, we treat common production as an uncertain future event.[4, 5] This means that in our model the cause of time discounting applies to the driving economic force and source of pro-social behavior (i.e., to the prospect of future production). Accordingly, we take *ß* as a measure of time preference.

Note that the main scope of our model is not to study the economic consequences that we should expect if we just *assume* individuals to be pro-socially motivated *or* impatient. Instead, we are interested how pro-social attitudes and time preference fundamentally interact. Therefore, we go one step behind and approach the relationship of fairness and impatience by studying the interaction of the respective causal conditions.

2.2 "Households'" Utility

Robinson and Friday receive utility from the consumption of goods in period 2. The utility is

$$u_P(x) = \frac{x^{1-\gamma}}{1-\gamma}, \qquad 0 < \gamma < 1 \qquad (1)$$

[3] The usual 'malleability assumption' applies, i.e., goods can be used for production as well as consumption.
[4] Interestingly, Anderhub et al. (2001) find that individuals' delay and risk aversion is positively correlated.
[5] In a similar way, Becker and Mulligan (1997) interpret time preference as the weight people assign to future opportunities. For applications of their theory of "endogenous time preference", see Stern (2000) and Haaparanta and Puhakka (2004).

where *x* is the amount of goods available to person P (Robinson or Friday, respectively) for consumption and γ is the coefficient of constant relative risk aversion (CRRA)[6]. For the utility gained from consumption in period 2, it does not matter whether the goods directly originate from unproductive storage in period 1 or from manufacturing in period 2.

Note, again, that production in period 2 is not possible in any case. Think, for example, about the possibility that a ship might approach Robinson's island, save him and take him away. Then, a joint production is no more achievable for Friday, left alone back on the island. The same applies to Robinson if Friday (for whatever reasons) leaves Robinson and joins his old tribe. Therefore, person P's expected utility in period 1 in respect of consumption in period 2

$$E_1 u(x_{P,2}) = \beta \frac{x_{P,2,Poss\Pr od}^{1-\gamma}}{1-\gamma} + (1-\beta) \frac{x_{P,2,NoPoss\Pr od}^{1-\gamma}}{1-\gamma} \tag{2}$$

is a weighted average of the utility in the cases that in period 2 production *might* (PossProd) or *might not* (NoPossProd) be possible.[7]

2.3 Production

Production in period 2 is carried out by specific human capital, only. Our concept of specific human capital is based on the idea that the two individuals are gifted with specific abilities. These abilities are made productive and developed to human capital by 'investing' the resources that both individuals carry from period 1 to period 2.[8]

As the natural abilities are specific to their bearers, human capital is specific as well. Accordingly, the two types of human capital cannot fully be substituted one against the other.

[6] We stay here with the usual terminology ("risk aversion") although neither Robinson nor Friday is confronted with a risky choice when they have reached period 2.

[7] E is the expectation operator.

This fact results in the production function of Cobb-Douglas type

$$y = \tau \cdot (a-d)^{\alpha} (b+d)^{\sigma-\alpha} \quad (3)$$

where (*a*-*d*) and (*b*+*d*) is A's and B's (Robinson's and Friday's) human capital, measured in terms of the resources necessary to form it. τ is a technology parameter, α and σ-α are the partial output elasticities of the respective factors *a* and *b*, and σ is the coefficient of the returns of scale. As it will turn out later, the assumption of specific human capital is crucial for the model outcome. However, this assumption is not as artificial as it seems to be at first glance. On the contrary, this assumption is in line with 'conventional wisdom' that different people are specifically gifted (even if the fields to which their personal gifts refer to are not equally useful in economic terms). In addition, one has to note that some kind of work cannot successfully be done even by the strongest and most gifted person, because he or she needs assistance for a successful outcome. Think about hunting or defending against wild animals on Robinson's and Friday's lonely island. Insofar, the production function reflects the 'economic' conditions of our early ancestors' small-scale societies that coined human decision behavior (Gintis 2006).

2.4 Bargaining Solution

If new goods are produced in period 2, they will be divided in the way Robinson and Friday have agreed on before starting the production. We assume that Robinson and Friday will behave according to non-cooperative bargaining theory (Ståhl 1972, Rubinstein 1982). For the matter of clarity and comparability, we first present the bargaining solution in general textbook terms and, then, refer to the specific case and notation of our model economy.

[8] Usually, the term "human capital" refers to training and education. For our island example, it might be more intuitive to think about means that strengthen body and health. For early work on the theory of human capital, see Becker (1962; 1964) and Schultz (1963).

The general outcome in the case of bargaining with outside options and bargaining time t converging to zero is the following[9]:

$$x_A^{**} = \begin{cases} \eta_A \pi & \text{if} \quad u(w_A) \le u(\eta_A \pi) \quad \text{and} \quad u(w_B) \le u(\eta_B \pi) \\ \pi - w_B & \text{if} \quad u(w_A) \le u(\eta_A \pi), \quad u(w_B) > u(\eta_B \pi) \quad \text{and} \quad u(w_A) \le u(\pi - w_B) \\ w_A & \text{if} \quad u(w_A) \le u(\eta_A \pi), \quad u(w_B) > u(\eta_B \pi) \quad \text{and} \quad u(w_A) > u(\pi - w_B) \\ & \text{or} \quad u(w_A) > u(\eta_A \pi), \end{cases} \quad (4)$$

where x_A^{**} is the equilibrium payoff of individual A (and of B symmetrically), π is the total benefit of an agreement, w_A and w_B are the outside options of A and B, and η_A and η_B are A's and B's shares of the total payoff π in case that both are not restricted by their outside option. u(•) is the utility function as defined in the previous subsection.

The (potential) shares η_A and η_B satisfy the conditions

$$\frac{u(\eta_A \pi)}{u(\eta_A \pi) + u(\eta_B \pi)} = \frac{r_B}{r_A + r_B} \quad (4a) \quad \text{and} \quad \frac{u(\eta_B \pi)}{u(\eta_A \pi) + u(\eta_B \pi)} = \frac{r_A}{r_A + r_B} \quad (4b)$$

with r_A and r_B being A's and B's marginal bargaining costs[10] and $\eta_A + \eta_B = 1$.[11] Accordingly, A's (potential) share η_A is positively related to B's relative bargaining costs $r_B / r_A + r_B$ and vice versa. This means that an individual's share is the higher, the (relative) lower his or her bargaining costs are.

[9] Equation (4) is a modified version of Muthoo's (1999, p. 103) Corollary 5.1. The modification directly reflects that the space of bargaining solutions is restricted by the outside options (see, Muthoo 1999, p. 105, Corollary 5.2). Furthermore, equation (4) is extended for the case of nonlinear preferences, as we assume $0 < \gamma < 1$. An identical utility function is assumed for all individuals. Note that the values of the shares η_A and η_B depend on the curvature of the utility function and deviate from those in Muthoo (1999), chapter 5, pp. 99-135.

[10] Being precise, r_P is the *marginal logarithmic rate* of the bargaining costs $x(1 - e^{-rt})$.

[11] In the case of linear preferences, equations (4a) and (4b) would collapse to $\eta_A = r_B / r_A + r_B$ and $\eta_B = r_A / r_A + r_B$ (Muthoo 1999, p. 103).

How does this general representation of the bargaining solution translate to our specific model? In our island economy, the production output y is the total benefit π that individual A and B (Robinson and Friday) receive from their bargaining agreement.[12] The resources plus/minus donation, $a-d$ and $b+d$, are A's and B's outside options, w_A and w_B. The amount of goods available for consumption if production in period 2 is possible, $x_{A,2,\Pr odPoss}$ and $x_{B,2,\Pr odPoss}$, is determined by the respective equilibrium bargaining payoff for A and B, x_A^{**} and x_B^{**}. The (potential) shares in our model are $\eta_A = \eta_B = \frac{1}{2}$, as we do not focus on details of bargaining and conveniently take A's and B's marginal bargaining costs as identical, $r_A = r_B$. Accordingly, we can rewrite equation (4) in a model-specific way:

$$x_{A,2,\Pr odPoss} = \begin{cases} \frac{1}{2}y & if \quad u(a-d) \le u\left(\frac{1}{2}y\right) \quad and \quad u(b+d) \le u\left(\frac{1}{2}y\right) \\ y-[b+d] & if \quad u(a-d) \le u\left(\frac{1}{2}y\right), \quad u(b+d) > u\left(\frac{1}{2}y\right) \quad and \quad u(a-d) \le u(y-[b+d]) \\ a-d & if \quad u(a-d) \le u\left(\frac{1}{2}y\right), \quad u(b+d) > u\left(\frac{1}{2}y\right) \quad and \quad u(a-d) > u(y-[b+d]) \\ & or \quad u(a-d) > u\left(\frac{1}{2}y\right), \end{cases} \quad (4.1)$$

How can we interpret equation (4.1)? To illustrate the answer to this question, we present four figures (2.1-2.4) that represent the four possible cases of the bargaining solution, i.e., the four lines of equation (4.1). The left pair of columns of each figure shows A's and B's utility from the outside options, *a-d* and *b+d*, and the middle pair of columns shows the utility from half of the production output, ½*y*. The right pair of columns represents A's and B's utility from the actual bargaining solution that they agree on, having considered the outside options and the (potential) production level shown by the left and the middle pair of columns. The columns are marked with specific patterns where vertical and horizontal lines refer to A's and B's outside option respectively, the grid pattern to half of the production, and diagonal lines to the residuals, i.e., the difference between total output and the opponent's outside option.

[12] Note that the implicit depreciation rate is 100% as *the future* is condensed to only one period (period 2) in our model economy.

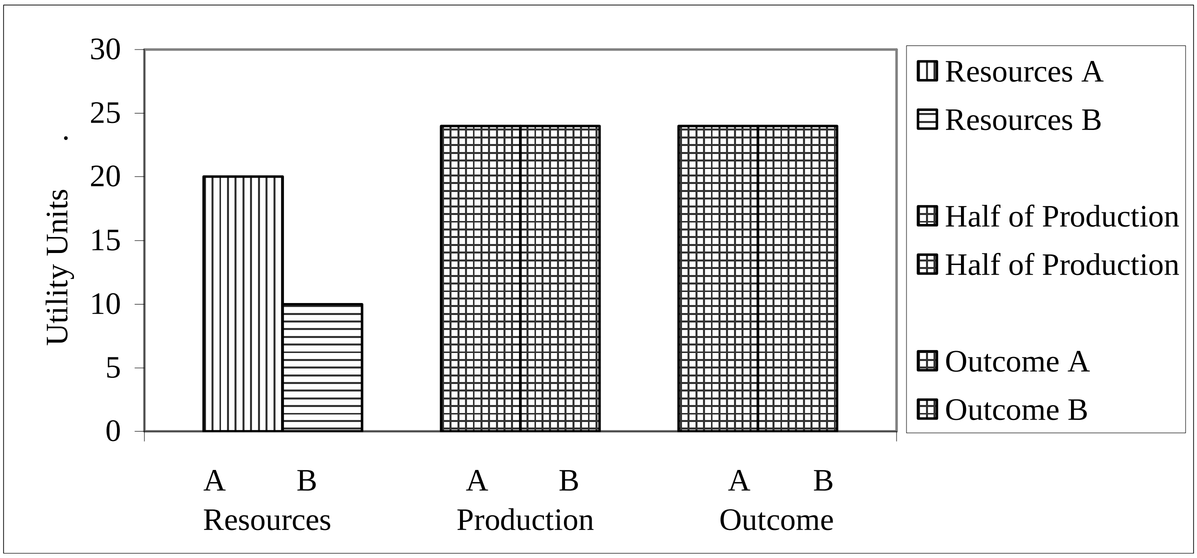

Figure 2.1: Solution to Bargaining with Outside Option – Case 1

Figure 2.1 (equation 4.1, line 1) represents the most favorable case: The utility that A and B experience from a division of the production output, $y = \eta_A y + \eta_B y = \frac{1}{2} y + \frac{1}{2} y$, exceeds the utility of both respective outside options, *a*-*d* and *b*+*d*. Therefore, A and B agree on the common production and, due to equal marginal bargaining costs, on an equal split the output. By the bargaining agreement, both individuals can increase their utility level.

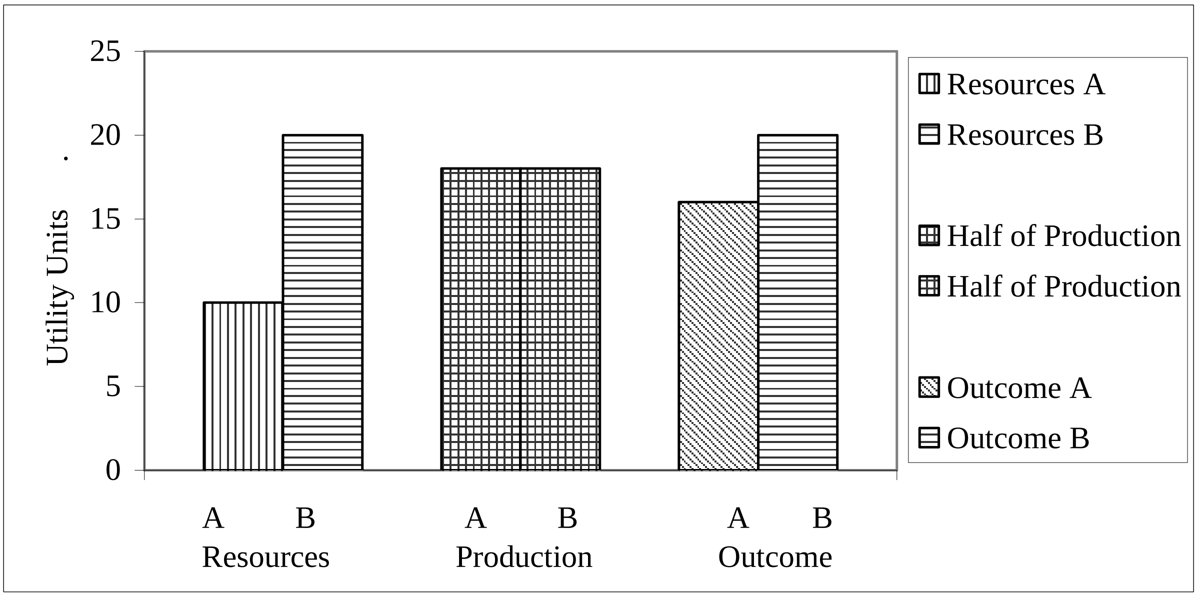

Figure 2.2: Solution of Bargaining with Outside Option – Case 2

In the intermediate case (figure 2.3 / equation 4.1, line 3), the utility of half of the production exceeds only the utility of individual A's outside option, $u\left(\frac{1}{2} y\right) > u(a-d)$, but not the utility of individual B's outside option, $u\left(\frac{1}{2} y\right) < u(b+d)$. Therefore, individual B stays with her[13] outside option $(b+d)$ whereas individual A receives the residual $y-[b+d]$. Of course, individual A will only accept the residual, as long as he is not better off with his outside option, $u(y-[b+d]) \geq u(a-d)$). Otherwise, also individual A will prefer his outside option (as shown by figure 2.3 / equation 4.1, line 3). The latter is the least favorable case where neither A nor B is able to increase the own utility by a bargaining agreement.

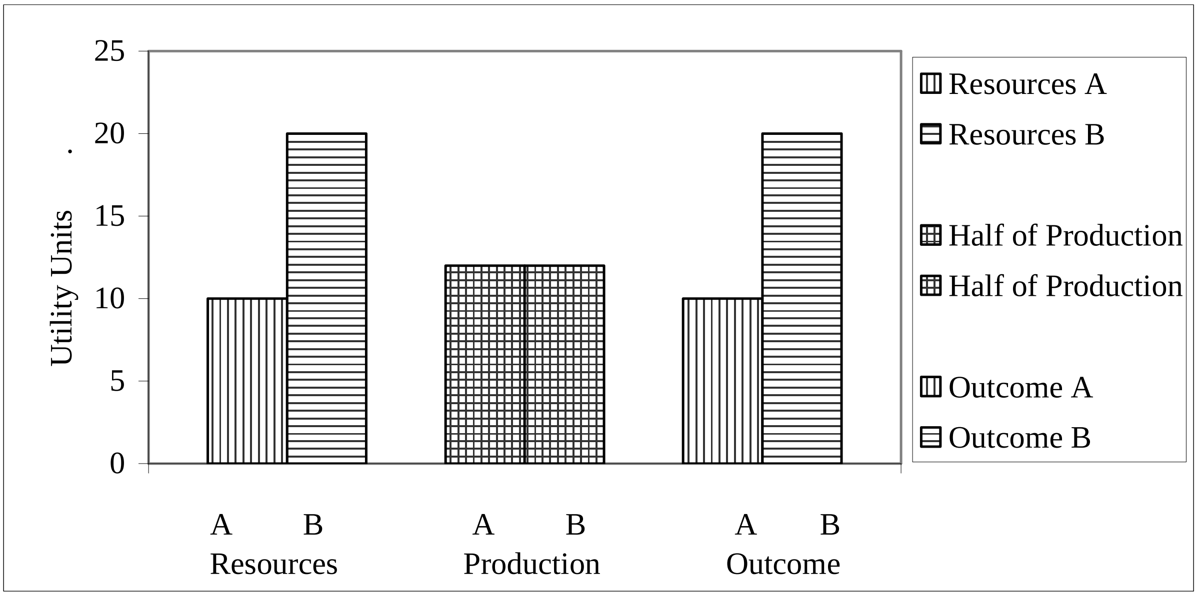

Figure 2.3: Solution to Bargaining with Outside Option – Case 3

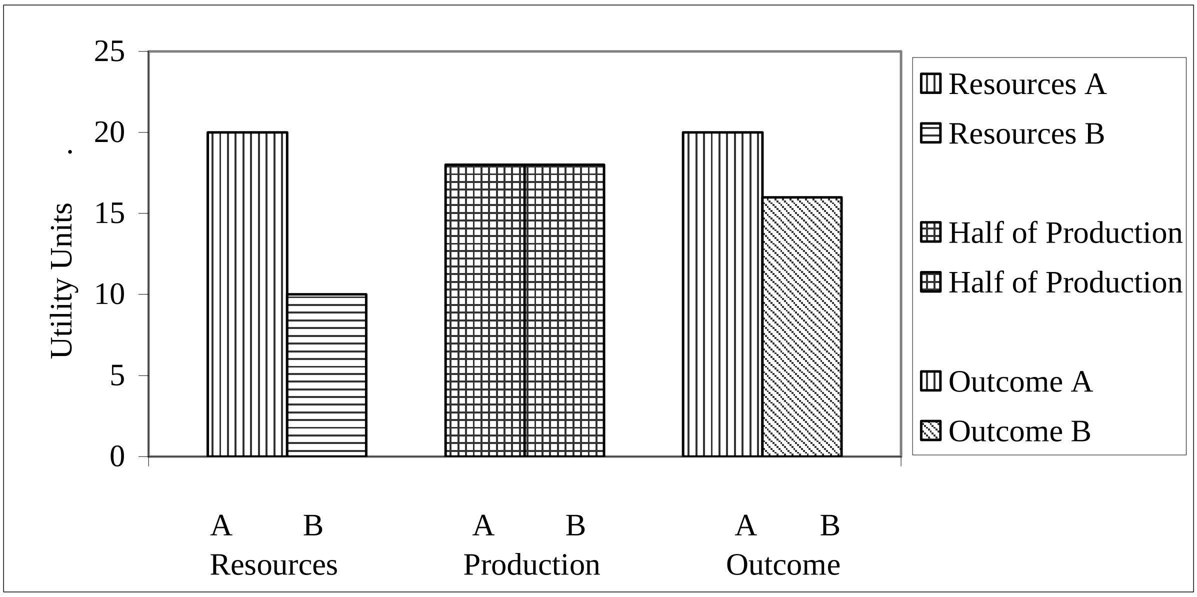

Figure 2.4: Solution of Bargaining with Outside Option – Case 4

[13] Despite of our island example ("Robinson and Friday"), we use feminine pronouns for individual B.

Figure 2.4 (equation 4.1, line 4) shows the case opposite to figure 2.2 (equation 4.1, line 2). Here, individual A is better off with his outside option, and individual B might want to accept the respective residual.

Resuming the description of our model economy, we can see that the expected utility, as defined by equation (2), mainly depends on three factors: the resource endowment, the production technology, and the bargaining power. In general, an individual's expected utility will increase with its share of resources because the share of resources determines the individual's outside option. However, as production is technically specific and resources[14] are not fully substitutable one against each other, the given total amount of resources will lead to a high production level when it is equally distributed among the two individuals. More precisely: The more the relative endowment of resources fits to the individuals' relative output elasticity, the higher the production level. This characteristic of our model accounts for the possibility that the benefits of a technically more efficient production may – in *absolute* terms - overcompensate the potential loss of bargaining power, caused by a less favorable endowment. In other words: An individual's expected utility is not necessarily monotonically increasing with his or her initial share of resources; instead, a smaller initial share of resources may locally be associated with a higher expected utility. In this case, it is rational for a well-endowed individual to voluntarily donate resources to poorer opponents. The receiving individual will not reject as he or she is better off than without donation (as we will see in the next section). Accordingly, our two-period "intertemporal" economy is characterized by a seemingly *fair and altruistic* behavior, although individual preferences are solely *self-centered.* This noteworthy result is due to the model's characteristic of future social production.

3. Measuring Fairness and Efficiency

In the last section we have explained that a simple model economy with a merely two-period "intertemporal" structure and quite common and plausible assumptions on the production

[14] Note that the production output depends on the input of specific human capital developed from resources.

technology can generate a (seemingly) fair and altruistic behavior, although the decision-making individuals behave strictly according to the concept of the self-centered and rational *homo oeconomicus*. More important, the model gives us the opportunity to study which effects changes in the 'deep parameters' have on the two magnitudes of interest: fairness and efficiency.

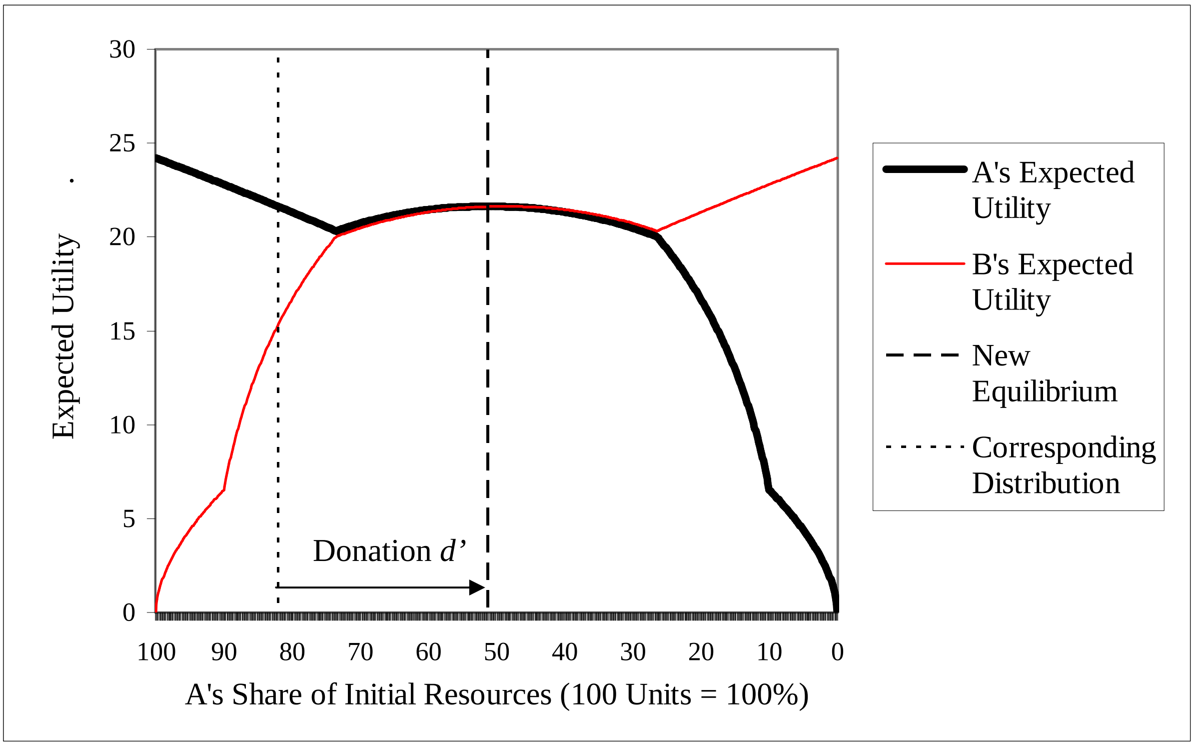

Figure 3.1: Measuring Donation

To facilitate the understanding of the measures of fairness and efficiency that we are going to apply, we first describe the model outcome that we receive for plausible parameter values[15]. Figure 3.1 shows how the expected utility of individual A and B depends on their share of the total initial endowment, which we assume to be 100 resource units. The shares are expressed in terms of A's initial resources (abscissa), implying that individual B is endowed with the rest of the total resources.

A's expected utility, shown by the bold curve, is highest if he owns all (i.e., 100 units) of the initial resources. In this case, A is best off if he stays with his endowment and does neither donate nor invest his resources for a common production. With a decreasing share of resources, A's expected utility is (initially) also decreasing. With A's share decreasing further, his expected utility starts to grow again, as, then, both individuals benefit from common production. A's expected utility is increased up to a local optimum, from where on his expected utility decreases down to zero and zero initial resources, respectively.

B's expected utility is represented by the thin curve. It develops in the opposite way of A's expected utility. It is highest when A's share of the resources is zero, and lowest when A's share is 100%. Due to common production, also B's expected utility is hump-shaped for moderate distributions. B's local utility maximum is generally associated with a resource share of A equal or smaller than at A's own local maximum.[16]

The dashed vertical line stresses A's local utility maximum. For a share of initial resources (moderately) higher than at his local maximum, it is optimal for A to donate the exceeding resources to B. Individual B will accept the donation as, thereby, also her expected utility is increased. Therefore, we refer to A's local maximum as 'new equilibrium'.[17]

With respect to A's expected utility, the resource distribution marked by the dotted vertical line corresponds to the one at the 'new equilibrium'. Despite of a different relative resource endowment, both distributions are associated with an equal expected utility of A. [18] Therefore, we call the distribution indicated by the dotted vertical line 'corresponding distribution'. It is incentive-compatible with the highest possible donation to B, which is represented by the length of the arrow. We label the highest possible amount of donated resources as donation *d'* and, in doing so, distinguish it from lower donation levels associated with lower initial resource shares of A. For our further analysis, we will focus on donation *d'*.

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[15] Details of the parameterization are described later on in this subsection.

[16] Note, also, that the two corresponding kinks, associated with a very small initial endowment and low expected utility of A and B, respectively, enclose the endowment distributions where (at least) one individual benefits from production. In contrast, the high utility kinks, stressing the non-monotonicity in A's and B's expected utility, confine the endowment distributions with both individuals being better off with production.

[17] Due to the symmetry characteristics of our model, we abstract here and in the following from resource distributions that are located on the right-hand side of B's local optimum. Similarly, we implicitly ignore the small range of distributions confined by A's and by B's local optimum in which neither individual A nor individual B has an incentive to donate.

[18] Note that the vertical lines intersect the bold black curve at the same level (expected utility = 21,64 units).

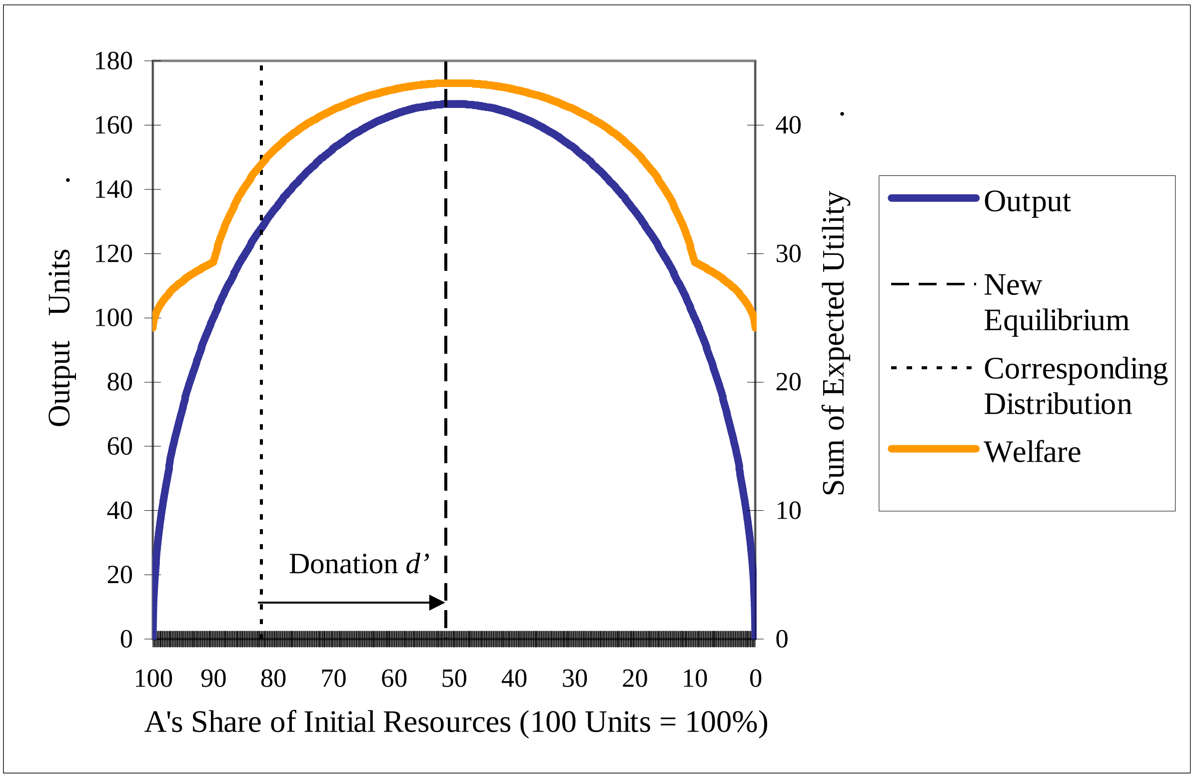


Figure 3.2: Measuring Output and Welfare

Figure 3.2 shows how production output[19] and welfare depend on the relative initial resource endowment. We define welfare as the sum of A's and B's expected utility. Again, the vertical lines show the 'new equilibrium' and the 'corresponding distribution'. Donation *d'* is represented by the arrow.

For the calibration procedure, we generally follow the methodology of Kydland and Prescott (1982)[20] but do take stylized values when it is required by the logics of the model. We take the coefficient of risk aversion to be $(1-\gamma)=0.570$[21], the time preference factor $\beta = 0.966$ (both, Hess 1993, p. 715), and the returns of scale $\sigma = 1$. The partial output elasticity we take as $\alpha = 0.5$ because it is a priori plausible to assume an equal productivity of

[19] For the matter of clarity, we mention again that production only takes place if at least one of the individuals is better off with production than with his or her outside option. The respective area is confined by the two kinks in the welfare curve. Insofar, figure 3.2 only shows *potential* production output outside the kinks, where production does not take place. However, this information is only of theoretical relevance as a local maximum in A's expected utility (i.e., the 'new equilibrium') only exists if both (and not only one of the) individuals are better off with production than with their outside options. Similarly, in the case of the 'corresponding distribution' production generally takes place for plausible parameter values. Additionally, we consider showing the potential output to be more plausible than to replace it by zero production or the sum of endowments where no production takes place. In any case, the welfare measure is not affected by these considerations. It does *not* build on *potential* output *but* on *actual* expected utility.

[20] For an overview, see Cooley (1995).

[21] Note that we use a notation different from Hess (1993).

individual A and B.[22] Then, we choose the technology parameter τ such that the sum of A's and B's utility from the consumption of the pure resources is equal to the sum of their expected utilities when A is endowed with 90% and B with 10% of the resources. This is, in our opinion, a proper substitute for an equilibrium condition, which we apply to the case of a highly disproportionate initial distribution, we are interested in. As already mentioned above, the marginal bargaining costs are assumed to be equal, $r_A = r_B$.

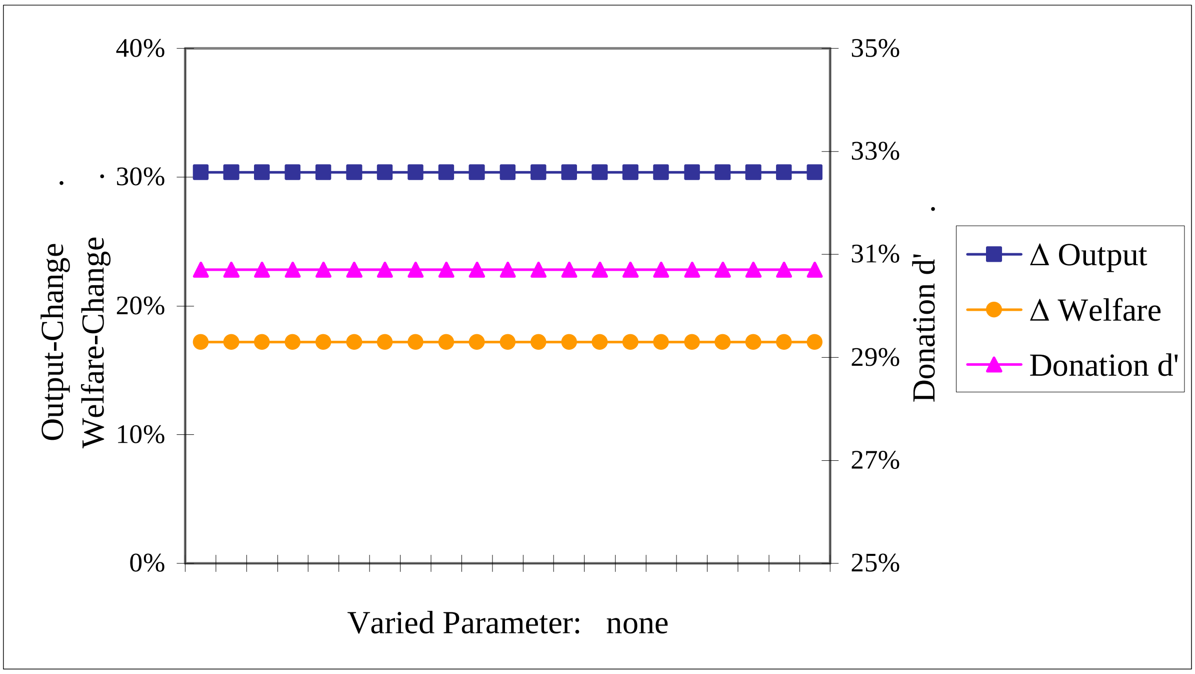


Figure 4.1: Effects of 'Parameter Change' on Donation (Baseline Parameterization)

Now, we are going to explain the evaluation procedure that we will apply in the following section: To identify the effects of time, risk, and productivity on fairness and efficiency, we vary the coefficients of time preference β, risk aversion $(1-\gamma)$, and partial output elasticity α by plus/minus 3%. Figure 4.1 shows our main tool to visualize these effects. The abscissa, in principle, describes the variation of the respective production/utility parameter (however, the parameters are kept constant for the pure matter of explanation). The triangled line displays how donation *d'* [23] (as percentage of the total resources) is affected by the parameter variation. Donation *d'* refers to the second ordinate and we take it as our main measure of (seemingly) fair behavior. The squared line and the circled line refer to the first ordinate and show to which degree output and welfare[24] are increased by donation *d'*, i.e. by the shift of the

[22] As mentioned above, the sum of initial resources is normalized to 100 units.
[23] See, figure 3.1.
[24] See, figure 3.2.

relative initial resource endowment from the 'corresponding distribution' to the 'new equilibrium'. Both, output and welfare, we take as indicators for the economic efficiency of A's behavior.

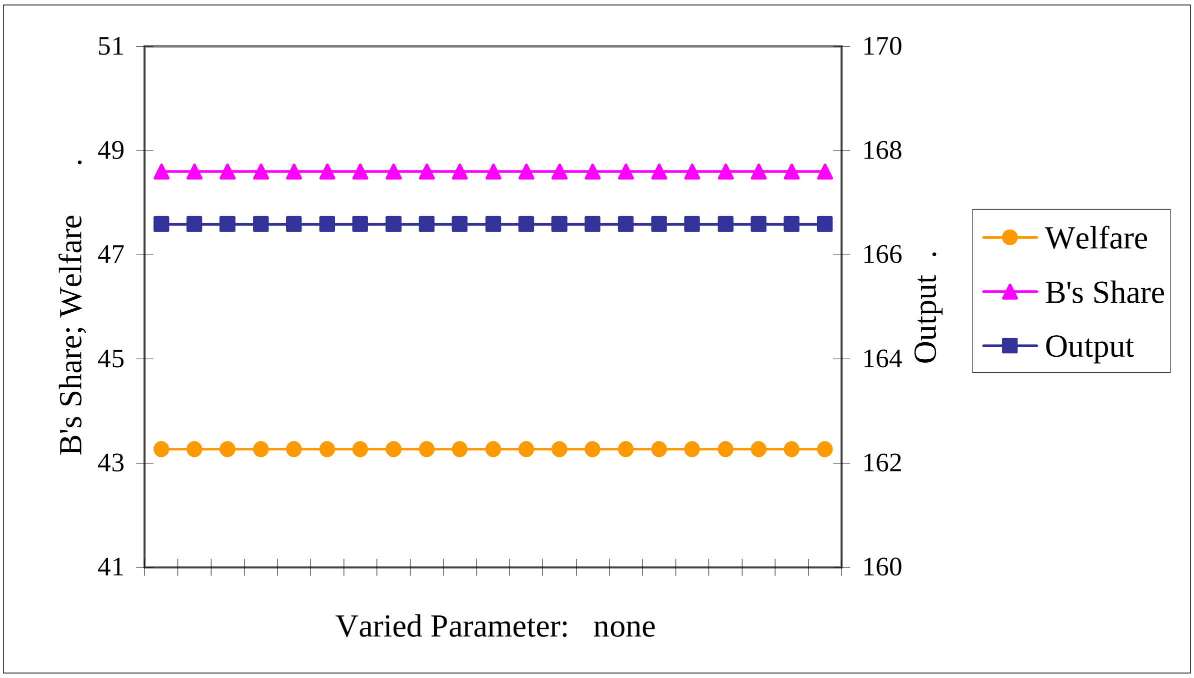
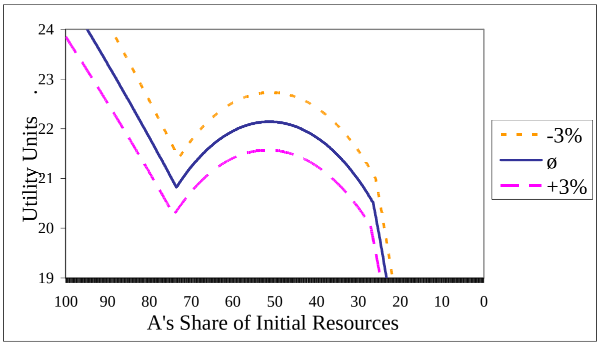


Figure 4.2: Effects of 'Parameter Change' on New Equilibrium (Baseline Parameterization)

For the matter of robustness, we accompany our first evaluation tool by a second one: The abscissa of figure 4.2, again, describes the variation of the parameter of interest.[25] The triangled line in figure 4.2 shows how the 'new equilibrium'[26] is affected by the parameter variation. Note that figure 4.2 describes the 'new equilibrium' from individual B's point of view, i.e. in terms of B's new share of resources after donation. B's new share is our second measure of fairness. The squared line and the circled line display the output and welfare level associated with B's new share (i.e. with the 'new equilibrium').[27] Note that in figure 4.2 the triangled line (B's share) and the circled line (welfare) refer to the first ordinate and the squared line (production) to the second ordinate.

[25] Again, we keep the parameters constant, here, for the pure matter of explanation.
[26] See, figure 3.1.
[27] See, figure 3.2.



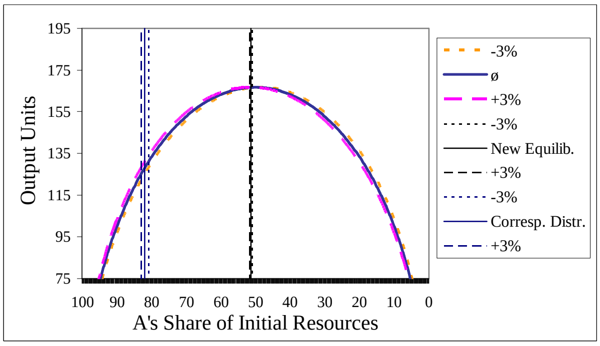
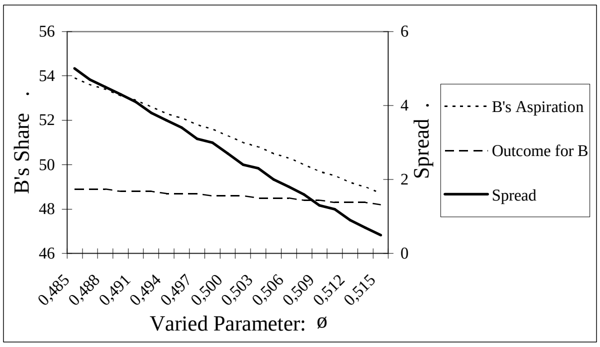


Figure 4.3 (left): Effects of Parameter Change on the Expected Utility of A
Figure 4.4 (right): Effects of Parameter Change on Production



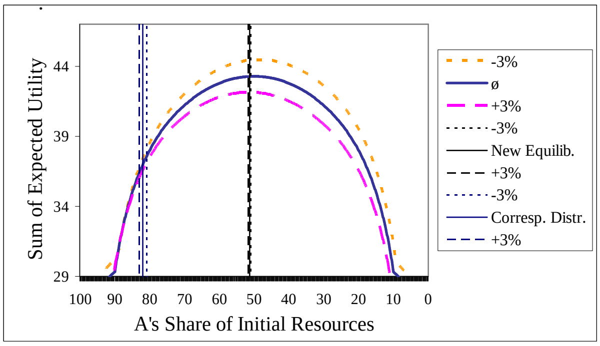


Figure 4.5 (left): Effects of Parameter Change on B's Aspiration-Outcome-Spread
Figure 4.6 (right): Effects of Parameter Change on Welfare

In addition to the two major evaluation tools, we apply figure 4.3-4.6 as auxiliary tools. Their purpose is to provide more details on and to complement the results shown by the two major tools. Figure 4.3, 4.4, and 4.6 display A's expected utility, total production and welfare depending on A's initial share of resources (abscissa). Figure 4.4 and figure 4.6 also show the 'new equilibrium' (right vertical line) and the 'corresponding distribution' (left vertical line). All curves and lines are tripled. The solid curve/line shows the values for the standard parameterization, whereas the dotted and the dashed curve/line refer to a reduction and increase of a specific parameter by 3%, respectively.[28] Figure 4.5 is organized similar to figure 4.1 and 4.2. The abscissa, again, shows the parameter variation. The dashed line shows the share of B that is optimal for A, i.e., the 'new equilibrium' in terms of B's share. Note that this share is not optimal from B's point of view. Instead, B's optimal distribution is shown by the dotted line which (as the dashed one) refers to the first ordinate. As B would like to achieve a distribution optimal for her, we interpret the dotted line as B's aspirated distribution. The solid line, referring to the second ordinate, displays the difference between B's aspirated and B's actually received share of resources.

[28]Here, we show an arbitrary parameter variation for reasons of pure demonstration. ø is a hypothetical parameter.

4. Results

In the previous section, we have described how the model gives rise to a seemingly fair but individually rational and purely self-centered behavior of A, how we calibrate our model, and how we are going to analyze the impact of time preference, risk attitude, and productivity on fairness and efficiency. Now, we start with this analysis carried out by the variation of the respective parameters.

4.1 The Impact of Time Preference

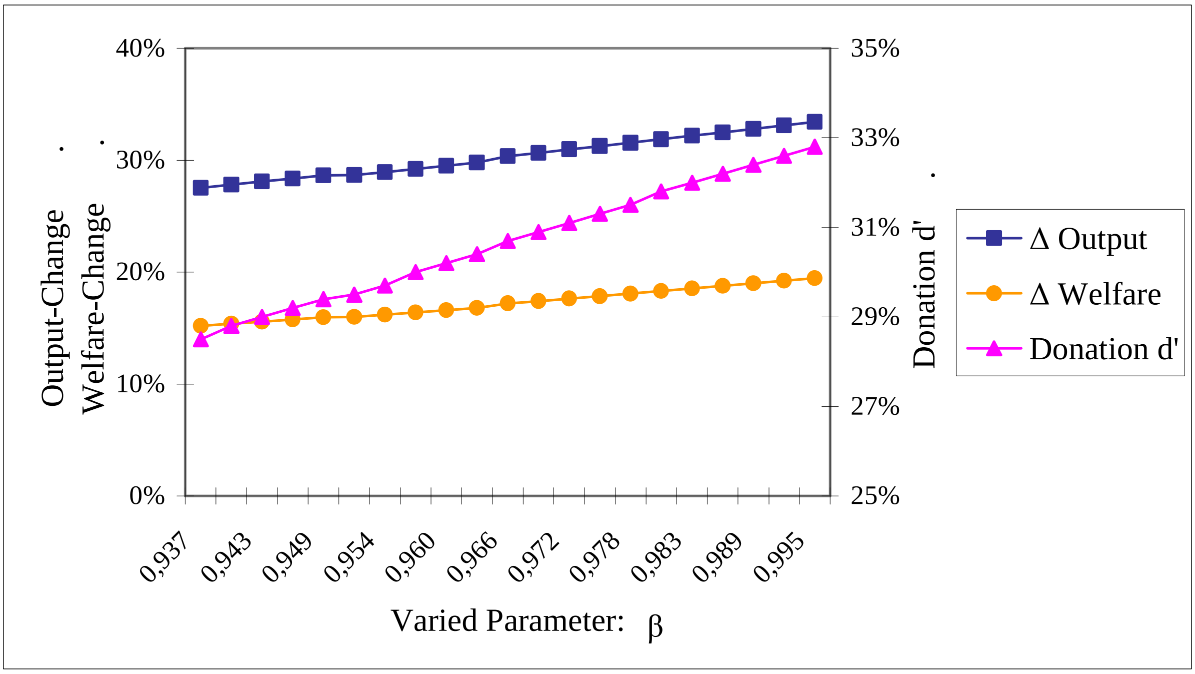


Figure 5.1: Effects of Time Preference on Donation

Figure 5.1 shows the impact of time preference on donation *d'* and the change of output and welfare. If the time preference factor β increases from 0.937 to 0.995, i.e. if the time preference *decreases*, donation *d'* is increased from 28.5% to 32.8% of the total resources. At the same time, the additional output due to donation *d'* rises from 27.54% to 33.42%, the additional welfare from 15.20% to 19.46%.

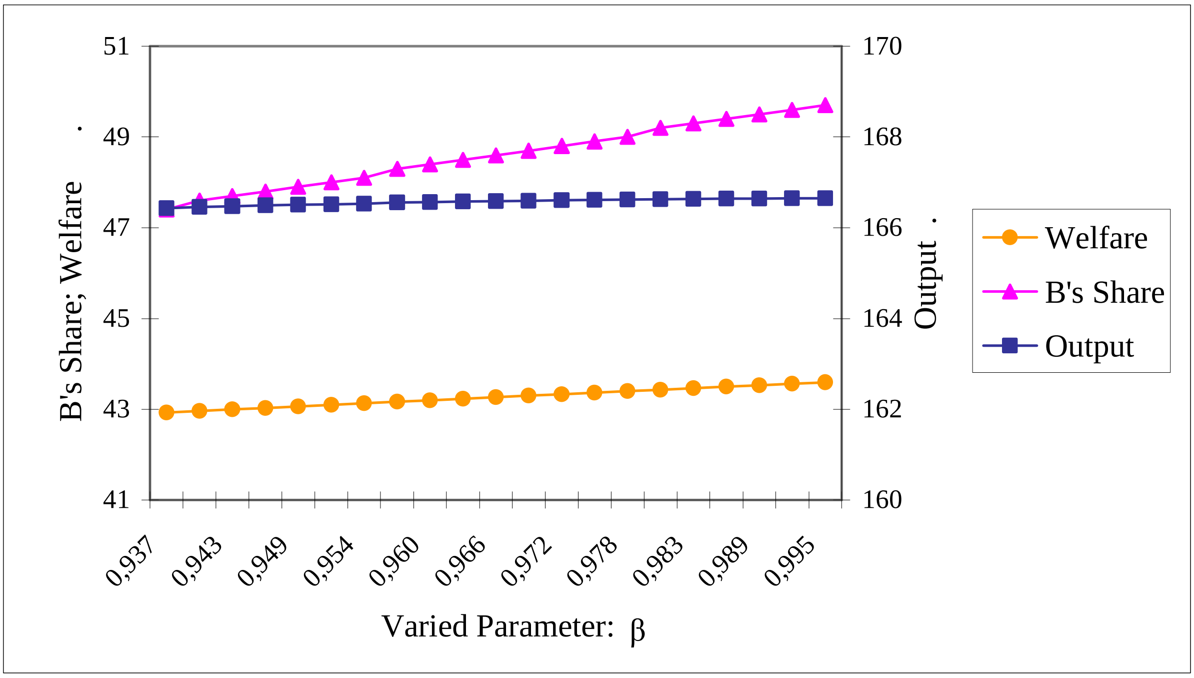
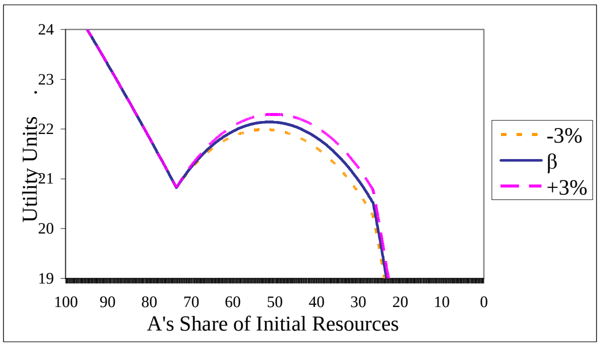


Figure 5.2: Effects of Time Preference on New Equilibrium

Figure 5.2 supports the results of figure 5.1. Although the effects are quantitatively less striking, the decreasing time preference also causes the three variables to rise: B’s share from 47.40 to 49.70 units of resources, output only from 166.42 to 166.65 produced units of goods, and welfare from 42.92 to 43.60 utility units.



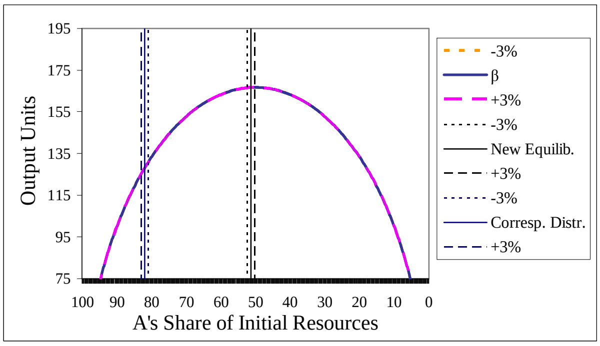
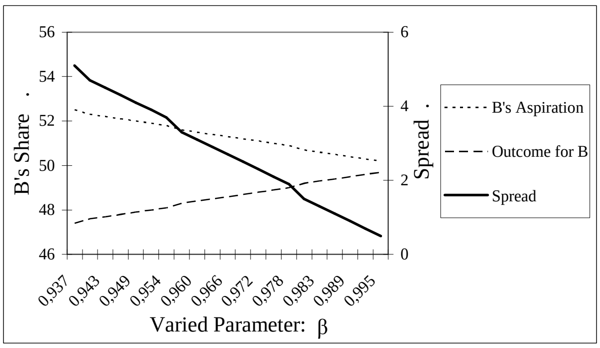


Figure 5.3(left).: Effects of Time Preference on the Expected Utility of A

Figure 5.4 (right): Effects of Time Preference on Production



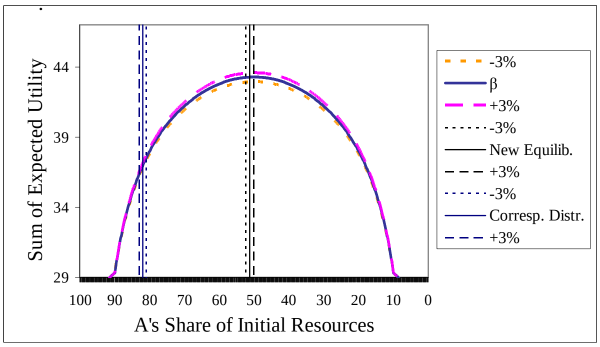


Figure 5.5 (left): Effects of Time Preference on B’s Aspiration-Outcome-Spread

Figure 5.6 (right): Effects of Time Preference on Welfare

Figure 5.3 shows that an increase of the time preference factor β (a *decrease* of time preference) turns A's expected utility curve counter-clockwise in its productive, hump-shaped area. Accordingly, the 'new equilibrium' distribution is shifted in favor of B (figure 5.4). The associated rise in expected utility shifts the 'corresponding distribution' to the left which further increases donation *d'*. Whereas the production level is mainly increased by the shift of the 'new equilibrium', welfare is additionally increased for resource distributions close to equality. Most important, a decreased time preference does not only improve B's actual outcome but also reduces her aspiration level, i.e., her optimal share. As a consequence, B's aspiration-outcome-spread shrinks towards zero (figure 5.6).

4.2 The Impact of Risk Aversion

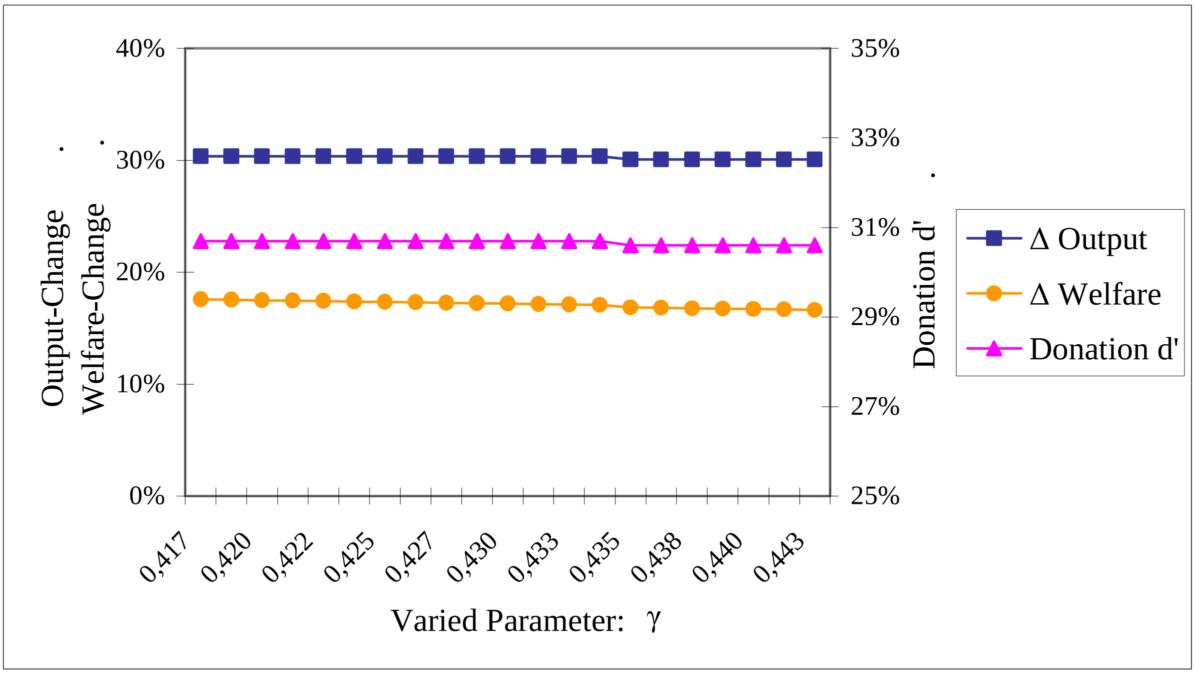


Figure 6.1: Effects of Risk Aversion on Donation

As Figure 6.1 shows, the effects of risk aversion on donation *d'* and related measures are small. If risk aversion increases (from $\gamma = 0.417$ to $\gamma = 0.443$), donation *d'* is decreased from 30.7% to 30.6% of the total resources. Accordingly, additional output due to donation *d'* shrinks from 30.38% to 30.09% and additional welfare from 17,58% to 16.64%.

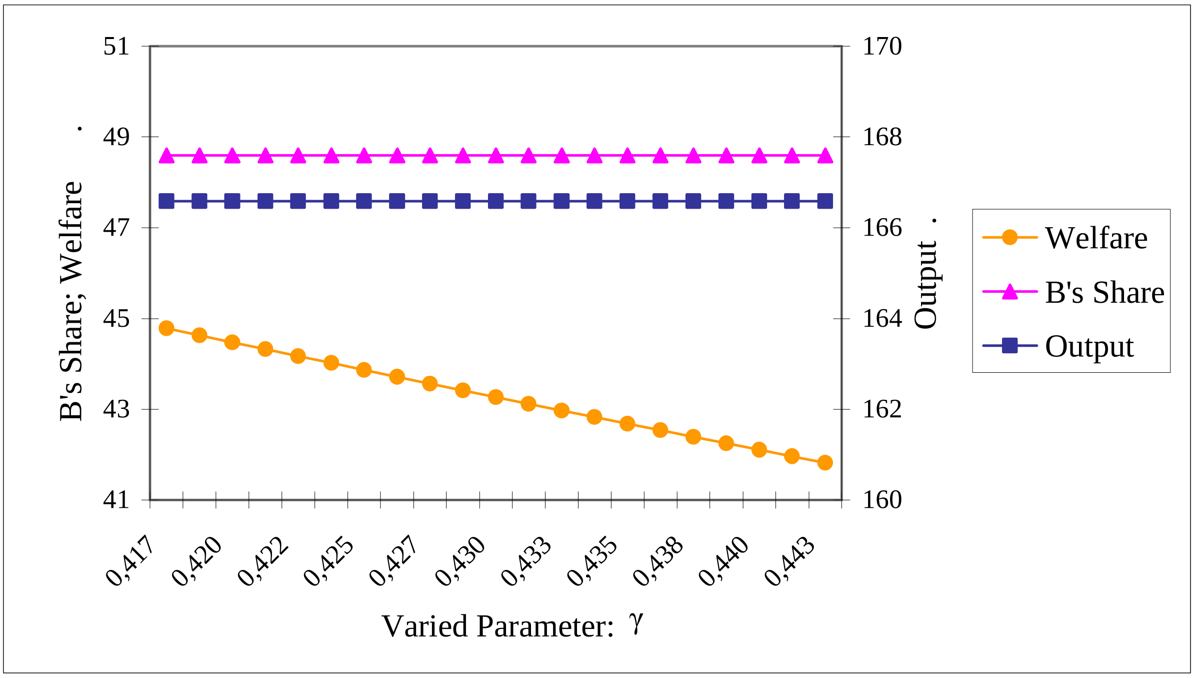
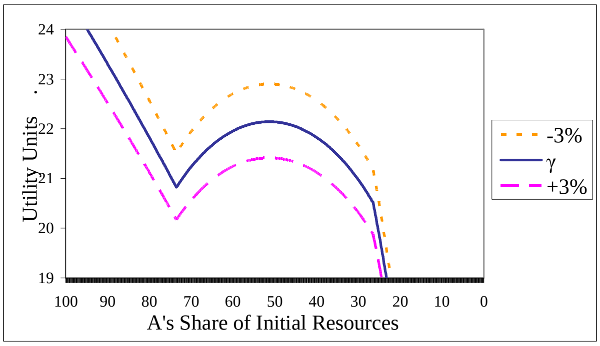


Figure 6.2: Effects of Risk Aversion on New Equilibrium

Figure 6.2 even strengthens the results of figure 6.1. A variation of risk aversion leaves B’s share of the resources (48.6 units) and the output level (166.58 units) unaffected. Only, and not surprisingly, welfare is reduced from 44.79 to 41.82 utility units.



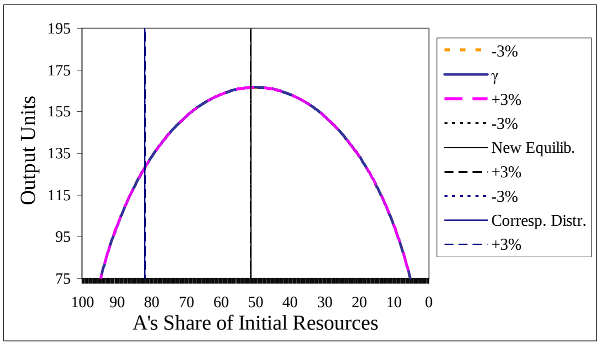
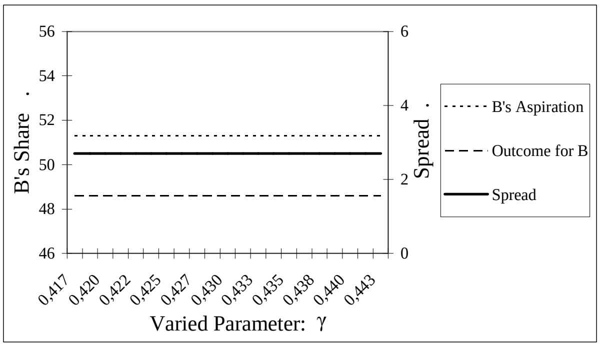


Figure 6.3 (left): Effects of Risk Aversion on the Expected Utility of A
Figure 6.4 (right): Effects of Risk Aversion on Production



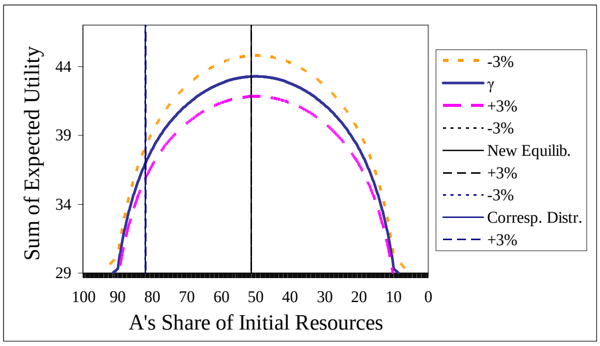


Figure 6.5 (left): Effects of Risk Aversion on B’s Aspiration-Outcome-Spread
Figure 6.6 (right): Effects of Risk Aversion on Welfare

How can we explain the results shown in figure 6.1 and 6.2? As we see from figure 6.3, 6.4, and 6.6, a change in risk aversion has no consequences on the 'new equilibrium distribution' and on the production level. A small, hardly detectable shift of the 'corresponding distribution' (left vertical line in figure 6.4 and 6.6) to the right side results in the slight decrease of donation *d'* and the associated additional production and welfare as described above (figure 6.1). Only expected utility, individual and common, is significantly decreased by an increase of risk aversion. B's aspiration and actual outcome is not affected by the level of risk aversion (figure 6.6).

4.3 The Impact of Relative Productivity

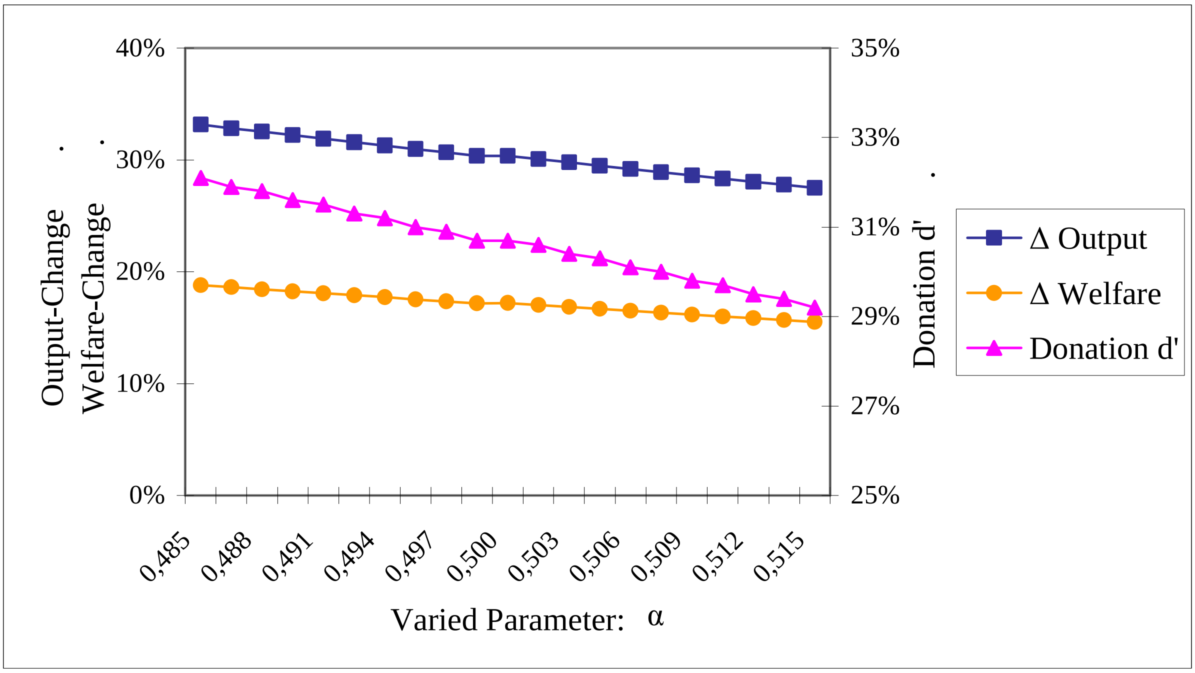


Figure 7.1: Effects of Partial Output Elasticity on Donation

By changing the partial output elasticity, we are going to measure the impact of the relative productivity of individual A and B. Figure 7.1 shows that donation *d'* is decreased from 32.1% to 29.2% of the sum of resources when A's partial output elasticity increases (from $\alpha = 0.485$ to $\alpha = 0.515$), i.e., when B's relative productivity decreases[29]. The reduction of donation *d'* causes a decline of additional output (from 33.15% to 27.49%) and welfare (from 18.80% to 15.53%).

[29] Note that B's partial output elasticity is $\sigma - \alpha$ with $\sigma = 1$ kept constant, here.

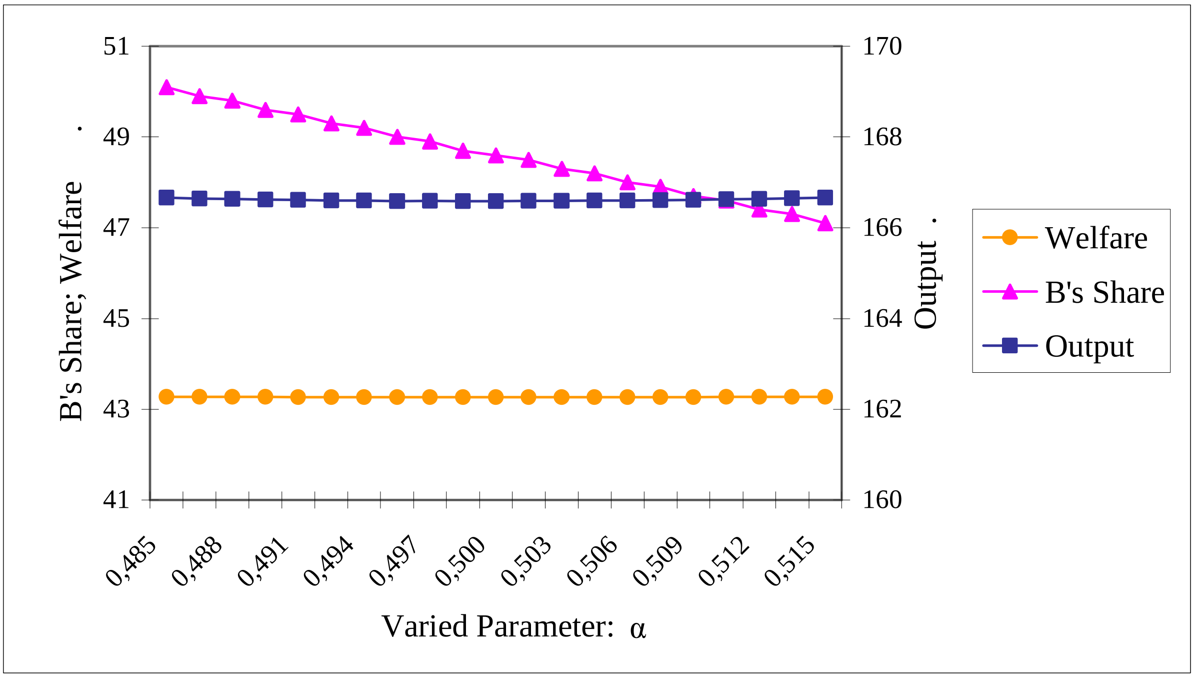
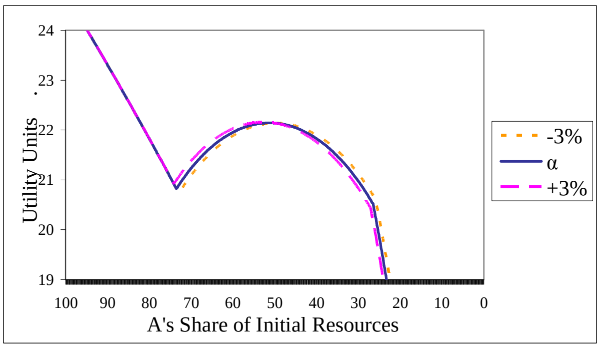


Figure 7.2: Effects of Partial Output Elasticity on New Equilibrium

In respect of the fairness measures (donation *d'* and B's share), figure 7.2 supports the results shown in figure 7.1. As A's partial output elasticity increases, B's share of total resources shrinks (from 50.1 to 47.1 of 100 in total). Noteworthy, the associated welfare level remains (nearly) unchanged at 43.28 utility units[30]. Due to the Cobb-Douglas-production-function, the output curve is slightly U-shaped. When the partial output elasticity is increased, the production outcome varies from 166.66 units via 166.58 units for $\alpha = 0.5$ back, again, to 166.66 units of produced goods.



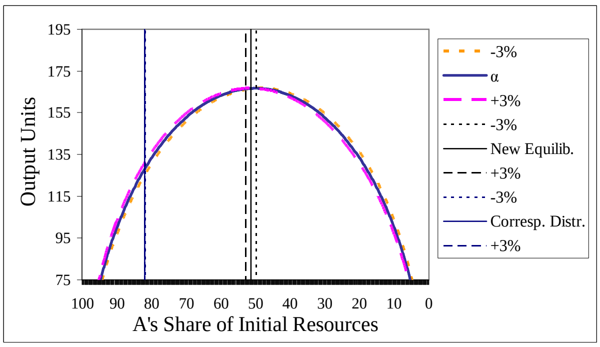
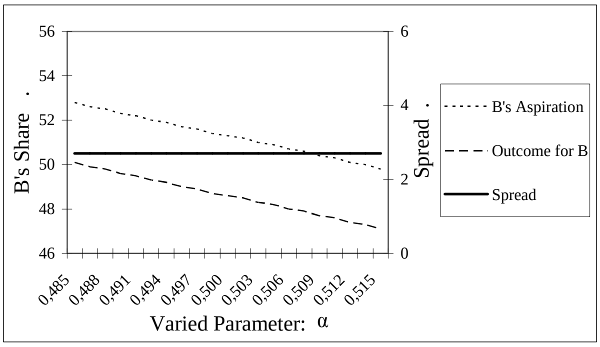


Figure 7.3 (left): Effects of Partial Output Elasticity on the Expected Utility of A
Figure 7.4 (right): Effects of Partial Output Elasticity on Production

[30] The welfare curve is – to a minimal degree – U-shaped. The sum of expected utility is 43.28 for unequal and 43.27 units for equal partial output elasticities of A and B.



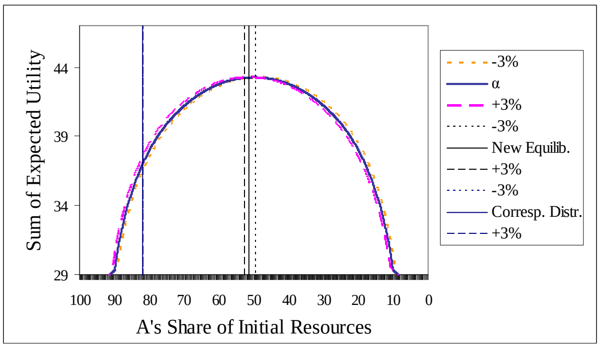


Figure 7.5 (left): Effects of Partial Output Elasticity on B's Aspiration-Outcome-Spread
Figure 7.6 (right): Effects of Partial Output Elasticity on Welfare

The results from figure 7.1 and 7.2 easily can be explained: Figures 7.4 and 7.6 show that A's local optimum ('new equilibrium' after donation) is shifted to the left, i.e., towards a higher share of resources for A, when his relative productivity is increased. The 'corresponding distribution' (left vertical line), A's expected utility (figure 7.3), production, and welfare are not or only to a minor degree affected by the partial output elasticity. Therefore, both measures for fairness but only one of the two measures for output and for welfare (respective changes due to donation *d'*) are changed considerably. The aspiration level of B and also the actual outcome for her is smaller, the higher A's relative productivity is (figure 7.5).

5. Discussion

What can we learn from our model? Our model predicts that the (seemingly) fair behavior and the time preference of individuals are interdependently linked. If the donator, the economically advantaged individual A, is more impatient, his behavior shows to be less friendly and generous. Similarly, the donation-receiving, economically disadvantaged individual B wishes to end up with a higher amount of resources, her aspiration level increases, if also she is more impatient. Accordingly, a general rise of time preference leads to higher social tensions as the material aspirations of individual A and B are going to be increasingly incompatible.

Higher social tensions due to a higher time preference are indirectly supported by experimental evidence (Güth et al. 2005): If, as they report, individuals care more about own than about others' delays, other-regarding but self-centered individuals can be expected to compensate the loss of utility from delays by higher material aspirations. Furthermore, Güth et al. (2005) report a strong positive correlation between time preference ("delay aversion") and individuals' self-centeredness in the allocation of social delays (own delays vs. others' delays). From this, in our opinion, we can infer that material self-centeredness and time preference are non-negatively correlated as well, as predicted by our model.[31] Of course, further empirical research on this topic is needed as Güth et al. (2005)'s findings refer to a specific experimental context.

Interestingly, risk aversion does not (considerably) interfere with fairness in our model. Risk aversion does only affect expected utility (and welfare) which, in turn, has a small impact on one of our fairness measures (donation *d'*). From Güth et al. (2005)'s findings, which are for risk attitudes similar to those for time preference, we infer, arguing as above, that the relation of self-centeredness and risk aversion can be expected to be non-negative. However, increasing social tensions due to a higher risk aversion, to be expected as well, are not predicted by our model.

Fairness and efficiency are positively related in our model. If individual B's partial output elasticity[32] is increased, individual A is more generous to her. To the same degree, individual B experiences more generosity, she expects it. This means that both sides symmetrically agree on an achievement-oriented notion of fairness. Hence, a change in relative productivity does not affect the wedge of material aspirations (figure 7.5). Note, however, that relative productivity does only influence the degree of the (seemingly) fairness and should not be mixed up with purely selfish behavior.

In general, we see that – independently of the varied parameter - our main measure of fairness (i.e., donation *d'*) always points in the same direction as our main measures of efficiency (i.e., additional production output and additional welfare due to donation *d'*; figures 5.1/6.1/7.1). This result is not in contrast but weakly supported by the second evaluation tool (figures 5.2/6.2/7.2). More importantly, a positive impact of efficiency on

[31] Güth et al. (2005) report that more delay (and risk)-averse people seem to be more kind in the allocation of material payoffs. However, we are sceptical about this statement (contrasting the result in respect of the allocation of delay and risk). We are not sure whether the applied measure of material kindness (reservation price (willingness to accept) for the prospect of an equal (undelayed, riskless) payment to the bidder and another person) is unambiguous: According to the experimental design, a higher reservation price *increases* the bidder's own expected payoff (in the empirically relevant range (reservation price≤39€)). Therefore, a higher stated reservation price does not necessarily reflect a kind behavior but might be caused by purely selfish motives and/or a more intensive reasoning of delay- (and risk-) averse people.

[32] Of course, figure 7.1 and 7.2 show – for the matter of consistent presentation - the result from A's point of view.

fairness (kindness)[33] finds a broad experimental support (Andreoni and Vesterlund 2001, Bolle and Kritikos 2001, Andreoni and Miller 2002, Charness and Rabin 2002, Cox 2004).

Resuming the results, we find that our stylized model is plausible in the light of empirical findings (to a lesser degree for the role of risk aversion). Therefore, we consider it as an interesting theoretical benchmark for further empirical studies in this field of research.

6. Conclusions

We have built and evaluated an economic model with 2 individuals and 2 periods, the latter representing present and future time. The 2 individuals are free to donate resources to each other in the present period, whereas they might have the opportunity to join for a common production in the future period. The output of common production is divided according to standard bargaining theory. We have been able to show that in our stylized but plausible model individuals have incentives to behave in a not only self-centered way although they are individually purely selfish and rational.

Furthermore, we could show that in our model time preference matters for the (seemingly) fair behavior. With increasing time preference, advantaged people (i.e., individual A) tend to be less generous, whereas the aspiration of disadvantaged people (i.e., individual B) increases. A rise in the time preference turns out to be a candidate for the explanation of higher social tensions.

Risk aversion does not have a major impact on fair behavior in our model. In contrast, an increase in productivity is associated with an increase of fairness, independently whether we vary the coefficient of time preference and the risk aversion or the relative productivity (partial output elasticity) itself.

We hope that our study, as it is based on the *homo oeconomicus* assumption and captures fair behavior as an endogenous outcome, can help to increase the acceptance of other-regarding concepts in a broader area of economics.

[33] Note that the cited experimental studies report that a non-negligible fraction of subjects is willing to accept even less money than their counterpart if this increases the total sum of payoffs. This extreme degree of kindness/altruism is remarkable as it conflicts with theories of inequality aversion. For a different experimental finding on efficiency and inequality aversion, see Güth et al. (2003).

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