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Does the Paradox of Plenty Exist? Experimental Evidence on the Curse of Resource Abundance

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Abstract:

There is conflicting evidence about whether abundant resources are indeed a blessing or a curse. We make use of specially designed economic experiments to investigate how resource abundance affects cooperation in the absence or presence of regulatory institutions. We observe that in the absence of regulatory institutions, there is less cooperation in groups with access to large resource pools than in groups with access to small resource pools. However, if regulatory institutions are present, we show that there is more cooperation in groups with access to large resource pools than in groups with access to small resource pools. Our findings also reveal that resource users are more willing to regulate access to abundant than to small resource pools. These findings provide causal evidence for the "paradox of plenty" and identify the causes for the pitfalls and potentials of resource wealth.

Keywords: lab experiment; stakes; institutions; rent seeking.

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1. Introduction

Are societies with abundant resources cursed? The "paradox of plenty" refers to the observation that many societies with abundant natural resources have worse economic outcomes than those that lack natural resources. Typically, this paradox is attributed to abundant resources crowding out activities that improve economic outcomes. Explanations following the crowding-out/in logic are that resource wealth crowds-out positive externalities like entrepreneurial activity (Torvik, 2002) and human capital development (Gylfason et al., 1999) or crowds-in anti-growth activities such as conflict (Collier and Hoeffler, 2005), rent-seeking (Auty, 2001), and corruption (Vicente, 2010). There is considerable disagreement about the empirical relevance of resource abundance for economic outcomes: some studies conclude that there is indeed a causal link (Ross, 2001; Sachs and Warner, 1995; Sachs and Warner, 2001) whereas others question its existence altogether (Brunnschweiler and Bulte, 2008; Alexeev and Conrad, 2009). Moreover, there are studies that suggest the institutional environment crucially determines whether large resource pools are a blessing or a curse (Mehlum et al., 2006; Robinson et al., 2006; Boschini et al., 2007) and it also seems possible that the level of resource endowment may determine the institutional environment (Ross, 2001).

One main unsettled question is whether *(i)* the abundance of resources itself, *(ii)* other variables such as the institutional environment, or *(iii)* the interaction between resource wealth and other variables *cause* inferior economic outcomes and conflict (Norman, 2009). To provide a behavioral test of one form of the paradox of plenty and whether it can be prevented, this study uses randomized experimental methods to shed insights related to more complicated settings. The main advantage of this approach is the possibility to observe how a single exogenous change in the level of resource abundance affects economic behavior at both the individual and group level. While the decision environment is obviously extremely simplified, it still captures the crowding-out potential of resource abundance and the important trade-offs between individual and group benefits that often characterize the inefficient exploitation of many natural resources in the field.

In our experiment, individuals are randomly assigned to groups of three and simultaneously decide about the extent to which they want to exploit a non-renewable resource (a common pool of money). The experiment lasts until the resource pool of the group is depleted, but maximally for five time periods. If the group's claims do not exceed the capacity of the resource pool then, at the end of each period, a fraction of the resource pool that has not been claimed is transferred to a public good account, which produces positive externalities for all group members. There are four treatments in our experiment in which we vary resource wealth ($20 or $100) and whether individuals have the institutional capacity to limit access to the resource pool (no regulations vs. voting to protect the resource pool).

We find sharp treatment differences and a significant resource wealth × institution interaction. If resource wealth is high, individuals request on average *82% more* at the start of the experiment than when resource wealth is low. However, if individuals have the option to establish an institution that limits exploitation, individuals exploit on average *50% less* at the start of the experiment if the resource wealth is high than when it is low. Moreover, individuals in the low resource wealth treatment are *3.2 times* more likely to vote *against* any resource protection as compared to individuals in the high resource wealth treatment. These treatment dependent behaviors lead to pronounced differences in economic outcomes. For example, giving subjects the option to establish an institution that limits exploitation increases growth of the group’s endowment by a factor of 26.8 if resource wealth is high but only by a factor of 4.4 if resource wealth is low.

Our study contributes to the experimental literature investigating public goods/common pool resource exploitation (Ostrom et al, 1992; Cason and Kahn, 1999; Sefton et al, 2007; Nikiforakis, 2008), the endogenous formation of institutions (Kosfeld et al, 2009; Andreoni and Gee, 2012) and voting (Walker et al, 2000; Tyran and Feld, 2006).

We also contribute to the experimental literature on whether cooperation decreases when stakes are large; this is particularly important since cooperation to conserve non-renewable resources in the field frequently involves very high stakes. The evidence on the role of stakes for cooperation comes mainly from ultimatum games and the findings are often mixed. Slonim and Roth (1998), Andersen et al (2011), and Leibbrandt et al (2015) find less cooperation when stakes are very large, whereas other studies report no or only minor stake effects (Forsythe et al, 1994; Hoffman et al, 1996; Camerer and Hogarth, 1999; Cameron, 1999; Clark and Sefton, 2001; Cherry et al, 2002; Parco et al, 2002; Rapoport et al, 2003; Carpenter et al, 2005; Johansson-Stenman et al, 2005). Important differences between these and our study are that we investigate cooperation under different stakes when actors make simultaneous decisions in groups (N>2). To the best of our knowledge, the only studies investigating cooperation in groups for different stake sizes are Marwell and Ames (1980) and Kocher et al (2008) who study behavior in public goods games. These studies do not find a significant stake size effect. In contrast to our study where resources can be completely exploited, the resource in their games is renewable as it resets in each period. Another important difference between their and our decision setting is that subjects can take money away from a group account in our setting, which closely mirrors the real-world resource curse and employs a frame that suppresses warm-glow (Andreoni, 1995).

Probably the closest related study to our own is Al-Ubaydli et al (2014), which investigates how resource shocks affect resource exploitation in a continuous time laboratory experiment conducted in a virtual online world. They show that unexpected positive resource shocks during their experiment cause more exploitation and that communication can mitigate the extent of exploitation. Our study differs from theirs in that we investigate cooperation under different stakes when actors make simultaneous decisions about the extent to which they exhaust a non-renewable resource. Perhaps most importantly, our study presents some of the first evidence on the interaction between stake size and institutional choice and demonstrates that institutions can turn resource abundance into a blessing instead of a curse.[1]

Moreover, our experimental set-up provides a complementary approach to existing empirical studies on the paradox of plenty, which typically rely on cross-country comparisons, case studies or panels (for recent overviews see Wick and Bulte, 2009; van der Ploeg, 2011). Results based on non-experimental data are difficult to interpret because their units of observation differ on many (possibly unobservable) dimensions, have unique histories, and all or some of these differences may crowd-in unproductive activities.

Finally, our study may also be of interest for the rich theoretical work exploring mechanisms through which resource abundance influences growth. In line with the design of our resource depletion game, a number of political economy theories emphasize the way that resource booms can encourage rent seeking (Tornell and Lane, 1999; Torvik, 2002; Mehlum et al, 2006; Hodler, 2006, van der Ploeg and Rohner, 2012). For example, in Torvik (2002), a

[1] Our results are very much in line with the seminal argument in Demsetz (1967): institutions internalize externalities, such as property rights, when the benefits are large enough to justify the costs.

greater amount of natural resources increases the number of entrepreneurs engaged in rent seeking and reduces the number of entrepreneurs running productive firms: more natural resources can thus lead to lower welfare. In Mehlum et al (2006), entrepreneurs can either "grab" rents from natural resources or they can invest them in production. If institutions are weak, all resources are grabbed but if resources are strong then all the resources are invested in production and the spoils are divided equally among all entrepreneurs. We hope that our study fills an important gap between the abstract but causal approach of this theory literature and the real-world but correlative approach of the empirical literature.

2. Experimental Design

We designed a game such that it captures the central feature of most political economy explanations for the paradox of plenty: resource booms discourage individuals from performing activities that produce positive externalities. These explanations follow the crowding-out/in logic and are based on the idea that large resource pools undermine cooperation among society members (i.e., crowd-in conflict/corruption/rent-seeking), and thus harm the functioning of a society.[2]

We call our game the *resource depletion game* (Figure 1). In this game, individuals are randomly and anonymously assigned to groups of three, which remain fixed throughout the

[2] While there are several proposed explanations (Sachs and Warner, 2001), we chose to focus on the crowding-in variant for at least four reasons. First, there is recent evidence that there are significant correlations between cooperation/conflict/corruption measures and economic outcomes (Ross, 2001; Collier and Hoeffler, 2005; Vicente, 2010). Second, there is also evidence for links between the institutional environment and economic outcomes (Bohn and Deacon, 2000; Acemoglu et al, 2001; Mehlum et al, 2006; Robinson et al, 2006; Boschini et al, 2007), which suggests a crucial role of cooperation/conflict/corruption as these behaviors are likely to be related to the institutional environment (Svensson, 2005; Mocan, 2008). Third, the crowding-in variant seems to be less contested than many other variants such as the Dutch Disease (Corden and Neary, 1982; Sachs and Warner, 2001; Mehlum et al, 2006). Fourth, cooperation/conflict can be accurately and objectively identified in a behavioral experiment.

game. At the beginning of the game, each group is endowed with a non-renewable common pool of money (the resource pool). In each period, each member of the group simultaneously chooses to extract none, some, or all of the available resources in the resource pool (by choosing any value in dollars and cents between 0 and the size of the resource pool). The experiment lasts until the resource pool of the group is fully depleted. Full depletion can occur because of members' depletion, but an additional feature of the game, as will be explained below, implies that the maximum length of the game is five time periods. If the group's claims on the resource exceed its capacity in a given period then the pool is divided in proportion to the individual requests. If the group's claims do not exceed its capacity then after each period a fraction of the resource pool that has not been exploited (up to 20% of the initial resource endowment) is transferred to a public good account where a one-time (i.e. not compounding) interest rate of 50% accrues.[3]

This last feature can be rationalized in different ways, it captures: *i)* investments in public goods/human capital/entrepreneurship/formal sectors etc. that generate positive externalities for society as a whole, *ii)* avoided opportunity costs when resource users refrain from fighting over the resource, or *iii)* an increase in the value of a non-renewable resource over time (e.g. because of increasing scarcity). The money invested in the public good and the accrued interest are equally distributed among the group members at the end of the experiment. For example, if $20 is transferred to the public good account in the first period, then this is increased by 50% to

[3] For example, suppose the initial resource pool is $100. At the end of period 1, $$R_1$ remains in the pool. If R_1 is greater than 20% of $100 then $20 is permanently transferred to the public good account and the group proceeds to period 2 with $($R_1$-20) in the resource pool. If R_1 is less than or equal to 20% of $100 then R_1 is transferred to the public good account and the game ends. At the end of period 2, $$R_2$ remains in the pool. If R_2 is greater than 20% of $100 then $20 is permanently transferred to the public good account and the group proceeds to period 3 with $($R_2$-20) in the resource pool. If R_2 is less than or equal to 20% of $100 then R_2 is transferred to the public good account and the game ends. This pattern continues until the end of period 5 since R_5 must always be less than or equal to $20. Thus, the game can last, at most, for five periods but may end sooner.

become $30 and, at the end of the final period, divided equally among the group so that each member receives $10.

{Insert Figure 1 about here}

Treatments on Stake Size

To create differences in resource wealth, we randomly assign sessions either to a small ($20; *S-treatment*) or a large resource pool ($100; *L-treatment*). Resource users could claim exact amounts in cents and potentially transfer between $0 and $20 in S ($100 in L) to the public good (Figure 1). If resource users are selfish they will immediately deplete the resource pool independently of its size and thus not invest any money in the public good. For simplicity and to obtain a pronounced social dilemma, the game was modelled such that the optimal decision for self-interested individuals is to deplete the resource whereas for society the optimal decision is zero exploitation; i.e., none of the group members extracts any positive amount from the resource pool. We investigate the existence of the paradox of plenty by observing whether exploitation levels are higher among groups assigned large resource pools and, as a consequence, their resources are depleted faster and used in a less efficient manner.

The incentive structure in the resource depletion game is similar but simpler than the incentive structure in the standard common pool resource game (Ostrom et al, 1992; Ostrom et al, 1994). An important difference to the common pool resource game and negatively framed public goods games (Brewer and Kramer, 1986; Andreoni, 1995) is that the duration of the game depends on the resource users’ choices in the resource depletion game whereas it is fixed in the common pool resource game. Our game is also related to single-period appropriation games in which individuals appropriate from a group fund and unappropriated resources yield a higher benefit to the group than to the individual (Dufwenberg et al, 2011; Cox et al, 2013). In contrast to these games, we study multiple periods where the resource has no replenishment between stages and each individual has the ability to fully deplete the resource. Thus, our game can capture group dynamics in settings with large strategic uncertainty. These features of our game arguably capture more closely the decision resource users face in the field when harvesting non-renewable natural resources because: *i)* there is one resource that can be depleted, *ii)* the resource does not grow or renew over time, and (*iii*) resource exploitation is likely path-dependent.

Treatments on Institutional Choice

Individuals were also randomized into two additional treatments (*VS* and *VL*) of our experiment where we introduce an institution that can limit access to the resource pool. These two treatments take into account that groups in the field may have the institutional capacity to reconcile their opportunistic interests with the efficient use of the resource pool. We implemented the possibility of establishing a regulatory institution through a voting mechanism. Before individuals decided on their exploitation of the resource, they voted over the limitation of access to either the small ($20; VS-treatment) or large ($100; VL-treatment) resource pool. The choices available to subjects were 100% limitation (the resource is completely protected from individual removals), 80%, 60%, 40%, 20% and 0% (no protection – as in treatments S and L). The voting for any of the available choices was always costless. We decided that the majority decision was enforced such that the second lowest voted percentage level was chosen as the restriction level; i.e., the median vote. For example, if group member A chose 100%, B 40%, and C 20%, then 40% of the resource pool was protected from extraction in this period. Before the individuals made their exploitation decision, they were informed about the outcome of the voting decision, i.e. the extent to which access to the resource was limited in a given period. The voting mechanism was chosen in order to give individuals the possibility to implement a strong institution with the help of a majority rule decision as simply and quickly as possible. Every subject in the voting treatments was required before the start of the experiment to answer additional control questions to test that they understood how the mechanism would be implemented.

Predictions for Resource Exploitation and Voting

The standard prediction for resource exploitation assuming rational self-interest is straightforward and treatment independent: maximal exploitation of all accessible resources. However, there is abundant evidence that some resource users are willing to voluntarily refrain from resource exploitation in social dilemma situations. We conjecture that this kind of cooperation depends on its price – i.e., that cooperation like most other goods is an ordinary good: if the price of cooperation is high than we expect less cooperation as compared to when the price of cooperation is low. Thus, we predict more exploitation in the high stakes than in the low stakes treatment.

With regard to resource protection, one would expect that resource users vote for 100% limitation as this is in the interest of all group members. However, voting for 100% limitation is only a strictly dominant strategy if a resource user believes that her vote is a tie-breaker for her group. In contrast, if a resource user believes that both of her group members will vote for 100% limitation, she is indifferent between the different limitation levels. Due to the only weakly dominant property of completely restricting access to the resource, we conjecture that a resource user in the high stakes treatment is more likely to err on the side of caution and choose 100% limitation.

Overview

258 subjects participated in this experiment in the four treatments (S: N=87, L: N=78, VS: N=48, VL: N=45). 40% of subjects were female and 71% were undergraduates (29% were graduate or non-traditional students). The experiments were conducted with the experimental software Z-tree (Fischbacher, 2007). Each of the 258 subjects participated in only one of the treatments. The experiments lasted for maximally one hour including payment. The average payoff across all treatment was $27.40 including a show-up fee of $5, and varied between $12.14 in S and $51.73 in VL ($13.79 in VS and $38.83 in L). The minimal payoff was $5 and the maximal payoff was $105. The instructions were neutrally framed, for example, the resource pool was referred to as an 'open group account'. The experimental instructions for all treatments are in the appendix.

3. Experimental Results

Individual Resource Exploitation

Consistent with our conjecture, we find that there are large treatment differences when resource exploitation cannot be regulated. The two histograms at the top of Figure 2 illustrate the differences between the S-treatment and L-treatment and show that individual resource exploitation in period 1 is significantly larger if the resource pool is large. In the S-treatment we observe that individuals request on average only 37.4% of the resource pool in the first period. 44.8% refrain from exploitation completely and only 26.4% completely deplete the small resource pool. In contrast, in the L-treatment we observe that individuals request on average 68% of the resource pool in the first period (Mann-Whitney *U*-test, Z=4.326, P<0.0001, two sided, N=165), that only 19.2% refrain from exploitation completely (Fisher's Exact test, P<0.001, two sided, N=165), and that more than double the proportion of subjects decide to completely exploit the large resource pool in the first period (57.7%; Fisher's Exact test, P<0.001, two sided, N=165). Appendix Figure A illustrates individual resource exploitation in all periods in treatments S and L.

{Insert Figure 2 about here}

There are also significant treatment differences when resource exploitation can be regulated – but in the opposite direction. The two histograms at the bottom of Figure 2 illustrate the differences between the VS-treatment and the VL-treatment where resource users can vote for limiting access to the resource pool when the resource pool is small or large. The histograms suggest that individual resource exploitation is more constrained when the resource pool is large. In the VS-treatment we observe that individuals exploit on average 18.1% of the resource pool in period 1. In contrast, in the VL-treatment we observe that individuals request on average only 9.2% of the resource pool, which is statistically significantly less (Mann-Whitney U-test, Z = 1.997, P=0.0458, two sided, N=93). Appendix Figure B illustrates the frequencies of individual resource exploitation across all five periods in the treatments VS and VL. As compared to Appendix Figure A where individuals could not restrain exploitation, we observe a completely different pattern here: the mode is zero exploitation in all periods for both treatments.

Table 1 provides econometric support for the observable differences in the previous figures and also shows whether the availability of a regulatory institution significantly interacts with the resource pool wealth. Models 1 and 2 regress individual resource exploitation on treatment, and treatment interactions. Model 1 uses only data from the first period in a Tobit regression whereas model 2 uses data from all periods and controls for period effects. The omitted category (the constant in the regression model) is individual exploitation in the S-treatment.

Models 1 and 2 show that institution × resource wealth interactions are highly significant ($p<0.001$) and have large coefficients. The interaction coefficients represent the additional reduction in resource exploitation when moving from L to VL as compared to when moving from S to VS, highlighting that our voting institution has a much stronger impact on resource exploitation when resources are large. In addition, both models show that resource wealth significantly increases resource exploitation in the absence of a regulatory institution ($p<0.001$) and that the regulatory institution decreases resource exploitation even if resources are small ($p<0.05$).

{INSERT TABLE 1 ABOUT HERE}

Group Outcomes

Moving from individual to group outcomes, Table 2 shows the likelihood of complete resource depletion over time in our four treatments. We observe that resource depletion clearly differs across treatments. It is quickest in L (no group survives past period 2) and slowest in VL (2/3 of the groups make it to the last period). Model 1 of Table 3 uses an OLS model with the period until which a group lasted as the dependent variable and shows that all treatment differences in survival are significant at $p<0.013$. The coefficients show that the voting institution enabled groups with small resources to stay alive for 1.1 periods longer than those without. The institution × resource wealth interaction shows that groups which have the option to restrict access to the larger resource pool stay alive for a further 0.91 periods.

{INSERT TABLES 2 & 3 ABOUT HERE}

We now turn our attention to growth. By growth, we mean growth of the group's initial endowment. For example, a group that starts out with \$100 and ends with \$150 (regardless of how it is divided among the group's members) would achieve a growth rate of 50%. The aforementioned differences in individual resource exploitation lead to significantly different growth rates (Figure 3). Groups with access to small resource pools (*N*=29) achieve much higher economic growth of 7.2%, calculated as the percentage growth of the initial endowment of wealth, than groups with access to large resource pools (*N*=26), which achieve only 1.5% (Mann-Whitney *U*-test, *P*=0.038, two sided, *N*=55) and face a lower risk that their resources are depleted in an earlier period (Fisher's Exact test, *P*=0.063, two sided, *N*=55). No group in the L-treatment achieves a growth rate beyond 15% whereas more than 20% in the S-treatment have growth rates of at least 17.5%.

{Insert Figure 3 about here}

In the voting treatments, we observe that groups with access to small resource pools (*N*=16) achieve a lower asset growth (31.8%) than groups with access to large resource pools (*N*=15, 40.2%; Mann-Whitney *U*-test, *Z=1.146*, *P*=0.252, two sided, *N*=31) and face a lower risk that their resources are depleted earlier (Fisher's Exact test, *P*=0.344, two sided, *N*=31). Only half of the groups achieve growth rates larger than 30% when the resource pool is small in comparison to 80% of the groups when the resource pool is large. Only 6.7% of the groups in VL deplete the resource in the first period compared to 25% of the groups in VS. Two-thirds of the groups reach the final period in VL but only half in VS. Table 3, model 2 uses an OLS model with growth rates as the dependent variable. We observe that all treatment differences in growth rates are significant at the 5%-level. The institution × resource wealth interaction shows that the growth rate is 14 percentage points larger when moving from L to VL than when moving from S to VS.

Willingness to Restrict Access to Resource Exploitation: Voting Behavior

The previous sections on individual resource exploitation and group outcomes report strong institution × resource wealth interaction effects. In this section, we provide evidence that these interactions are driven by two factors: *(i)* the differential willingness to restrict access to resources and *(ii)* the crowding-in of rent-seeking in VS. We explain each of these factors in turn. Figure 4 illustrates the number of individual votes for resource access restriction in treatments VS and VL in all periods. In the VS-treatment where the resource pool is small, we observe that 23.2% (20.8% in period 1) of the votes are against any resource access restriction while 57.7% (52.1% in period 1) of the votes are in favor of complete resource access restriction. In contrast in the VL-treatment where the resource pool is large, we observe that only 7.3% (8.9% in period 1) of the votes are against any resource access restriction while 82.8% (73.3% in period 1) of the votes are in favour of complete resource access restriction. Thus, individuals use the voting institution to better protect resources when they are large (Mann-Whitney *U*-test, $Z=5.409$, $P<0.0001$, two sided, $N=360$ for all periods; Z=2.259, $P=0.0239$, two-sided, $N=93$ for period 1 only). The treatment differences over periods are also statistically significant using a Tobit model controlling for period effects and with standard errors clustered at the group level ($p=0.006$). Further, we observe that there is a significant correlation between individual voting choices and resource exploitation. Individuals who exploit fewer resources in the first period, vote for higher resource access restriction in VS ($r=-0.323$, $p=0.025$) and VL ($r=-0.669$, $p<.001$).

{Insert Figure 4 about here}

The different voting behaviors in VS and VL result in different protection levels and different levels of disagreement over the optimal protection levels. Only 56.25% of the groups in VS resources enjoy complete resource protection in the first period, compared to 80% of the groups in VL. While in VS only 68.45% of the individuals voted for the protection level that was actually implemented, this figure is substantially higher in VL (83.85%). Did being out-voted have an impact on individual exploitation decisions? We find no indication that individuals who voted for a lower or higher restriction level than implemented exploit more in a given period in VS and VL than individuals whose vote reflected the voting outcome (four *t*-tests, $P>0.246$, one-sided) suggesting that the median voting outcome has no negative impact on overruled individuals – regardless of the size of the resource pool.

Individual Resource Exploitation Conditional on Access

The second factor explaining the interaction effect is that there are no differences in individual extraction for *unprotected* resources regardless of resource wealth, suggesting that the voting institution crowds-in extraction when resources are small. To start, in the first period in VL subjects extract 68.1% of the unprotected resources, which is very similar to VS where 65.4% is extracted (Mann-Whitney *U*-test, $Z=0.024$, $P=0.981$, two sided, $N=30$). For all periods the percentages are 63.6% in VL and 60.1% in VS (Mann-Whitney *U*-test, $Z=0.380$, $P=0.705$, two sided, $N=69$). Thus, while the possibility to restrict resource access does not change extraction levels for the unprotected resources when the resource pool is large (Mann-Whitney *U*-test, $Z=0.237$, $P=0.813$, two sided, $N=114$), it crowds in high extraction levels in VS as compared to S (Mann-Whitney *U*-test, $Z=4.066$, $P<0.0001$, two sided, $N=180$).

Models 3 and 4 of Table 1 provide more evidence for the treatment specific extraction of unprotected resources. The models use the percentage of unprotected resources extracted by an individual (conditional on the resource pool being accessible) as the dependent variable. Model 3 regresses individual extraction of unprotected resources in period 1 on treatments and treatment interactions and model 4 uses a Tobit model with clustered standard errors to regress individual extraction of unprotected resources in all periods on treatments and treatment interactions. We observe that resource exploitation is clearly larger in VS as compared to S ($p<0.001$) suggesting that the regulatory institution crowds out the voluntary willingness to refrain from exploitation if the resource pool is small. A plausible mechanism for this crowding-out of altruistic behavior is the erosion of a social norm by the introduction of a regulatory institution (Gneezy and Rustichini, 2000), akin to the responsibility alleviation effect (Charness, 2000). However, our simple experimental design does not allow us to rule out other explanations. For example, it could be that the voting served as a signal to individuals with restraint that they have been randomly assigned partners who wish to exploit the resource, although the data does not support this hypothesis. Alternatively, it could be that individuals were willing to risk voting for no constraint as long as the potential loss was relatively small because they were curious to find out about the actual level of unconstrained exploitation.

In addition, we observe that the institution × resource wealth interaction is significantly negative ($p<0.1$), cancelling out the institutional effect. This provides further evidence that the voting institution did not further crowd-in any additional extraction in VL. This may be because altruistic behaviour is already largely crowded out in the high stakes settings, as our earlier results suggested.

4. Discussion

By studying the exploitation of non-renewable resource pools in specifically designed behavioural experiments we are able to provide internally valid evidence for the existence of the paradox of plenty. If groups cannot form regulatory institutions, we find that large resource pools are more heavily exploited compared to small resource pools leading to faster resource depletion and less asset growth. However, if groups have the possibility to form strong regulatory institutions, we observe that large resource pools are better protected than small resource pools, resulting in less extraction and longer lasting resources. The sharp interaction effect between institution and resource wealth is driven by a more pronounced willingness to protect resources if they are large and the crowding-in of resource exploitation if there are regulating institutions when resources are small.

The findings in our behavioral experiment are partly consistent with the existing cross-country evidence on the relevance of institutions for the paradox of plenty (Mehlum et al., 2006; Robinson et al., 2006; Boschini et al., 2007). A particular challenge that these non-experimental studies face is to disentangle the combined role of institutions and resources. For example, within the current literature, it remains unclear whether resource abundance affects the institutional environment or whether the institutional environment determines whether resource abundance is a curse. By experimentally randomizing resource abundance and institutions we are able to investigate the causal impact of resource abundance on the institutional environment.

We corroborate the general findings in the non-experimental literature that there is a paradox in the absence of good institutions and show, in addition, that good institutions are the cause for abundant resources to be a blessing. Thus, this study fills an intellectual gap between the conflicting correlative approaches of the empirical literature and the causal but abstract approach of the theory literature. One disadvantage is that the findings from our behavioral experiment may be difficult to extrapolate to complex natural field settings although there is evidence that these kinds of experiments can accurately predict individual resource exploitation decisions in the field (Fehr and Leibbrandt, 2011). Our results do not provide striking policy recommendations for nation states but they do represent a significant contribution to our understanding of the internal validity of the paradox of plenty hypothesis. Groups in weak institutional environments are cursed by large resource endowments but this curse can be lifted by the introduction of well-enforced, democratically-chosen rules.

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Figures 1-4

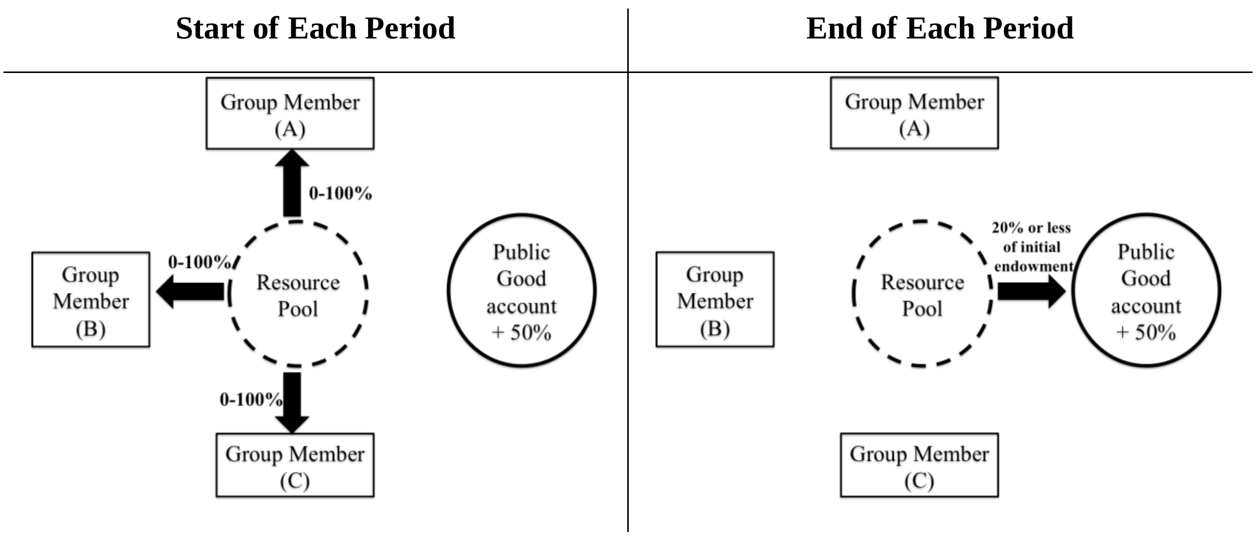

Figure 1. The resource depletion game. At the start of each period, individual group members can make claims on the resource pool between 0% and 100% of what is available. At the end of each period, 20% of the initial endowment is transferred to the public good account (if possible).

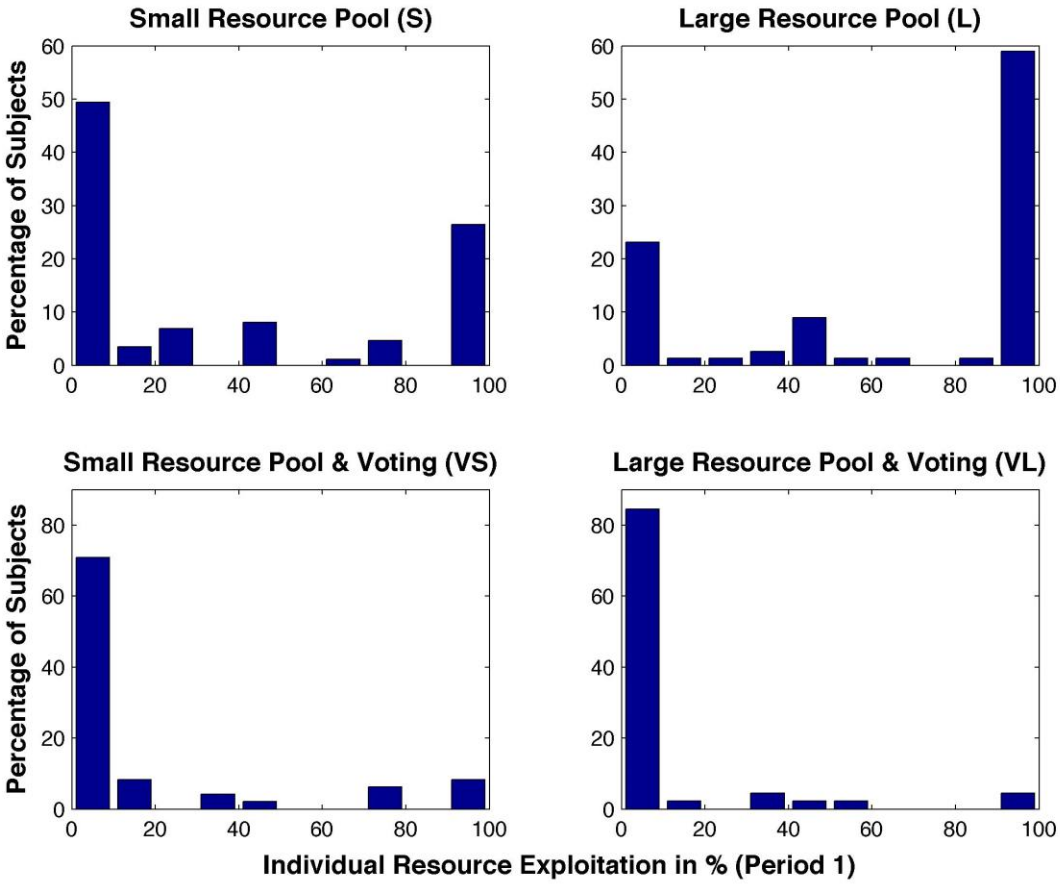

Figure 2. Individual resource exploitation depending on the size of resource pool and on whether individuals could restrict resource pool exploitation. Top left (right) shows exploitation for the small (large) resource pool. Bottom left (right) shows exploitation after voting for regulatory institutions of the small (large) resource pool.

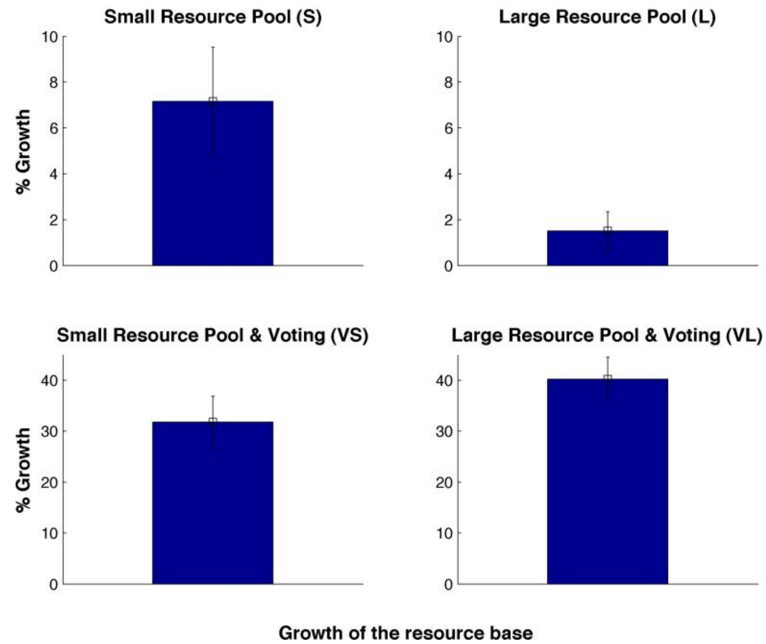

Figure 3. Economic growth depending on the size of resource pool and on whether individuals could restrict resource pool exploitation. Top left (right) shows growth for the small (large) resource pool. Bottom left (right) shows growth after voting for regulatory institutions of the small (large) resource pool. Standard error bars shown.

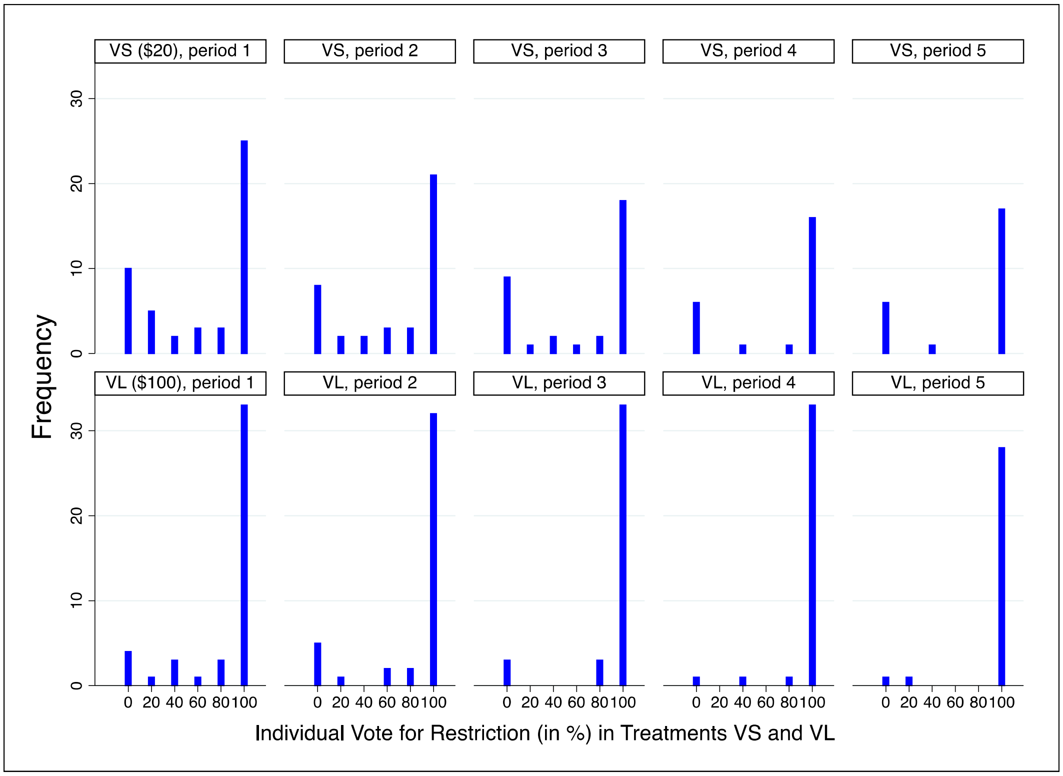

Figure 4. This figure shows the number of individual votes for restriction of access to the resource pool in each of the five periods. The top panel shows the patterns for the VS-treatment where the resource pool was $20 and the bottom panel shows the patterns for the VL-treatment where the resource pool was $100.

Tables 1-3

Table 1. Explaining Individual Exploitation (Tobit).

	(1) exploitation in period 1	(2) exploitation in all periods	(3) conditional exploitation in period 1	(4) conditional exploitation in all periods
Institution	-67.464**	-77.515***	97.443***	83.595***
(VS-treatment)	(26.212)	(24.979)	(35.970)	(28.384)
Resource Wealth	101.409***	71.923***	103.880***	89.705***
(L-treatment)	(24.380)	(21.373)	(25.268)	(21.748)
Institution × Resource Wealth	-165.188***	-110.268***	-108.334*	-78.032*
(VL-treatment)	(42.468)	(36.505)	(56.632)	(43.902)
Period		-13.892**		-15.555
		(6.148)		(11.695)
Constant	14.655	38.293**	13.877	32.493
(S-treatment)	(15.349)	(16.072)	(15.766)	(20.355)
N	258	588	195	294

Notes: *p<0.1, **p<0.05, ***p<0.01. Robus t standard errors in parenthesis. Standard errors are clustered on group level in models 2 and 4. Models are censored at 0 and 100.

Table 2. This table shows the likelihood in % that the resource pool is completely exhausted in a given period depending on the treatment. Treatment S = $20 resource pool, no voting; L = $100, no voting; VS = $20, voting; VL = $100, voting.

Treatment	Period 1	Period 2	Period 3	Period 4
S	65.5%	86.2%	93.1%	93.1%
L	92.3%	100%	-	-
VS	25%	31.3%	50%	50%
VL	6.7%	13.3%	20%	33.3%

Table 3. Survival and Growth in Groups (*OLS*)

	(1) survival	(2) growth
Institution	1.111***	24.642***
(VS-treatment)	(0.301)	(5.544)
Resource Wealth	-0.406***	-5.655**
(L-treatment)	(0.152)	(2.524)
Institution × Resource Wealth	0.912**	14.045**
(VL-treatment)	(0.359)	(7.032)
Constant	1.483***	107.155***
(S-treatment)	(0.142)	(2.378)
R-squared	0.547	0.578
N	86	86

Notes: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parenthesis. Observations on group level. Survival defines in which period (1-5) group resources are depleted. Growth determines %-growth of resource (base is 100%).

Appendix

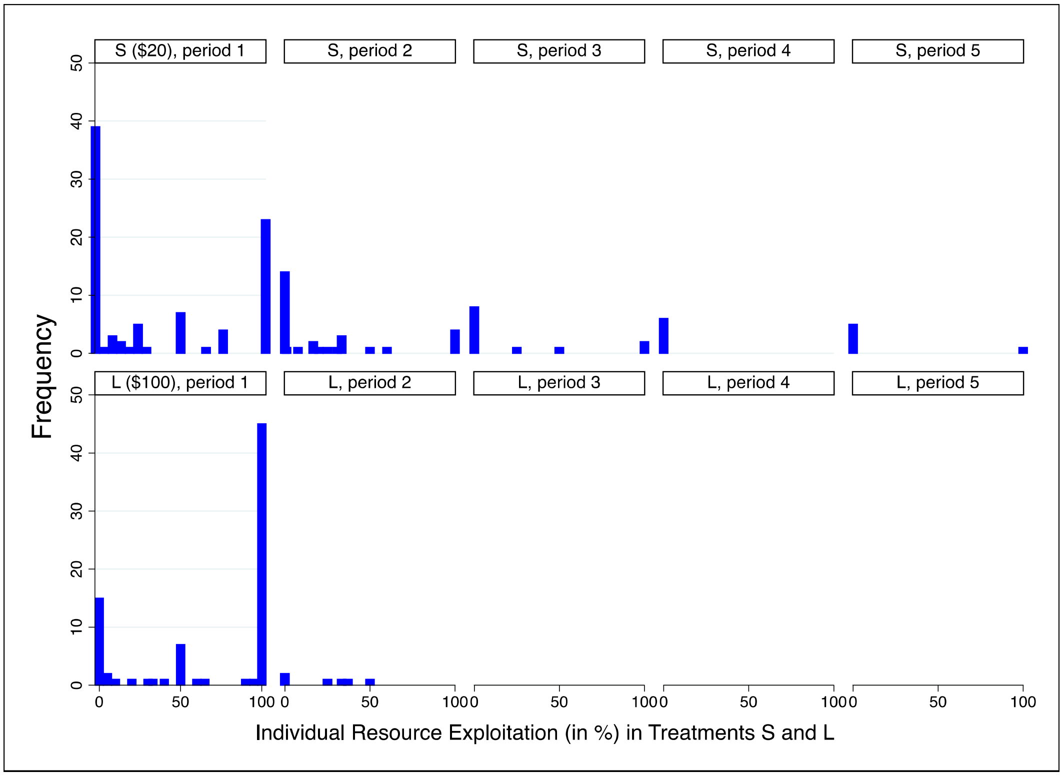

Figure A. This figure shows the level of individual exploitation of the available resource pool in each of the five periods in %. The top panel shows the patterns for the S-treatment where the resource pool was $20 and the bottom panel shows the patterns for the L-treatment where the resource pool was $100.

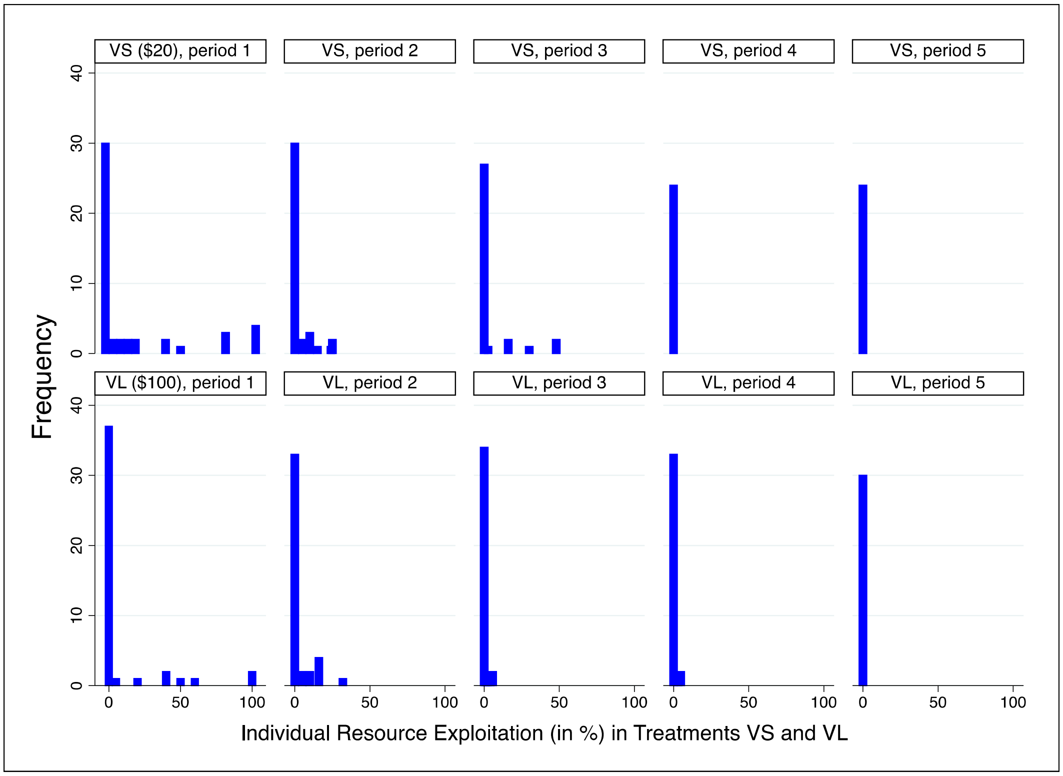

Figure B. This figure shows the level of individual exploitation of the resource pool in each of the five periods in % in the treatments where subjects voted for restriction of access to the resource pool. The top panel shows the patterns for the VS-treatment where the resource pool was $20 and the bottom panel shows the patterns for the VL-treatment where the resource pool was $100.