The quest for governance: Decision making on a groundwater commons in India's Drylands

by

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Abstract

Natural resource management in much of the global south is characterized as a shift to governance involving hybrid engagements between neo-liberal states, communities and markets based incentives. Agriculture, a large part of rural livelihoods, turns out to be the largest user of groundwater, an increasingly declining common pool resource (CPR). India is the world's largest groundwater extractor for combined agriculture and drinking purposes and offers a challenging arena for groundwater governance. Recent trends in decentralization in the form of community based natural resource management (CBNRM) are slowly making their way to groundwater regulation. This work uses a CPR experiment replicated with students from all disciplines at the University of Michigan (n=50), The University of Delhi (n=75) and residents of six villages in three different states of India (n=360) to study the differences in extraction decisions across locations and livelihoods in a groundwater setting and test theories of collective action involving the concept of social capital. Post experiment surveys and interviews were also conducted to augment and explain the experimental results.

The main findings are that student groups differ from rural participants in extraction choices but only in treatments that involve voting for a costly external enforcement of rule adherence on the commons. While the two student groups were not statistically different in extraction levels across all treatments, Indian students differed from Indian rural participants in the experimental treatment involving a costly external monitor. The variance in decision making by subject group is attributed to differences in preferences, beliefs and experience. Evidence for this is found in the post game interviews and surveys conducted with each group. This furthers the findings of recent

work on the role of social framing in decision making. Additionally, social capital was marginally significant in lowering extraction levels but institutions were more so.

Broadly, my findings indicate that decentralization policy for groundwater will be a negotiated process that needs to consider the tensions within populations. Also, there is a role for the state as an external actor in CBNRM projects since farmers seemed to express a need for fuller citizenship by engaging with the state.

Chapter 1:

Introduction

It is 3:47 am on a stuffy and still April night in the village of Salri in Madhya Pradesh, India. The naked light bulb flickers on and I hear a few calls across the roof top, where the women and children are sleeping, to the barn next door. I see a faint glow from a flashlight moving away towards the fields. It is Satnarayansingh, I find out the next day, on his way to start the tubewell for the approximately three hours the electricity will last. Before I doze off I think about the millions of farmers who have stayed awake this night waiting for electricity to run their pumps to irrigate their fields.

India has over 20 million private tubewells for irrigation and is the largest consumer of groundwater throughout the world (Briscoe et al. 2006; Shah 2009). Groundwater is generally considered to be water present below the land surface that saturates all cracks and fissures. Aquifers are the layers of the earth that yield groundwater and tubewells are only the latest (though most powerful) of a line of water extraction technologies starting from bullock powered technologies to oil, diesel and now electric power. Since by its nature groundwater is present almost everywhere, it is easier to access on an individual level than distant surface water sources. This has contributed to a large amount of private investment for groundwater irrigation. For India an estimate of the magnitude of private financing has placed it at more than three-quarters of the public surface water investments (Shah 2009).

The overuse of tubewell technology by private investment is in large part driving groundwater scarcity (and even salinity) according to most (Dubash 2002; Mukherji and Shah 2005; Giordano 2009). This over extraction can occur because of a regulatory vacuum since India does not currently regulate groundwater extraction; in fact, a rule of

capture prevails. In recognition of these trends India's central government drafted a model groundwater bill as early as 1970 and issues modifications at regular intervals. Water and thus groundwater is under state government purview in India's federated system, and so far only a few states have adopted regulation though none is currently enforced (Iyer 2003; Shah et al. 2006; Birkenholtz 2009). Large scale surface water irrigation systems have been the tools of kings and states in securing agricultural livelihoods as part of the hydraulic mission (Reisner 1986). Now however, government spending on irrigation infrastructure and development is falling as farmer investments are rising (Meinzen-Dick 2007). Groundwater extraction by Indian farmers is because and in spite of this absence of the state. In India, where groundwater meets 70% of the country's irrigation needs and 80% of its domestic water supplies, demand for both rural and urban uses is expected to exceed supply by 2020 (Briscoe et al. 2006). A large number of these farmers are in semi-arid India, the drylands, and have moved away from solely rainfed agriculture with the help of tubewell technology (Shah 1998). Falling prices of pump sets since the introduction of cheaper Asian models has furthered the appeal of on demand irrigation potential for smallholder farmers that form over 80% of all farmers in the country. Additionally, current government planning is targeting higher growth through agriculture in these very water-stressed regions (Parikh et al. 2007).

The recursive processes of investment in scarcity reducing technologies and the related ecological and institutional changes brought about by individual actions in groundwater use in India are only now being examined (Birkenholtz 2008). The question of how the country will sustain its groundwater resources is usually accompanied by 'clamours and silences'(Mollinga 2010) While much attention is paid to groundwater scarcity some point out that scarcity politics have resulted in the building of large scale dams displacing many instead of needs or demand management (Mehta 2007). In spite of the development state's obsession with large scale surface water undertakings like the National River Linking Project a lot of recent attention is also being paid to establishing property rights and markets and to decentralized technologies of community management, efficiency enhancing technologies like drip irrigation along with rainwater harvesting and recharge movements (Gunnell and Krishnamurthy 2003; Narayanamoorthy and Deshpande 2005; Briscoe et al. 2006; GOI 2006; Parikh et al.

2007). Groundwater regulation is the purview of individual state governments and while the central government has pedaled a model groundwater bill for decades only a few states have established regulations though they are not enforced (Shah et al. 2006; Shah 2009). Hence, policy and regulation on how to govern the resource still eludes.

This study attempts to shed further light on the question of groundwater governance in the following ways: first, I use a common pool resource (CPR) experiment, a tool from experimental economics, to measure decision-making of farmers in the context of a groundwater commons. Next, I use a survey on social capital to measure the norms and networks of participants which is then used to predict extraction levels in the experiment and find a link if any between social capital and collective action. Finally, I compare extraction decisions among three participant groups, Indian farmers, Indian students and students at Michigan to look at the heuristic basis for decision making in social dilemmas.

In Chapter 2, I review the environmental governance literature and concentrate on the community based natural resource management (CBNRM) approaches that have been espoused for over two decades in the development community. Community based groundwater management would involve a shift to a common property based rights system in an institutional arrangement that primarily involves open access regimes It seems that with the lack of widespread collective action for resource governance, setting up of common property rights would involve a significant engagement of the State. Also, the uncritical application of CBNRM approaches to groundwater is problematic because of the varied social preferences of people based on their experiences with this resource I measure this with the help of the CPR experiment and the rate of voting for an external regulation treatment among farmer participants in three dryland states. I find that the rate of voting in the experiment is affected by education and marginally by social capital. The most significant influence on voting is the cost of the institution. In treatments with costly external rule enforcement and monitoring, farmers voted at significantly lower rates for the rule. These results indicate that decentralization of groundwater governance to CBNRM institutions will meet resistance from some and attention needs to be paid to the equity considerations in securing access to the resource.

I examine the concept of social capital in explanations of successful collective action for resource governance in Chapter 3. Here, I begin with an analysis of the meaning and methods of measurement of social capital. I then look at applications of social capital to common property theory and following this the effects of social capital on behavior in the CPR experiment. The hypotheses I present are first that social capital has a positive effect on cooperative behavior (measured as lower extraction amounts) and second that institutions (the treatments introduced in the experiments) also affect how much people cooperate. I find that there is a marginally significant impact of social capital on cooperative behavior, but institutions matter significantly more. Interestingly, caste is also a marginally significant predictor of behavior with dominant castes extracting less or being more cooperative. I discuss these findings in the context of groundwater extraction in India and proposed regulation.

In Chapter 4, I present the larger experimental design that included three distinct populations: dryland Indian farmers, students at Delhi University and the University of Michigan. This was motivated by the need to provide external validity to theoretical findings on the CPR experiment which was replicated in three spatially and temporally distinct locations to study the differences in extraction decisions across locations and livelihoods. Post experiment surveys and interviews were also conducted to augment and explain the experimental results. The experiments were conducted with students from all disciplines at the University of Michigan, The University of Delhi and residents of six villages in three different states of India. The main findings are that student groups differ from rural participants in extraction choices but only in treatments that involve voting for a costly external enforcement of rule adherence on the commons. While the two student groups were not statistically different in extraction levels across all treatments, Indian students differed from Indian rural participants in the experimental treatment involving a costly external monitor. This result is difficult to interpret given that students by not voting for the institution in this treatment essentially played a different experiment compared to the farmers. Thus, to further examine differences in decision making I outline the variance in beliefs, preferences and experiences provided by a qualitative analysis of the reasons for decisions in the post game interviews and surveys. I find that farmer groups seem to cognitively transform the decisions in to a continuous one which

provides methodological insight to experimentation in the field This chapter also furthers the findings of recent work on the role of heuristics in decision making.

Satnarayansingh, the farmer from the story I started with, shares ownership of his tubewell with two brothers. This is already an adaptation to groundwater scarcity as such partnerships did not exist in the previous iteration of groundwater extraction, the dug well. The sheer cost of tubewell undertakings have resulted in these novel arrangements. Satnaraynsingh had been planning an orange orchard in 2008 with the help of a subsidy from the horticulture department. Oranges are a water intense crop and not really suited to the semi-arid climate of Salri. When asked how he plans for the future Satnaraynsingh brought up his tubewell and how he will see what the future brings in terms of rainfall and water levels 2010 has been a low rainfall year, by accounts of villagers in Salri, yet the orchard for oranges is still being watered.

Chapter 2:

Environmental Governance, the State, and Social Capital in India

2.1 Introduction

Globally rising anxieties about water resources are producing trajectories of intervention ranging from overt privatization to covert decentralization of water management. As with other water resources, levels of groundwater drawdown are of genuine concern when groundwater extraction outstrips recharge in many parts of the world (World Bank 2010 Shah 2009). The development state in the Global South is being further challenged in its abilities to keep up in its attempts at innumerable and mostly inefficient watershed development projects. In the face of these trends, community based natural resource management (CBNRM) is a much championed policy and development intervention arising from decades of environmental governance research and practice. The popularity of CBNRM based approaches has been attributed to claims of higher accountability, transparency and participation of local communities (Agrawal and Ostrom 2001; Larson and Ribot 2004; Agrawal et al. 2006).

After decades of watershed and other natural resource projects there is a realization within academic and policy circles for a need to examine the impacts of decentralized CBNRM projects (Castree 2008). Many have found the promises of decentralization to need much qualification (Larson and Ribot 2004) and this extends to water reform (Lemos and De Oliveira 2004; Agrawal and Gupta 2005). The main critiques relate to the lack of real devolution of administrative power but also the manufacturing of

communities. The success of decentralization projects has been attributed to many variables an important one being social capital (Evans 1996; Lemos and De Oliveira 2005). I use case studies from rural India to concentrate on the relationship, within CBNRM projects, of social capital (structural and cognitive elements of networks and norms[1]) and the role of external regulatory agencies, particularly the state (Leach et al. 1997; Brosius et al. 1998; Leach et al. 1999).

India is the world's largest groundwater irrigator (irrigation in turn contributes to the highest use of water) at some 210 billion cubic meters (Shah 2009). Within watersheds, groundwater extraction has increasingly come to portray an impasse for governance though it is considered a critical area for improvement in Indian agriculture having been the main driver of irrigation since the green revolution (Kulkarni et al. 2004; Mukherji and Shah 2005; Mollinga 2010). In this chapter I examine the literature on social capital in India and use it in the analysis of environmental governance in the region and globally. I contextualize this review in light of my research on groundwater governance in central and western India where I measured decisions using a common pool resource (CPR) experiment. This experiment emulated similar CPR experiments conducted in field settings with the added attention paid to the role of social capital (using surveys) and attitudes to external regulation (Cardenas 2005; Rodriguez-Sickert et al. 2008).

Within the CPR and larger Public Goods experimental literature increasing attention is being paid to the role of punishment imposed internally within a community (Ostrom et al. 1992; Fehr and Gachter 2002; Henrich et al. 2006; Janssen et al. 2010; Putterman 2010) but as I outline, attention needs to also be paid to the role of external regulatory bodies in influencing behavior, a phenomenon widely found in the post colonial developing world (Agrawal 2005; Cardenas 2005; Birkenholtz 2009). CBNRM projects that strive to fit a model of environmental governance that separates the increasingly neoliberal state from communities need to be contextualized and possibly modified. Evidence from central and western India's drylands presented here as well as recent scholarship finds that rural residents are willing to engage with the state by

[1] In chapter 3 I provide a detailed study of the role of social capital in extraction decisions in the CPR game. Here, I restrict myself to a study of voting behavior.

demanding their rights to citizenship but that this engagement is subjective (Agrawal 2005; Li 2007; Baviskar and Sundar 2008; John and Deshpande 2008; Shah 2008; Birkenholtz 2009).

In the sections below I start by outlining the approach to environmental governance most embodied in CBNRM projects though often not explicitly recognized (Swyngedouw 2005). By examining India's water policy process with respect to groundwater extraction I outline the deficit of property rights that makes governance of this unregulated yet intensely used resource so contentious. By trying to overlay an increasingly privatized way of governing this resource development agencies and even states rely on the concept of social capital. I present a review of social capital for the Indian context applied to natural resources along with the implications of this trajectory of resource governance and development. Overall, I offer that in thinking about community based responses to groundwater governance, in the Indian context, attention needs to be paid to access to a fuller citizenship by realigning the relationship between the state and dryland farmers through such initiatives.

2.2 Environmental Governance, watersheds[2] and groundwater in India's drylands

The term environmental governance is today extremely popular in academic and policy spheres but has gained dangerous traction in the way it is increasingly used to gloss over the realities of political democracy engendered by a shift to 'governance' from 'government' and its application to all kinds of 'commons' (Swyngedouw 2005). The focus here is environmental governance as collective action for resource management and what that signifies for state-society relations particularly with respect to the concept of social capital and the very construction of a commons. Environmental governance has been theorized to consist of a triad of actors the state, the market and civil society along with their hybrid linkages (Lemos and Agrawal 2006). The state-society link is referred to as co-management or co-governance (Lemos and Agrawal 2006; Agrawal and Chhatre 2007) This relationship, particularly in the post colonial and increasingly neoliberal

[2] A watershed is most conventionally defined in geo-physical terms as the area from which all water (surface) drains to a common point (Brooks et al. 2003).

developing world, is usually characterized by the devolution of state functions to local/ regional level community based actors though there are other forms of decentralization (Baviskar 2007, Li 2008). Within the CPR framework, based mostly on case studies that report the success of CBNRM, the discourse in academic and policy circles has been dominated by attention to the conditions for successful collective action (Ostrom 1990; Agrawal 2001; Poteete and Ostrom 2008).

Groundwater in India is not predominantly governed as a commons with common property arrangements (more on this in the following section) but planned decentralization reforms take the creation of a groundwater commons as a desirable outcome (Postel 1999; Parikh et al. 2007). This poses a challenge for decentralized management efforts since efforts to bring in regulation and the making of groundwater as a commons will be inequitable to some and thus conflict ridden (Birkenholtz 2009). Some authors have described the attitude of the post colonial Indian state towards bulk water investments as "build-neglect-rebuild" (Shah 2009 p: 25). The expansion of groundwater exploitation has occurred because and in spite of this cycle of investment and neglect though it has itself been an almost completely neglected aspect of state intervention other than as a form of capital accumulation through subsidies for drilling tubewells[3] and other access investments, a phenomena referred to as 'welfare colonialism' (Baviskar 2008).

Groundwater is a 'democratizing' only in the sense that once access is gained[4] there are currently no barriers to applying water on demand to fields at critical times in the growing season. The tubewell, originating in colonial times gained widespread use post India's green revolution to now contribute (along with other groundwater extraction mechanisms) more than 70 percent of irrigation or at least ten times 1960 levels (Parikh 2007, Shah 2009). Following Mitchell, the introduction of technology in water extraction at once created a new 'nature' and simultaneously took away older knowledge forms of adjusting to cyclical scarcity [5] (2002). Now the question of how to secure depleting groundwater resources in India has drawn in the state, district and local level bureaucrats,

[3] I use tubewells to denote both tubewells and borewells though regions with hardrock aquifers tend to have the latter. The difference regards the amount of casing provide in the well.

[4] Gaining access is a highly inequitable process embedded in systems of patronage and marginalization as Dubash reminds us and Mosse extends to tanks in S.India (2002, 2003).

[5] See Mehta on the politics of scarcity (2007).

industrial and commercial entrepreneurs, academics, non governmental agencies (NGOs) and politicians. But the question has not yet trickled down to most state governments in India where the dominant discourse is still on improving supply to groundwater or as some call it, the resource development mode (Burke and Moench 2000)[6].

In India alone, particularly following the 73rd and 74th constitutional amendments in 1992, there have been numerous projects undertaken under the aegis of watershed development and more recently watershed plus (Parikh et al. 2007)[7]. While other resources have had colonial (forests) and pre-colonial (canal irrigation) co-management antecedents watershed based governance has largely emerged as a post-colonial neo-liberal project (Mollinga 2010). Hence, the state has retreated in its welfare role and the lack of groundwater regulation in terms of safeguards or compensation for the effects on farmers marginalized by this 'primitive' capital accumulation bears witness to this. Some authors cite the recent National Rural Employment Guarantee Act[8], Right to Information Act (RTI) and micro-credit schemes in rural livelihoods as the welfare attempts of the state (Chatterjee 2008). However, others have insightfully pointed out that these were hard won legislation (though problematically implemented) by the very political or unruly peasants portrayed as being unwilling to accept state authority (Baviskar and Sundar 2008; Shah 2008).

There are increasing attempts being made to establish policy for groundwater management based on the model groundwater bill[9] designed and encouraged by the central government for states to adopt in India. A large part of the proposed regulation deals with establishing individual property rights but newer versions are pushing the idea of decentralized CBNRM. A recent report submitted to the Indian Planning Commission states:

> 'Cooperative management by users to facilitate groundwater use in an equitable manner seems inescapable. While groundwater recharge schemes may not be the final answer, they do call for community efforts and create the spirit of

[6] The current DMK government in Tamil Nadu is promising free pump sets to farmers (The Hindu 2010)
[7] There were older watershed management plans that predate the PRI act but the 'scaling up' of watershed management plans and their wide undertaking has been post the act. Watershed plus refers in main part to community engagement.
[8] The impacts on water resources from the NREGS could be detrimental as a case from SPS's project area outlines (Vijayshankar 2009)
[9] The first Model bill was introduced in the 1970s and has gone through many iterations.

> cooperation needed to subsequently manage sustainably groundwater as a community resource' (Parikh et al. 2007)[10].

While there is great optimism in this model of environmental governance particularly in international policy and development circles not much attention is being paid to the detrimental impacts on some in the name of CBNRM (Swyngedouw 2005, Birkenholtz 2009). It is only now that evidence is being gathered on the results of these exclusions and conflicts and further on more hybrid management examples in the context of watershed governance. The lack of attention to redistribution of rights of access to groundwater is certainly problematic but in spite of this, increasing and highly dispersed groundwater depletion is such that co-management with an explicit recognition of the role of the state might be necessary.

2.3 Property rights requirements for successful decentralization of groundwater management

Groundwater, is a CPR by nature but is governed by open access or the rule of capture in most instances in India. One of the 'design' principles in long standing successful CBNRM systems is the boundedness of the resource. Another is the recognition of rights of a community to the resource by the state though this does not need to cover the right to alienate (sell). Groundwater resources in India (and almost everywhere else) violate the first design principle if not the second with the complications of a society divided along caste lines. The apparent 'hands off' approach to groundwater extraction by the state along with the proliferation of technology to secure access to it has resulted in various technologies of governance (COMMAN 2005; Birkenholtz 2008). The cases studied here include examples of group well partnerships (Nakhatrana, Gujarat) private extraction (Agar, Madhya Pradesh) and farmers managed systems (Ahmednagar, Maharashtra)[11].

From studies on property rights governing CPRs, people possess bundles of rights (Schlager and Ostrom 1992; Ostrom 2010) and that for successful decentralization of natural resource management to take place clear property rights to the resource need to be

[10] This report was submitted to the planning commission of India by an expert group that included Drs. Tushaar Shah and Navroz Dubash, who have both written on the role of markets in groundwater extraction and the ensuing inequities though Dubash has concentrated more on the latter.

[11] Each of these cases consisted of a pair of villages where one village with forms of groundwater management were compared to a case nearby that did not have the same institutions in use.

established (Meinzen-Dick 2007). This has been a robust finding across numerous studies on the success of CBNRM even groundwater(Schlager 2007). Property rights are just one of a number of other variables identified in the CPR literature that promote long term sustainability of management systems (Agrawal and Chhatre 2006) The reason for discussing them here is that groundwater tends to have more complicated property rights arrangements that surface water and other CPRs (I will later cover social capital, another variable thought to improve CPR governance outcomes). Also, establishing property rights requires immense negotiation with and by the state[12] and groups/individuals that might not possess the agency and might themselves be fragmented along caste and class lines. Hence decentralization plans that privatize governance might be more problematic in the case of groundwater.

For regulation studies the state is not really autonomous but 'a social relation and a site of strategic actions by different parts of civil society' (Bridge and Perreault 2009). Jessop finds that environmental regulation is a result of the interactions and negotiations of many different groups as does Appadurai in the slums of Bombay and Baviskar in Delhi (Appadurai 2001; Jessop 2002; Sinha et al. 2006). However, these studies mainly concern urban environmental governance. In India, whether urban or rural, since land is held privately and groundwater is tithed to land, it is, in effect, governed by an open access regime of private land owners (who could be part of smaller collectives) extracting the inherently common pool resource (Iyer 2003). Hardiman, has demonstrated how this was actually an outcome of rural elites campaigning for the right to subsoil against the colonial state that tried to levy a rent on it in Gujarat (1998). Groundwater like surface water is under the state government purview in India though no explicit separation between groundwater and surface water is made in the National Water Act of 1974. Common law still seems to be held regards groundwater in that it is tied to land ownership (Hardiman 1998; Cullet 2009). Recognizing the excessive depletion of groundwater stocks the central government has been pressing state governments to adopt groundwater policies in line with its Model Groundwater Bill of 1992 and 2002 (which is

[12] It is possible for non state actors to establish property rights but that seems unfeasible with the history of open access and essentially state ownership of groundwater in India.

a draft bill and not actual regulation) though very few states have actually adopted any regulation or enforcement (Cullet 2009).

Groundwater as a resource has been mostly absent in regulatory mandates outside the watershed development and management framework and has only recently been developed in to state guidelines of its own in Goa, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and West Bengal though these measures are not accompanied by enforcement. This is in large part due to the property rights governing this 'invisible' resource and the difficulty in mapping it. Groundwater usage and recharge rates, some of the only used statistics are more often crudely estimated using rainfall data at the block level instead of a more appropriate watershed level (Burke and Moench 2000; Kulkarni and Shankar 2009). As recent reports point out, the national estimates are first very conservative of the actual extent of groundwater use and second unclearly representative of 'micro-trends'(Shah 2009; Shankar et al. 2011)

In spite of this lack of 'data' at the local level attempts are being made to develop heuristics on groundwater management based on crude estimates (Shankar et al. 2011). However, groundwater as it is accessed in most agricultural settings in India violates a number of the property rights bundles that would enable its successful governance as a commons. I have also presented the issues of proposed decentralized management that assumes an unproblematic creation of the commons or private property rights. Next, I describe how social capital, a popular concept in the development and lending spheres is invoked to predicate success of improperly designed projects.

Successful CBNRM in groundwater management in India will need to confront the previously absent state yet try to establish common property rights along with rules of access and limitation in an unequal agriculturalist society. This undertaking will also have to negotiate the proliferating partnerships between the state and corporate capital, another branch of the environmental governance triad (Lemos and Agrawal 2006). The Rajiv Gandhi Watershed Mission of the state of Madhya Pradesh has just signed a memorandum of understanding with the industrial giant Mahindra and Mahindra[13] (Press Release 2010).

[13] Mahindra Samriddhi, an initiative of Mahindra Farm Equipment, is in the business of 'agri - consulting'. The press release quoted a Mahindra employee "Apart from developing self sufficiency in water

2.4 Distinction in aspects of social capital

Much hope, particularly in the case of common pool resources has been invested in the concept of social capital (Ostrom 2000; Adger 2003; Pretty 2003; Leahy and Anderson 2010). Social capital has come to be a poster-child of large development organizations including the World bank and gained such prominence following the work of Robert Putnam who found that civic connectedness had a significant role to play in differing levels of economic development between northern and southern Italy (Bebbington et al. 2004).

According to Putnam, social capital is "features of social organization such as networks, norms and trust that facilitate co-ordination and cooperation for mutual benefit" (Putnam et al. 1993). Putnam's work is based on earlier conceptualizing by Pierre Bourdieu and James Coleman with each iteration differing from the previous in important ways (Baron et al. 2000). Bourdieu stresses the capital in the concept implying that it is economic capital represented by social ties(1986). People participate in social networks as a means to gain, making social capital very important for a community. Bourdieu also found that forms of capital (economic, human, cultural and symbolic) are fungible (1986). No claims are made to the altruistic nature of the concept that social capital has gone on to assume subsequently, a seemingly deliberate move in development policy and literature (Bebbington et al. 2004; Woolcock 2010). Bourdieu in fact does not have much to say on the role that social capital can play in transcending structures of class and power something considered deeply problematic in light of its current use (Portes and Landolt 2000; Arneil 2006). James Coleman a contemporary of Bourdieu concentrated on the individualization of the concept and found that community ties are important and should be preserved where they still exist and where they have faded they should be replaced with schemes of economic incentives to replace the disappearing social ties or capital (1994). So the initial usage of social capital was as an attribute of the "structures of relations between persons and among persons" that can be accessed by individuals (Coleman 1994: 302). Putnam is accused of 'conceptual stretching' by

availability, this initiative is a huge step towards community development and will also help us achieve our vision of FarmTech Prosperity. Mahindra will depute a full-fledged team managing the watershed development program at MP. Alongside, we shall also undertake many livelihood development programs which will benefit farmers" (Press Release 2010). No farmers seem to have been present at this signing.

extending the concept (mainly Coleman's) to become "an attribute of the community itself" without adequate theorizing (Portes 2000: 3). However, the two definitions do not seem to be incompatible unless distinctions are not made between the collective and the individual and bridging versus bonding social capital[14]. This lack of explicit distinctions has muddied the water further on how to measure social capital and the significance of its effects as most authors and critics refer to diverging definitions of the concept. The main distinctions in social capital are outlined by Woolcock as bonding and bridging (linking) social capital (1998). Bonding social capital refers to the strong familial and kinship ties that exist between family members whereas bridging social capital refers to the weaker links between people of different backgrounds or among state and society actors. In general bridging social capital is considered more beneficial to getting ahead (Cleaver 2005). The major critique of Putnam's work is that it seems to capture predominantly the bonding social capital and therefore incomplete measures of networks (Krishna 2002; Arneil 2006).

This study is specifically concerned with bridging social capital or weaker[15] social ties along with measures of norms and is based at the individual level. To measure bridging social capital it is important to look at activities that cross sub-groups i.e. those that villagers engage in as a community. In rural western India, particularly in arid regions, cattle rearing is an important occupation along with farming to provide a secondary income. The maintenance of common cattle drinking ponds or channels is usually undertaken at the village level. Rules in use about common pasture land are also useful indicators of network participation as opposed to membership in externally sanctioned user associations (Krishna 2002; Baviskar 2004).

Social capital is understood to be critical for collective action though it is difficult to indicate in exactly what way since it is problematic to operationalize making an empirical measure elusive (Hechter 1988; Krishna 2003). Also, there is a lack of understanding of how social capital translates to the functioning of institutions. In this case, does social capital alone matter for how individuals make decisions in a natural resource context or

[14] The negative effects of social capital have been attributed to mainly bonding social capital with examples ranging from the Nazis in Germany to Philadelphia's urban elite (Portes 1998; Arneil 2006). The perverse or dark side of social capital has also been documented by (Rubio 1997; Ostrom 2000).

[15] Bridging social capital does not necessarily have to be weaker, it is more the nature of the ties being different from those of bonding social capital or kin/caste based networks.

do institutions matter? Is social capital linked to institutions? While people may or may not have social capital, what they achieve with it is not clear, particularly in the lauded sustainable environmental governance outcomes hoped for where the burden of success is placed on them. Additionally more attention needs to be paid to linking social capital in these contexts within the large concept of bridging social capital that is much promoted.

2.5 Social capital and institutions

A careful assessment of the definition of social capital and institutions used sheds light on this continuum though a critique of the different definitions is not attempted here. I present a few definitional issues and concentrate on the ways social capital concepts have been applied in collective action theories for CPRs. Most definitions of social capital include trust, norms and networks. Trust can be the interpersonal trust borne of repeated interactions between individuals or generalized trust through knowledge of the population being dealt with and their background (Durlauf and Fafchamps 2005). However, it is still unclear whether trust is a product of social capital and therefore feeds back in to the level of social capital (Cook et al. 2007; Woolcock 2010). It does seem that similar to bridging social capital, the latter is considered more feasible and better at fostering social capital as it is easier to build in the large number of studies rising out of Fukuyama's study of trust as social capital (1996). I include it in the measure of social capital dues to its prominence in the social capital and experimental literature but show that it is not highly correlated with other variables used to capture social capital (chapter three).

Institutions are almost colloquially defined as the 'rules of the game' in mainstream new institutionalism (North 1990). A refinement in the definition of institutions being "a system of rules, beliefs, norms and organizations that together generate a regularity of (social) behavior" (Greif 2006 p.30) is useful here and brings us closer to the concept of social capital. This definition of institutions by including beliefs overcomes the limits of institutional analysis by not only considering formal institutions. But if institutions are a system of rules, norms, beliefs and organizations, social capital complements if not constitutes the former and this is where confusion could set in. Some theorists attribute the confusion in social capital to the conflation of institutions and social capital that is to identify social capital with institutions is a mistake: "institutions emerge from networks, they are

themselves not the networks" (Adger 2003; Dasgupta 2003). Others reason that it is well functioning formal legal institutions and state organizations that protect property rights and effectively deliver public goods (North 1987; North 1990) making social capital a distant second, to be called upon when institutions are failing or lacking. However, strong institutions increase the effectiveness of social capital overall (Bowles and Gintis 2002; Durlauf and Fafchamps 2005) along with agency (Krishna 2002; Krishna 2007). Some have explicitly modeled the link between institutions and social capital though not in a behavioral experiment but with the help of linking games (Aoki 2001).

Borrowing from Greif, I am interested in "regularities of behavior generated by man-made non physical factors that are exogenous to each individual whose behavior they influence", and that real institutions are the combination of the formal rules and actual social practices (2006). Thus, whether a society acts "morally" or opportunistically depends on a society's institutions and on its social capital (Pretty and Ward 2001). Institutional selection itself (see chapter 2) depends on social and cultural factors (Guinnane 1994; Greif 1997). While Guinnane finds that agricultural credit cooperatives in Germany were much more successful as compared to Ireland where they were imported, Greif finds that cultural beliefs affect the success and endurance of institutions in medieval trade networks in Genoa and Venice (Guinnane 1994; Greif 2006). By outlining the applications of the concept to natural resource management I illustrate some of the problems of its conceptualization and recent advances followed with the description of how social capital is applied to India.

2.6 Social capital in India

No assessment of social organization at the cross-section of environment and development can avoid an engagement with social capital. The most popular conceptualization of social capital in the development literature is by Putnam as outlined above. With his co-authors in Italy he demonstrates how social capital improves development outcomes and in the USA democratic participation (Putnam et al. 1993; Putnam 1995). The social capital project (since it is treated as a project by the World Bank) has since overtaken the term sustainability and even development in the publication record and is increasingly employed in developing countries to measure

economic performance (Woolcock and Narayan 2000; Narayan and Cassidy 2001; Woolcock 2010). The use of the concept in India has varied from explaining political participation ((Menon and Daftary 2010), health of tanks (Mosse 2006), communal violence (Varshney 2003), development (Krishna 2002). However, most of these studies make the point that social capital is a western academic concept that to be used in India needs contextualization something I concur with (Fine 2003). Also, to contextualize social capital to environmental governance in India, a further look at civil society in India is warranted.

'Community' based actors are thought to form an important part of the environmental governance triad (along with the state and the market). Recent watershed management projects proposed by the Food and Agriculture Organization as inputs to the Indian Planning Commission use diagrammatic representation that shows how environmental governance in India is increasingly organized with what Chatterjee calls civil society and political society (2008). Civil society is then 'elite citizens wedded to western modernity' whereas political society consists of all others. In the context of rural environmental and developmental issues, the members of NGOs and other development assistance agents could be the former and rural residents the latter. Thus it has been pointed out that social capital probably varies in meaning across different parts of society and does not work as one harmonious principle of organization across communities. Evidence from the field corroborates this as outlined below but I find that the attributes of civil and political community are in reality reversed, something others have also pointed out (Baviskar and Sundar 2008; Shah 2008).

As elsewhere, in India social capital is usually theorized as an important factor in the devolution of natural resource management responsibilities to communities (Bhattacharyya et al. 2004). This is indeed the basis of CBNRM as projected policy for groundwater regulation by the planning commission of India. Sundar with a study on joint forestry management, India's premier example of CBNRM, which is an example of the co-management link of environmental governance, finds that devolution of forest governance interacts with social capital in multiple ways (2001). Here social capital has not helped people achieve much other than holding the state accountable for rent seeking practices by wealthier logging groups. Gidwani finds that it is not so much social capital

but symbolic capital that dictates 'economic evolution' in the Kheda district of Gujarat (2002). Similarly, I present some examples from my field work to demonstrate that social capital seems to work in divergent ways depending on other factors particularly engagement with the state.

In India, Putnam's work is particularly criticized for its ignorance of the role of the state (Bhattacharyya et al. 2004). This role is increasingly felt in diverse ways in the context of watershed development plans as described below. Therefore attempts made by NGOs and other actors both local and international to circumvent the state by working directly with rural residents particularly regarding the environment can still face the many hurdles presented by complex state society relations.

2.7 A discussion of the field sites

In 2008 I spent several months with farmers in three states of India (see figure 2.1) conducting decision making experiments and also measuring their social capital. In the course of my field work I came in close proximity to various NGOs in Kutch, Shajapur and Ahmednagar which provided much information on their village based groundwater activities. Villages were picked in pairs in each location where one village had exhibited some level of groundwater governance ranging from protecting recharge ponds and aquifers with rules in use regarding crop choice restrictions, and tubewell technology bans.

Figure 2.1: Map of India with the three case study states shaded.

Hiware Bazaar in Ahmednagar district of Maharashtra is an example of a community managed system since the initial impetus for groundwater management evolved from within the village without any external encouragements or monitoring. This case, a successor to Ralegaon Siddhi in the rural development imagination is much documented (Menon et al. 2007; Sangameswaran 2008). With its well loved sarpanch (village council leader), Popat Rao Pawar it is an 'adarsh gaon' (ideal village), an annual title bestowed by the state government to villages that meet certain development criteria. Hiware Bazaar achieves this title through continued presence on government administrative maps. It has established a name for itself and very strong ties with local, regional and national governments in India. From furnishing an office with a computer for the local talati (government records keeper) whose hours of work are well known and personal phone number available from a number of villagers, a loud speaker system to broadcast information on meetings and news, an updated visitor book to the frequent

visits by urban and rural families from Pune and Ahmednagar and further as tourists (besides the usual official 'dignitaries', researchers and journalists) it has ensured its status and continues to garner attention[16] in these and many other ways

Pimpalgaon Wagah is almost a polar opposite to Hiware Bazaar though they are neighbors. Pimpalgaon was an early beneficiary of the Indo-German watershed program intervention in the state in the early 1980s. In the dry months that I visited both villages, Hiware Bazaar though water stressed was not using tanker supplied water for drinking water (only the limited plot of fruit trees planted on common land required extra water) whereas Pimpalgaon relied heavily on tanker water to meet its drinking water needs. Pimpalgaon does not have rules on private tubewells of which it has some (Hiware has none for irrigation) though it does have rules about water extraction from the common village pond created as part of its older watershed project.

Based on answers to questions about their norms and networks (see chapter three) Hiware Bazaar has higher social capital than Pimpalgaon Wagah and the former's groundwater resources were in better condition. More than fifty percent of respondents in Pimpalgaon mentioned high groundwater stress for groundwater including household use compared to less than ten percent in Hiware Bazaar. Education levels of respondents tend to be higher in Hiware Bazaar then that of Pimpalgaon. One indication of the attention to Hiware Bazaar's groundwater resources is that the Ahmednagar GSDA[17] has three observation wells within the perimeter of the village whereas Pimpalgaon its neighbor by five kilometers has none. Hiware Bazaar has codified rules in the gram panchayat (village council) forbidding private tubewells, rules for drip irrigation of more water intensive vegetables and some crop choice restrictions arising from the knowledge and monitoring of their groundwater and rainfall levels. But there are also very strategic actions of citizenry employed. By insisting on a well functioning school (Popatrao's earliest and well sustained intervention and it had the highest education levels of the six villages presented here), the training of its youth (Krishna's new leaders), banning the electioneering of political parties with the village limits, and Popatrao's tireless mingling

[16] Interestingly, Popatrao himself epitomizes the transformation to an 'adarsh'(model): for example a large number of villagers still eat meat but it was pointed out to me that Popatrao does not anymore, a sign of improvement 'sudhar'.
[17] GSDA is Maharashtra state's Groundwater Services and Development Authority

with government dignitaries within the state and around the country, Hiware Bazaar ensures continued state engagement[18]. The village has set up their own NGO that employs people from their village and now undertakes similar watershed based projects in neighboring villages (Menon et al. 2007). Hence, while Hiware Bazaar seems to have high levels of social capital it is also the strength of its ties with state agencies[19] and continued and persistent external attention that allows the success of village initiatives for groundwater demand management.

In Madhya Pradesh, Salri, has experienced water harvesting work undertaken in a 'ridge to valley' scheme with sustained involvement from the villagers during the length of the Foundation for Ecological Security (FES) supported project (FES 2002). However, FES has not had as much impact on groundwater governance in the almost ten years of presence in Salri and Moyakheda though Salri still has rules in use about extracting water from the recharge ponds built with FES inputs. Salri's social capital scores were not much different from Moyakheda's but both villages suffered from groundwater scarcity in the dry months. Another complication is a lack of inclusion of groundwater extraction rules in the original plans and an interruption with the local team leadership as well as staff with three staff changes from 2006-2010, the length of my acquaintance with this field location. They have lost charismatic local leadership to the Reliance Life Sciences corporation (a part of the Reliance Industries behemoth) who continue to work with farmers in the same area as FES[20]. While FES has a presence in multiple states of India and enjoys relationships with regional and national governments and benefits from connections with numerous academics who conduct field research and internships in their areas of work (including the author) it faces a constant reassessment and management of relations with local government bureaucracies. In a meeting at the Agar irrigation

[18]The GSDA has used the example of Hiware Bazaar as an example of how since 2004 it has kept a water account of the village watershed level and since the village is self-sufficient in food grain production it has attracted the attention of funding agencies including UNICEF to partner with the GSDA in three different districts. Hiware Bazaaris is ensuring further drinking water potential by securing a GSDA project that uses well blasting to alter the aquifer itself.

[19] Something referred to as linking social capital in the literature (Woolcock 1998).

[20] During my stay in the Agar farmers were being encouraged to grow Jatropha a drought hardy plant to be used in biofuels. Reliance provides the seeds at subsidized prices and buys back the grown plants at market rates. That project has been sidelined but in recent phone conversations farmers in Salri informed me that the Reliance team was still around though their current plans are unclear.

department a field irrigation engineer expressed much distrust in the work of NGOs on watershed projects quoting a case from another village where the

> "NGOwallahs[21] [not FES] disappeared with the funds and we had to complete the structures….I accept the government eats money (paisa khati hain), but we don't eat up as much as these NGOwallahs, at least one third of the money goes to the villagers and we know the technicalities [of constructing watershed structures]" (Field Notes Agar April 7th 2008)[22].

In Bhuj, Gujarat the Kutch Nav Nirman Abhiyan, a consortium of 18 different NGOs deals with drought and earthquake relief among other mandates. Within this Sahjeevan building upon the initial ten year involvement of the women's group Kutch Mahila Vikas Sangathan (KMVS) identified natural resource security as a priority. In Dador, one of the first villages where work was started in 1989, there has been experimentation with group wells starting in 2006. However, the wells have only been in existence under three years and water levels during the time of field work were too low to use them at all. They have rules in the group well register regarding crop choice restrictions in bad rainfall years as well as well spacing requirements. The strong and established presence of KMVS and its federation style of organization have lent a level of legitimacy and pride in the eyes of the villagers particularly the women who have been KMVS members all along and continue to represent not only their village but neighbors at the local and regional state offices ((Ramachandran and Saihjee 2000), interviews in Dador 2008). However, the fragmented communities present a challenge to the applicability of the concept of social capital in its positive effects on collective action. Both Dador and Kharadiya had different caste and religious groups living in separate locations (vaas). While in Dador the Thebas and Ahirs (muslims and hindus) worked well together and shared the group wells, the verars (muslims) have historically been disengaged. The NGO members and other villagers from Dador talked about how the verars insisted on getting a group well in their settlement though the groundwater resource was not ready and have since abandoned its maintenance. The situation in terms

[21] NGOs are commonly granted contracts to be PIOs in MP and other states. See Baviskar 2007 on how some entrepreneurial villagers have started their own NGOs to access the benefits of the watershed mission. Hiware Bazaar and Pimpal Gaon also have their own registered NGOs.

[22] A visit to Chipia, the village in question showed that indeed the irrigation department had completed some physical structures after the PIA had stopped work but the full project as explained to villagers was never completed. There was an incomplete canal running almost to the village.

of groundwater availability and use was not very different between Dador and its neighbor Kharadiya that had no evidence of groundwater governance and no involvement with an environmental NGO at the village level. The lack of state bureaucracies in the Kutch landscape is much more apparent than the other locations and much work is achieved through the interventions of the local NGOs who have now employed villagers themselves I negotiations with the state.

2.8 Achieving 'deep democracy' in groundwater governance: the role of social capital

In his outline on the functioning of deep democracy in the slums of Mumbai, Appadurai highlights the rejection by the Alliance of slum dwellers' organizations of the projectivization of slum development and the connections made and sustained between the Alliance and state actors at the urban, regional and national level (Appadurai 2002). It is this link, the connections between state and local residents (farmers), that I want to stress when considering the role of social capital for groundwater governance in rural India. Work on the role of organizational culture in fragmentation most often produced in multi-agency rural development projects has found that questions of meaning, practice and power cannot be ignored (Bebbington et al. 2007). Hence, NGOs operating with an ideology of welfare have to contend with the business of meeting project targets but also, in the situations presented above, have to compete with the partnerships between the state and corporate capital if not themselves aligning with both.

In terms of social capital, villages with high stores of social capital responded differently to cooperation arrangements and this was explained to some extent by their willingness to vote for external enforcement in the common pool resource experiment. This willingness to accept external enforcement depended on their prior relationship with the state where Hiware Bazaar with strong state ties was more likely to engage with external enforcement compared to its neighbor Pimpalgaon waga. Weiss finds that the state is diverse in its capacities and politically aligns itself in transformative ways (1998). Baviskar traces the practices of particular state officials, village level and community organizers to capture the benefits of watershed management in Jhabua, a plan of decentralization greatly promoted among policy makers and funding agencies (2007).

Farmers then have to negotiate welfare opportunities not only from the state but also the other external civil society actors present. NGOs in turn have to face a constant struggle of establishing legitimacy with the state and rural beneficiaries while also representing the interests of those beneficiaries. Hence it would seem that having high stores of social capital is not enough. Being able to exercise agency, something Krishna also finds, to work alone or with NGOs in sustaining state attention is what facilitates continued groundwater governance as is the case in Hiware Bazaar (2002).

Relying on social capital to privatize environmental governance at the local level is not enough as evidenced from the Kutch and Shajapur examples where high levels of social capital had limited results in terms of groundwater governance (presence of rules in use and resource availability). The presence of intervening agencies, in most cases NGOs is useful in as much as they provide agency to petition the state in meeting its responsibilities toward water resource management. While the state still struggles with measuring groundwater resources and pursuing further supplies, environmental governance that has been privatized continues to be precarious if it even gets off the ground. Increasingly even NGOs are striving:

> 'to support the systems developed by villages for water sharing with policy. As the aquifers are developed for drinking water, again it will become important to protect these resources solely for drinking water alone. With the enormous information and understanding of the water resources of Kutch, we propose to mobilize support for a comprehensive ground water legislation being designed that we will facilitate. –Sahjeevan 2010

Krishna outline how social capital can take on the rule of 'glue' and not the 'gear' in rural development (Krishna 2002). Not much forward motion can be achieved without both. In the cases presented above, external interventions to establish groundwater governance are not successful when they only consider the glue or social capital and not the gears of state recognition in a sustained manner. Hiware bazaar possesses both and is able to successfully manage its groundwater resources with minimal internal conflict and much state recognition. Salri with a lot of glue has not managed to sustain groundwater governance

2.9 Conclusion

Social capital, a predominantly western oriented concept needs to be better contextualized to be applicable to regions like south Asia where the importance of networks and civic organization in rural areas is not as high as state-society synergies as well as political and civil society linkages. The complex property rights arrangements surrounding groundwater resources in India present an added challenge to effective groundwater governance in a collective arrangement. It is again here that the relations with the state can solidify the role of social capital.

In the face of evidence that CBNRM projects can also sustain state making, elite capture and inequalities, attention needs to be paid to the role of much championed concepts like social capital in achieving conservation and development outcomes by virtue of their 'depoliticization' of development (Harriss 2002; Mosse 2006). Democratic decentralization becomes extremely challenging for resources, like groundwater, that exist in a public-private continuum. I recount a contentious relationship between NGO field workers, street level bureaucrats[23] and rural residents who will have to maneuver between these actors to gain benefits of potential CBNRM and state led initiatives.

The increasing privatization of environmental governance when examined in the context of groundwater access and use needs to be assessed carefully and reliance on social capital might not be enough to ensure good governance. The property rights arrangements surrounding groundwater in India are complex enough that privatizing governance by excluding the state will not be successful. Watershed development and management plans that cover groundwater resources will need to negotiate these complexities and not rely on under-contextualized notions of social capital.

[23] (Lipsky 1980)

Chapter 3:

Individual Decision-Making and Levels of Social Capital on a Groundwater Commons

3.1 Introduction

Does social capital improve levels of cooperation in common pool resource (CPR) dilemmas? This chapter presents an answer to this and ensuing questions as to what degree, if any, this influence occurs by using experimental evidence collected among farmers in semi-arid India. The motivations for studying this relationship are many: the last four decades have seen a rising awareness of human interactions with increasingly stressed environmental resources particularly in rapidly developing countries with important implications for resources and livelihoods. These stressors have further strained weak governments who are now trying to secure resource bases by controlling demand through regulation. Most post-colonial states in spite of large inputs of development aid are unable to provide adequate monitoring and enforcement and hence efforts have finally come to rest on the shoulders of 'communities' and market and individual focused incentives (MAFIs) (Lemos and Agrawal 2006). The phenomenon of decentralized, community based natural resource management (CBNRM) has lead to extensive studies of the success and failures of communities at managing their environmental resources particularly in the developing world. CPRs refer to environmental and other goods that are subtractable in nature and from which exclusion is difficult. The hypothesis presented here is that higher levels of social capital result in more successful collective action for groundwater demand management. Social capital

refers to the ties that bind, or "social networks, the reciprocities that arise from them, and the value of these for achieving mutual goals" (Baron et al. 2000).

This chapter is focused on the outcomes of social capital on individual behavior in a commons dilemma. While an acknowledgement is made of the problematic nature of concepts of the commons (Bardhan and Ray 2008) and social capital (Harriss 2002), the popularity and sheer volume of interdisciplinary work as well as prescriptive use makes it a fruitful endeavor to carry on the conversation[24]. Essentially, this chapter asks the question, "What effects if any does social capital have on decision making to extract a valuable natural resource such as groundwater"[25]. This is motivated by consideration of the largely positive outcomes of social capital (as social norms of trust and networks of reciprocity) in overcoming the 'tragedy of the commons' in numerous CPR settings (Wade 1988; Berkes 1989; Ostrom 1990; Pretty and Ward 2001; Ostrom 2010).

I make the point that social capital is used uncritically in the CBNRM literature to signify norms of trust and reciprocity and membership in civic engagement and much work is still to be done on sharpening the concept and accounting for the politics of resource use. I present a measurement of social capital based on a previous survey used in Rajasthan and Madhya Pradesh, India.[26] Following this I measure the impact of social capital in a behavioral experiment on collective action for resource governance. Based on the literature on the positive outcomes of social capital, I test whether individuals with high social capital will be more cooperative in a social dilemma and find some evidence for this. This work is much needed since the level of decentralization for CBNRM is increasing apace even though it is based on a problematic operationalization of social capital and a theory that explains if and why people cooperate in the presence of stronger social ties and norms is still illusive (Cleaver 2000{Cleaver, 2003 #1055)}. In earlier work I have covered the idea of a creation of the commons (chapter 1) and here I will focus on the concept of social capital (what it means and how it could be measured) in

[24] The use of the term social capital continues unabated as Woolcock finds, its citation counts are currently a 100 times larger than 20 years ago (2010).
[25] As Avner Greif points out, the economy is an integral part of society and cannot be ignored in the study of social capital, institutions and CBNRM (2006).
[26] Anirudh Krishna developed and tested the social capital index and found impacts of an interaction between social capital and agency in developmental outcomes in rural India (Krishna and Uphoff 2002; Krishna 2003).

CBNRM policy along with its measured effects on decision making in a commons dilemma..

Social capital is popularly defined using "networks, norms and trust" (Putnam 1993: 35) Current conceptualizations of the concept make it hard to understand the causation if any between social capital and collective action for CPR management (Durlauf 2002; Sobel 2002; Ballet et al. 2007; Ishihara and Pascual 2009). This chapter explores this relationship using the CPR experiment (a version of the public goods game) among users of groundwater. Groundwater is subject to the problem of non-excludability and also subtractability and in that way is a classic CPR. It is however difficult to manage groundwater as a CPR (COMMAN 2005; Koundouri 2005; Shah 2009).To a large extent this is due to its invisible nature and a general lack of understanding of its properties including extraction and recharge (Burke and Moench 2000; Dayton-Johnson 2003; Schlager 2007) Studying groundwater provides its own unique set of challenges. In most cases it is a resource firmly in the realm of open access and it exists in a regulatory vacuum particularly in India. By being linked to land (a resource usually privately owned), acute distributional issues in access make sustainable governance of groundwater elusive.

The reluctance of development agencies to be involved and the inaction of the state in the governance of such a resource that requires redistribution of access and shifting 'common knowledge' of its management is only changing now. Groundwater is a critical resource (particularly in terms of livelihoods) and in steep decline making the issue of its sustainable governance extremely urgent (Glennon 2002; Gleick 2007). The failure of large scale water management schemes in the developing world, regions that concurrently face acute groundwater shortages, makes this an important area to test out theories of ideal governance mechanisms and causal relationships between social capital and behavior.

India is a prime example of the phenomena of a 'race to the bottom' of aquifers in both rural and urban areas (Dubash 2002; Mukherji 2006; Giordano 2009; Shah 2009; Mollinga 2010). The largest users of groundwater are invariable agriculturists and more than 70 % of irrigation is from groundwater (Shah 2009). This study is based among agricultural populations in semi-arid regions of India that are groundwater stressed

(Briscoe et al. 2006). In India, the use of groundwater for irrigation is the most important driver of agrarian change and is in dire need of 'good' governance (Dubash 2002, Shah 2009, Birkenholtz 2009).

The next section details the proposed role of social capital in natural resource decision making and the idea that social capital is only effective in so much as it creates "common knowledge" in such dilemma situations and that this is a process of 'symbolic power' or the power to legitimize certain knowledge as common knowledge and can be violent (Bourdieu 1990; Ishihara and Pascual 2009). I then outline the methodology employed in first measuring social capital through a survey and then capturing decisions with the help of a CPR game. Last, I discuss the results of the comparison of the social capital scores with the game data and the implications of these findings.

3.2 Social capital and its role in natural resource decision making

Social capital has historically been invoked by name or intent in most studies of successful CPR governance (Ostrom 2003; Lehtonen 2004). The role of a 'social something'[27] in the management of surface irrigation systems, grazing pastures, and forest resources has been introduced in examples of successful collective action by many (Ostrom 1992; Lam 1998; Bardhan and Dayton-Johnson 2002; Dayton-Johnson 2003; Miguel and Gugerty 2005; Miller and Buys 2008; Khwaja 2009). Adger holds that "social capital has explanatory power specifically in the area for collective action for environmental management" (2003 p.389) and illustrates this qualitatively. However, it is only recently that an explicit link between social capital and common pool resource governance has been made. Ishihara and Pascual highlight the role of expectations in game behavior and the role of social capital in creating common knowledge (2009). Common knowledge refers to the understanding of other's preferences (Chwe 1999). This does not imply the nash equilibrium prediction that dictates the maximizing of individual payoffs in a game given the expectations of what others will do.

[27] Pricthett and Hammer describe how the policy and academic atmosphere of the late 1990s was conducive to a 'social something' and Putnam's powerful associates were instrumental in championing social capital to fill that role (2006).

Common knowledge represents an understanding of "you know that I know that you know" ad infinitum (Chwe 1999, Ishihara 2009). Expectations in a game about other's behavior become beliefs and can transcend the game or transaction in which they have been 'crystallized' (Greif 2006). Everyday village transactions around crop choice, number of irrigations provided, whether people can be trusted, collective action to maintain cattle ponds all involve beliefs and expectations about other's behavior. In the strategic exercise of the CPR game such beliefs guide behavior. This does not mean that common knowledge is easily created and maintained. As Birkenholtz finds with groundwater extractors in Rajasthan "shifting meanings and power relations around groundwater and irrigation knowledges produce tensions that will undoubtedly negatively impact future groundwater governance strategies (2008: 466). In a way this brings us back to a simple recognition of the importance of information. As outlined below, the role of social capital in acceptance of common knowledge can be critical in making institutions of formal external monitoring and sanctions successful.

In a critique of the usefulness of social capital in governing the commons, Mosse finds that, "successful collective action is embedded in wider systems of "corruption" and "patronage", as well as in village social hierarchies and it is implausible that villages with higher social capital will have stronger collective action for tank management (2006: 702). However, Mosse takes a limited view of social capital by only considering associational ties and as evidence provided here indicates there are a number of other aspects of social capital that can be measured and have significant effects on the decisions of individuals in water extractions from a common well (2006).

In the realm of common property theory, Ostrom defines social capital as "the shared knowledge, understandings, norms, rules, and expectations about patterns of interactions that groups of individuals bring to a recurrent activity" (1999: 176) and finds a role for social capital in the governance of surface irrigation systems in Nepal. Ballet et al find that 'bringing Bourdieu back in' is important to be able to bring the analysis of the interactions between the different forms of social capital (2007). One of the critiques of Putnam's work is the use of network membership alone as an indicator of social capital and in later work the use of a generalized trust measure. "Grossing up the organizations to which people belong tells us very little about the strength of social

capital if it is not accompanied by information on two scores: what people actually do as members of an association, and how far this relates to public as well as private goods" (Baron et al. 2000 :27). Another critique concerns the use of questions on trust that are inappropriate for the field site (Krishna 2002). The most popular measure for trust is the answer to the question: "Do you agree that most people can be trusted?" (Knack and Keefer 1997). However, locally relevant referents need to be used to measure the various components of social capital and the question on trust as stated needs to be modified. In the next section I explain the measure of social capital used here.

3.3 Measuring Social Capital

Social capital is measured as an independent variable through a survey and using a behavioral measure of extraction decisions in a CPR experiment makes the link between measured levels of social capital and its effect on behavior in a commons dilemma clear. There are numerous variables associated with social capital based on norms, networks, homogeneity, previous activity and trust (Woolcock 1998; Krishna 2002). This has generated a very large scholarly (and policy) literature with numerous claims for the efficacy of social capital. Overall the variables can be broken down into two categories: structural and cognitive or networks and norms (Baron et al. 2000; Krishna 2003). The main intuition is that one needs a locally relevant measure that can be tested empirically. For this study, a survey developed by Krishna and Uphoff and tested in Rajasthan and Madhya Pradesh was utilized (1999, Krishna 2002). Fieldwork was conducted in western and central India from January through August 2008 and consists of survey data to measure the independent variable (social capital) and an experimental setting to measure the dependent variable (groundwater extraction levels). See figure 2 1 for location of the field study area.

Variable	Factor
Cattle ponds	0.6574
Common land	0.6429
Crop disease	0.4369
Trust	0.4153
Credit	0.3912
Solidarity	0.3763

Table 3.1: Social Capital Factor Pattern.

Social capital was measured by asking respondents in six villages in western India questions about their village (structural) and their perceptions of village life (cognitive and norms). An exploratory factor analysis was performed on all the variables thought to constitute social capital. See factor loadings in Table 3.1 and Appendix II for the survey questions. While the same variables were not found to load on one factor as Krishna, this data finds evidence for the suggestion that social capital is constituted by norms and networks (Baron et al. 2000; 2002). The results of the factor analysis[28] confirm that individuals are embedded in multiple social relations and measurement needs to involve meaningful activities and perceptions that govern the 'transactions' of life which affect structural and cognitive features of social capital (Greif 2006). The social capital factor was scored and used in the regression analysis reported below. Carpenter argues that asking people about their levels of trust, or willingness to lend people money could suffer from the problems of 'hypothetical bias' (2004). Here, social capital is measured using a survey that captures both structural and cognitive elements of the concept. While structural questions are very appropriate to a survey method responses to cognitive questions may not be well captured again indicative of the lower factor loadings for trust, solidarity and credit in Table 3.1 (Glaeser et al. 2000).

[28] The factor loadings were calculated using a varimax rotation. A screeplot shows a distinct elbow after factor1. Also, I used an iterated principle factor which takes in to account measurement error something Krishn's measure does not by using a principle components analysis (Gorsuch 1983). This could also account for some of the lower factor loadings here.

3.4 Behavioral Measure: A groundwater commons modeled as the common pool resource game

Previous work has found that collective action for governance of a groundwater commons by controlling extraction is possible (Blomquist 1992; Ostrom 1993; Koundouri 2004; COMMAN 2005; Steenbergen 2005). However, self-governance requires cooperation in spite of private costs and research has predicted that cooperation as group equilibrium (despite private costs) can be achieved and sustained (Axelrod 1985; Ostrom et al. 1992; Ostrom et al. 1994). This research conceptualizes collective action as "voluntary actions that achieve a common objective" (Meinzen-Dick et al. 2004). In the context of the CPR experiment presented here, the lower the individual's extraction, the more cooperative they are. When studying collective action for natural resources a common expectation is evidence of rules, norms and sanctions specifically those that put group interest above individual interests. Accordingly this study explicitly models institutions or rules that promote collective action to secure the groundwater resource.

The CPR experiment was conducted with groups of five village participants per session. Participants were given instructions that they shared a common well and each could extract up to eight tokens in each of twenty rounds. 360 farmers participated in 72 sessions of five groups each Table 3.2. All participants were vetted for their ability to count, to be able to read the tables and also tested on their understanding of the game procedure. In each village women were also included in the study and between two and three all female sessions were run in each village. Participants played one of three types of games in a group of five players for a total of twenty rounds. Rounds 1 to 10 were the same across all three types of games and rounds 11 to 20 were played post the administration of the 'treatment'.

Experimental Treatment	Stage 1 (10 rounds)	Stage 2 (10 rounds)		Indian Farmers
		New Rule	*Rounds 11-20*	
Baseline Information Provision	$X_1, X_2, \dots, X_{10}$	Information on social optimum + No rule change	$X_{11}, X_{12}, \dots, X_{20}$	[**5** farmers] x [**4** sessions] x [**6** villages]
Endogenous Vote No Cost	$X_1, X_2, \dots, X_{10}$	Information on social optimum + Inspection: 3 out of 5 players in each round: p=3/5; f=10(overextraction)	$X_{11}, X_{12}, \dots, X_{20}$	[**5** farmers] x [**4** sessions] x [**6** villages]
Endogenous Vote With Cost Cost = 50 points	$X_1, X_2, \dots, X_{10}$	Information on social optimum + Inspection: 3 out of 5 players in each round: p=3/5; f=10(overextraction)	$X_{11}, X_{12}, \dots, X_{20}$	[**5** farmers] x [**4** sessions] x [**6** villages]

Table 3.2: Experimental design, stages, and treatment per village.

The CPR experiment is modeled as an *n* person prisoner's dilemma game. In this study there were five participants in a session with three different types of sessions. The empirical testing of the CPR experiment in field settings with actual resource users was brought to prominence by (Cardenas and Ostrom 2004). Their empirical model was based on that proposed by Ostrom et al and while they found interesting results this assumes computational abilities on the part of participants which may not be present (1994). Following this, Cardenas conducted multiple field experiments and his model of endogenous and exogenous regulation is adapted and used in this paper (2005). Henrich and Smith use a simpler model based on extraction and not contribution to the CPR (2004). While they only tested the baseline CPR experiment it provided valuable in sight in to the cultural differences in game strategies of subjects in 15 small scale communities across the world. The model presented in this paper is similar to earlier versions but

includes treatments on voluntary external regulation with and without costs. As mentioned by Carpenter and Cardenas, more empirical work is required to evaluate the evolution of institutions and their role in decision making (2005). My research attempts this by testing the rise and evolution of cooperation particularly under the imposition of incomplete external regulation, which is highly relevant to decentralized natural resource management in developing nations. As field experimenters have pointed out "there seems to be a universal pattern of a partial cooperation in most baseline CPR experiments, but rather little is known about the effect that subsidies or pecuniary fees may have in cooperation rate, particularly when the regulator has limited capacity of monitoring compliance" (Cardenas and Carpenter 2005: 36; Cardenas and Carpenter 2008).

3.4.1 Baseline Non-cooperative CPR game

The theoretical model used in this design follows from that used by (Cardenas 2005). The model is set up as an extraction based CPR where n participants decide on how many units of the resource to extract each round of the game. Player *i*'s level of extraction increases her payoffs at a diminishing rate. She will directly benefit from her extraction by – when *a, b* > 0. Her payoffs will also be indirectly benefited from the aggregate extraction in that round . Player *i*'s payoff is given by

–

where *a, b* and *α* are constants, is the level of extraction per round and is the total number of resource units for the *jth* round. If player *i* chooses to maximize the first-order conditions that produce the optimal level of extraction are —

giving

For

Similarly to achieve the socially pareto optimal outcome, the maximization of aggregate payoffs gives us

For

In the CPR game, the first ten rounds are played with only instructions on game mechanics explained. See appendix III for game instructions. In each round participants make decisions simultaneously and anonymously. The experimenter subtracts the total extraction (from 0 to 8 tokens per individual) from the total number of tokens in the common pool (40). The number of remaining tokens out of 40 is announced and participants refer to their payoff table to compute their payoffs. The only information required to refer to the table is the number of tokens taken in that round by themselves and the remaining tokens after all extractions have been entered.

3.4.2 External regulation treatment

The second stage of the game introduces the possibility of an external regulation (in both the endogenous vote for external enforcement sessions). A penalty *f* as introduced in Cardenas can be imposed as a cost with probability *p* to an individual extraction above the socially optimal level however the probability of being inspected is increased to three out of five here making it non-trivial (2005). In the baseline experiment, participants are provided with the information on the socially optimal level of extraction (one unit per individual per round) and also introduced to the concept of free riding in the game. For example if four participants were to extract 1 unit of water each and the fifth individual extracts three the payoffs shift from 81 points for each at the one unit extraction level to 77 and 93 for the over extractor. No rules are instituted in the baseline experiment.

The treatments in the next two sessions involve the possibility of endogenous voting before stage 2. If by majority (three out of five) participants vote yes then a rule of one unit extraction per individual in each round is instituted and the experimenter will examine the extraction levels of three individuals at random by announcing their id numbers (no one is identified by name). Hence, these treatments involve applying the regulation exogenously by the experimenter and endogenously through initial voting by the group. In the vote with cost sessions the players are charged a onetime fee of 50 payoff points in round 11 if the external regulator in engaged by a majority vote. In both types of voting sessions the fine is in payoff points and equals ten times the level of over-extraction.

Hence player *i*'s payoff is now

The Nash prediction for player *i* is

For

For the field experiment, the parameters used reduced the Nash equilibrium to 5 units of extraction in the first stage and throughout the baseline experiment and 2 units in the second stage if the rule was employed. The socially optimal extraction level was 1 unit of extraction in both stages of the game (across all game types).

3.5 Comparing social capital scores with extraction choices

A major critique of the conclusions drawn from social capital is that they are based on an abstraction with no historical bias and political stresses. However, by assuming that individuals are boundedly rational I am able to use rational choice theory which provides the mechanism "that mediates between cause and effect" (Little 1991: 39; Ostrom and Ahn 2003). Also, the data is collected among individuals involved in agriculture as their main livelihood, living in rural India and subject to the stresses of falling aquifer levels. Post game interviews with farmers provide evidence that the game was connected to everyday irrigation decisions[29]. Along with demographic indicators of age, gender and education I include indicators of social position (caste) and the variables from a social capital survey described above. As other studies of community based irrigation (all surface water) in India and globally find, limiting the analysis to rational choice is not enough but is still critical in explanations of the evolution of institutions for collective action (White and Runge 1995; Mosse 1997; Baker 2005).

The first hypothesis is that an individual farmer's social capital score effects his/her level of extraction in the game. That is do farmers with high levels of social capital tend to be closer to the socially optimal level of extraction (took) in the common pool experiment? The second hypothesis is that institutions matter: the type of treatment

[29] In answer to the question, "why did you change your extraction levels in each round?", respondents often cited crop choice or climatic reasons, "because it rained that time and I did not need the water I left it for my neighbors" See chapter 4.

(outlined in table) is a significant predictor of behavior. The first hypothesis is based on the social capital literature and the second on the large number of studies set in common property theory. A hierarchical linear mixed effects model was constructed to test this relationship[30]. Rural participants are clustered at the experimental session level. This is because their behavior in a game is related to the other members of the session as well as the type of session. The session level includes a random intercept effect in the model. The analysis is conducted at the level of the individual (id) as indicated in table 3.3. The data structure is longitudinal in the sense of pre and post treatment stages of the session. Round stage is linked to session type (the three different treatments) and post is included as a dummy variable that equals one for the second stage of each of the three experiment types. This provides the longitudinal measure of the model and the random effects of stage and game type are included at the individual (id) level. Fixed effects covariates at the individual level are the age, gender, education and caste of the participant. Caste is coded as a dichotomous variable with 0 being a marginal caste and 1 being a dominant caste of the village.

[30] A restricted maximum likelihood or REML is considered appropriate here since the observations are clustered at the session level and the dependent variable "took" is a repeated measure in 20 rounds of the experiment. See appendix IV for model fit and post estimation results.

(a)

Experimental Session (Level 3)		Individual Farmer (Level 2)								Longitudinal Measures (Level 1)	
Cluster ID	Covariate	Unit ID	Covariates							Time Variable	Dependent Variable
SESSIONID	Random Intercept	ID	Game type	Social Capital	Lag	Fine lag	Age	Gender	Caste	Education	Post	TOOK

(b)

	N	Mean	Median	SD	Min	Max
Round 11 (Dummy)	7200	0.05	0	0.218	0	1
Caste	7200	0.819	1	0.385	0	1
Social Capital	6400	0	0.146	0.850	-2.88	1.18
Age	7020	35.0	30	13.0	18	81
Gender	7200	0.778	1	0.416	0	1
Education	6660	6.30	7	4.12	0	18
Lag	7200	21.6	22	8.29	0	36
Fine Lag	7200	0.960	0	5.76	0	70

Table 3.3: Structure of longitudinal data (a) and descriptive statistics for independent variables (b).

Table 3.3 presents descriptive statistics on other individual level covariates including the social capital factor score and the possible effect of history from the previous round of the game. History of play is captured by the number of tokens left in the common pool in the previous round after all five extractions have been made (lag). This number (less than or equal to 40) was announced in each round so participants could compute their payoffs and also gain insight into the decisions of others in the group. To capture the immediate effect of round 11, the first round after the treatment was introduced a dummy variable was included. Finally, for stage two (post), the fact that a fine was imposed in the previous round could affect the amount extracted in the present

round hence finelag was included. The dependent variable is the number of units of water extracted by an individual in each round of the game (took).

3.6 Results and discussion

3.6.1 Extraction decisions

Variables	Coefficient (Std. Err)
Game type 2 (FXR)	0.203 (0.201)
Game type 3 (CXR)	-0.036 (0.204)
Post (baseline)	-0.548 (0.154) ***
Post * FXR	-1.378 (0.216) ***
Post * CXR	-0.932 (0.216) ***
Round 11(Dummy)	-0.729 (.099) ***
Caste	-0.340 (0.192) *
Social Capital Factor	-0.152 (0.088) *
Age	0.003 (0.006)
Gender	-0.191 (0.212)
Education	0.002 (0.018)
Lag (Earnings rounds 1 to 10)	-0.005 (0.004)
Fine lag (Fined in previous round)	0.014 (0.004) ***

Table 3.4: Output from linear mixed model (fitted using REML estimation). Dependent variable - number of units extracted per round. *, **, and *** signify statistical significance at 0.1, 0.05, and 0.001 levels.

Table 3.4 presents estimates of fixed effects in a linear mixed model with random session effects and random effects of individuals within sessions, for independent variables potentially affecting extraction amounts. The dependent variable is amount

extracted in each round per individual and the independent variables are the type of game (baseline, FXR or CXR), the round stage (pre is the referent level and post is displayed), an indicator for round 11 (immediately after treatment was administered) along with demographic variables of caste, social capital factor, age, gender and education. Land (in acres as reported in the survey) was also included as a proxy for income but was insignificant in its effects and was not correlated with social capital and given the number of predictors in the model was excluded from the final analysis[31]. History of play was also included in terms of fines if any in previous round and total earnings from pre treatment stage of the game. The mixed effects included allow different individuals within a session and also the same individual to have different means in pre and post stages. For the purpose of the present, the model was used to control for correlation within a person and between people within a session.

The results presented in table 3.4 show that social capital (a measure of cognitive and structural elements) is marginally significant (.088) in a farmer's decision to extract less units (.156) of water. This provides evidence for a weak relation between social capital and behavior. However another finding is that institutions (treatment type) are highly significant in individual decisions to cooperate by extracting less from the CPR. The treatment introduced after stage 1 in each type of experimental session has a very significant influence on extraction levels (refer table post and game type). The negative effect of post (-0.662) in the reference treatment group (baseline) becomes significantly more negative in the FXR (-.662 - -1.432 = -2.094) and CXR (-.662 - -.969 = 1.631) treatments. In the FXR treatment the expected decrease in amount taken for post relative to pre is roughly 2.1 tokens, while in the CXR the expected decrease is approximately 1.6 tokens. Also these decreases are significantly larger than in the reference treatment group (post baseline).The implications are that information on the sustainable extraction amount has an effect but instituting a rule has a much stronger effect on extraction choices. The experimental results imply that the changes in rules (or the introduction of rules along with information) are significant in directing individual behavior.

Participants in the treatment stage of the baseline (information), FXR (costless vote) and CXR (costly external regulation) extract less than in the pre-treatment stage of

[31] Where land was reported in bighas, a local measure that differs by state, an approximate

their experiments. The evidence provided here is critical in thinking about the effect of social capital in mediating or extending the effect of institutions. There was however no significant impact of an interaction between social capital and treatment (institution).

In the baseline experimental session, villagers are provided the information on the socially optimal solution (taking only one unit of water each) and how free riding (or defecting by taking more than 1 unit) could occur and could cost the members of the group that cooperated by limiting their individual extraction. The treatment that involves providing information on the dynamics of the payoffs from the CPR significantly affects extraction levels (see table 3.4 for coefficient at post baseline) in subsequent rounds of the game. This follows work that has found deterioration in cooperation in later rounds without rules (Ostrom, Gardner, Walker 1994, Cardenas 2005). This finding supports the extensive literature on CPR theory that individuals can and do respond with a selection of strategies wider than the Nash prediction based on maximization of individual material gain (Ostrom et al. 1994; Carpenter and Cardenas 2004). Cardenas and Ostrom speculate on how individuals use information in making decisions in a strategic situation on the commons (2004). In a series of field experiments they find that people bring layers of information to the game. Individuals "interact with institutions as rules of the game' and thus gather information (Cardenas and Ostrom 2004). More attention needs to be paid to the role of information in the dilemmas surrounding complex environmental goods including groundwater.

The results show that caste has an inverse and marginally significant relationship with extraction levels. The higher the caste (zero for marginal and 1 for dominant) the less the extraction in the experiment (see table 3.4 caste). This seems counterintuitive to the general understanding of caste relations in the agrarian context in India and with groundwater in particular in that we would expect dominant castes to extract more versus marginal castes (Dubash 2002). This result points to the importance of Bourdieu's 'class habitus' that social class or caste is not simply a condition of being. Instead, it is conditioned by practice which in turn arises from choices as they are influenced by relationships (subjective and objective) within structures (Rudd 2003). Therefore, this is evidence more that the nature and direction of relationships are critical as well as the

relations between different forms of capital as appropriated by different groups(Banerjee and Somanathan 2001).

I find that farmers from dominant caste categories, (Yadav-Ahirs in Agar, Jadeja, Ahir, in Nakhatrana and Maratha in Ahmednagar) took significantly less tokens in the experiment (table 3.4). The higher propensity of marginal castes to extract more water in the experiment could be related to their lack of access to social, human and economic capital. In the aftermath of the introduction of recent groundwater decentralization policy in Rajasthan, Birkenholtz finds that support for state regulations to limit tubewell construction differed among castes with less support from lower castes 'due to their fear of losing access and to their historical mistrust of the state' (Birkenholtz 2009 p: 215). This alignment of powerful interests with regulatory power is echoed in Baviskar's and others' findings that in urban areas of Delhi, middle class environmental entrepreneurs have used the judiciary through public interest litigation to first evict marginal laborers but have themselves been granted special concessions to build homes and businesses on 'regularized' land (2003; Sinha et al. 2006)

The significance of caste in extraction decisions lends credence to the argument that while social capital is usually attributed to a community (in this case a village) it is also specific to individuals in their ability to access it to achieve cooperative outcomes or collective action. Also, the outcomes themselves while viewed as cooperative could be interpreted as coercive depending on a person's social position. There is however no correlation between caste and social capital in the data presented here. Krishna does not find a significant relationship between caste and political participation, a measure he includes to study the impact of social capital on development (2002)[32]

Khwaja in his study of collective outcomes for infrastructure projects in North Pakistan finds as much variation within communities as between communities (2009). These findings point to an important critique of social capital as group attribute that undermines the politics of development (Portes 2000; Harriss 2002; Mosse 2006). While we can think of social capital as 'resources embedded in social relations and social structure, which can be mobilized when an actor wishes to increase the likelihood of

[32] In fact Krishna takes great pains to add 9 more villages from the neighboring state of MP (where one of my field locations is) to his 60 Rajasthani villages to validate the result. I also find no correlation between social capital and caste though there is a relationship between caste and extraction decisions.

success in a purposive action' this wish of an actor is itself subject to constraints facing the actor by being so embedded (Lin 2001 p: 24). Thus I find that it is primarily the position of an individual in a sociopolitical context and their relative power that affects their ability to cooperate and their strategy in a social dilemma as modeled here. This insight on the nature of social capital needs to be further unpacked in terms of caste.

Additionally, social capital is marginally significant in that people with higher social capital scores take out less in the experiment. The broader implications are that while social capital matters in improving cooperation, the type of institution (specifically a free or costly external monitoring) matters more. A much more statistically significant finding is that the institutions of enforcement and monitoring curtail water extraction. This follows similar findings in the experimental literature on extraction from fisheries and forests (Cardenas and Carpenter 2008{Castillo, 2005 #1843)}. Hence, it leads to the conclusion that while social capital does improve collective action outcomes for natural resource management it is not as stable and robust as state (or other) regulation and enforcement.

The contestations of forms of knowledge and the surrounding tensions can impact possible collective action for groundwater demand management. According to Cleaver, 'there is a need to better understand how the interactions of everyday life link to the functioning of institutions' (2005: 894). Though Cleaver is ultimately critical of the usefulness of social capital it is evident from the results of the factor scores of social capital and its effects on extraction levels that while attention needs to be paid to the specific interactions modeled, there are important implications for CBNRM policy.

In the mixed model there was evidence of significant unexplained variance between sessions (estimated variance component =.203, 95 % CI = .08 .51) and between individuals within a session (estimated variance component = .946, 95 % CI = .748 1.194)[33]. This suggests that selected session and individual level variables not accounted for in the model might be causing between session and between individual variance in amounts taken. This could be due to the lack of an econometric model including social capital variables in decision making, something further research should undertake. Carpenter and Cardenas also report similar levels of unexplained variance when

[33] Confidence Intervals (CI) computed according to (Bottai and Orsini 2004)

considering social capital in their model (2005). Mixed modeling techniques like this allow for a richer examination of the variables at each level of the design (game session, individual) that might influence the amount taken. Future research should consider applying this technique.

3.6.2 Voting decisions

Since the treatments that involved a voting element (FXR and CXR) were significant in curtailing extraction levels I now turn to the propensity to vote for the regulation in the experiment. The voting results display a marginally significant yet negative impact of social capital on the willingness to accept external enforcement. When comparing individual social capital scores to voting behavior in the experiments it was found that in both FXR and CXR games (free and costly votes) higher social capital scores resulted in lower voting for the external enforcer. Also, the type of institution (costly versus free) also mattered in how farmers voted. The probability of being caught was high enough (3 out of 5) to be a credible threat once the regulation was enforced even though incomplete. Similar work has included high and low cost institutions with very low probability of being caught (1 out of 5) with voting rates being significantly lower for the costly institution (Rodriguez-Sickert et al. 2008). The finding lends credence to the pitfalls of the increasing privatization of environmental governance in the global south in the inattention paid to the effect of institutions on preferences. Not all farmers voted the same way either.

	Odds Ratio (Std Err)
Payoff in previous 10 rounds	0. 997 (0.002)
Type 3 experiment (CXR)	0.468 (0.123)**
Social Capital Factor Score	0.517 (0.174)*
Gender	0.528 (0.226)
Age	1.006 (0.014)
Education	0.932 (0.040)*
Caste	0.847 (0.390)
Villid1	1.442 (0.549)
Villid2	6.867 (3.357)***
Villid3	0.773 (0.364)
Villid4	0.295 (0.124)**
Villid5	0.432 (0.302)

Table 3.5: Estimated odds ratios in Logit model of individual voting behavior in experiment. *, **, and *** signify statistical significance at 0.1, 0.05, and 0.01 levels.

Table 3.5 presents estimates of odds ratios in a logit model, for independent variables potentially affecting participant's voting decisions. The dependent variable is voting (Yes/No) and the independent variables are payoff from first 10 rounds (immediately preceding voting), whether the voting is free or costly (FXR is the referent group), demographics and also village location. The coefficients are transformed in to odds ratios (by exponentiating the estimated coefficients). The results show that voting is affected by social capital and type of institution and level of education. That is, one extra year of education multiplies the odds of voting by .932, or decreases the odds of voting by 6.8 percent. Also, for one unit increase in social capital factor score the odds of voting for the external enforcement are multiplied by 0.517, or decrease by 48.3 percent. This implies that individuals that have access to higher social capital are less likely to establish

external enforcement of rules. Hence, for decentralization policy, attempts at building social capital to increase engagement with state or other external monitoring and enforcement need to be more nuanced. Approaching communities as one unit is perilous not only because they might not exist and if they do, they resist external enforcement. Although table 3.5 presents estimated odds ratios contrasting the odds in villages 1 through 5 with village 6, other ORs with different referent villages were also found to be significant: village 2 Vs village 3.

Here social capital has an inverse relationship with acceptance of external enforcement. I consider this evidence that social capital is a means of pooling resources for a 'political'[34] society to remain political and not passively accept devolution of the state but rather demand recognition of their ability to organize or self-govern. Relatedly, Krishna finds that social capital[35] is used to seek the benefits of development by the state through the agency of village leaders who tend to be better educated (2002). That is, for high social capital to result in high development outcomes requires agency but this agency is used to access not accept. The significance of education for voting behavior found here adds further insight to studies that consider institutions as givens.

In most cases collective action among local resource users is considered a prerequisite for decentralization policies to be successful and much attention has been paid to communities that can or try to overcome internal free riding (Ostrom et al. 1994; Garner et al. 1997; Cardenas 2000; Ostrom 2010). In this study I demonstrate that participants in rural India were successful in achieving high levels of cooperation which follows numerous similar results in the literature (Henrich et al. 2004; Cardenas and Carpenter 2008). However, by examining the relationship between social capital, collective action and institutions, I add nuance to the received wisdom CBNRM studies engender.

In post experimental debriefings participants mentioned 'ekta' (unity) and 'ekjut'(solidarity) as reasons for not voting for external enforcement and even sometimes the costs of elections and politics While there is some merit in the claims of social capital, by voting for external regulation, farmers are exhibiting a desire to 'become legal,

[34] From Chatterjee (2008)
[35] Krishna's measure of social capital is very similar to the one used here since I used the same survey in my field sites (see chapter 2).

to gain recognition and entitlements from the state' or even civil society (Baviskar 2008) In work comparing associations in India and Brazil, Menon and Daftary find that it is the nature of association (political more versus social) that improve political participation (2010). The social capital factor used here consists of variables based on social activities and norms and they have a negative effect on political participation[36] as do the social associations measured in Menon and Daftary (2010).

In the costless vote participants voted 87 out of 180 times or 48% (almost half) of the time for external enforcement. For the vote with cost participants voted 62 out of 180 times or 0.34 (close to a third) of the time. So while there is evidence that people are willing to significantly reduce extractions in spite of imperfect external monitoring and vote for it, post game debriefings provided evidence of deep seated bias against regulations among some. However, in some cases cooperation degenerated in spite of initial high levels of cooperation under external monitoring which seems to be an accurate reflection of reality (I discuss this finding in chapter 4). Also when considering the different villages as an individual's attribute I find mixed results described next.

[36] I capture political participation by voting behavior in the experiment whereas they measure it using survey responses.

Village (Villid): Location	Social Capital	Caste	Vote=Yes (Total 8)	Education (years)
HB (2) Ahmednagar	.5887	Maratha	8	9.644068
PG (5) Ahmednagar	-1.238	Maratha	4	8.033333
DAD (1) Nakhatrana, Kutch	-.325	Theba/Jadeja	8	3.816667
KHAR (3) Nakhatrana, Kutch	-.230	Jadeja / Soda / Rabari	5	5.133333
SAL (6) Agar, Shajapur	.5665	Ahir	2	6.377358
MOK (4) Agar, Shajapur	.4641	Ahir	3	4.170732

Table 3.5: Village level descriptors and voting behavior.

Social capital has a significant presence or absence between villages i.e. some villages surveyed had higher levels of social capital on average than others (see Table 3.5) but the direction of the effect of an individual's village on voting rates differed (by village). When compared to the baseline village (village 6 Salri), villages with higher social capital tend to vote for external enforcement. Interesting to note is that all villages vote less for external enforcement in comparison with Hiware Bazaar (village2) at a significant level (see Table 3.5). Hiware Bazaar votes for external enforcement at a significantly higher rate than Salri (the baseline village 6) but Moyakheda (village 4) votes less (as compared to Salri). Kharadiya and Dador do not differ significantly in their extraction levels. Social capital and caste are not correlated themselves and their interaction is not significant and was dropped from the model presented here[37].

To summarize, in terms of voting, the most significant effects are the type of treatment: if the institution was expensive participants were less likely to vote for it, the social capital score: the higher the social capital score, the less you vote for the treatment, and education (measured in number of years of formal schooling): the greater your education the less you vote for the regulation. The education levels of villages differ

[37] The lrtest comparison of a model with the interaction term and without was not significant.

significantly from each other (see Table 3.5). Hiware Bazaar , village #6 exhibits the highest education levels of all. And also possesses high social capital on average. Interestingly, land (as a proxy for income) is not correlated with social capital and was also insignificant in the model.

Applications of social capital in educational studies (its intellectual origins) have found a "blurring of the distinctions between resources and the ability to obtain them in the social structure" (Dika and Singh 2002). This blurring of boundaries takes place as described in the development paradigm between social capital and institutions. According to Mosse, the link between social capital and collective action is very weak because one would have to establish that there was variation in "trust derived from social interaction", "in terms of the presence of organizations" or "the intensity of associational life" (2003 : 714). He claims the first is implausible and the rest nonexistent in his cases or perform perversely (i.e reduce collective action). While there is evidence for the latter claim it is not all aspects of social capital that behave perversely when it comes to making decisions in a commons dilemma.

3.7 Conclusion

The evidence provided above implies that close attention needs to be paid to how we conceptualize and measure social capital and how it is incorporated in CBNRM projects. I first outline a measurement of social capital that is contextually specific in definitions of networks and norms. I then demonstrate that social capital is marginally significant in its impact on extraction choices in the CPR experiment. Institutions as measured by the treatments of external voting introduced are however, highly significant in impacting behavior.

The aim of this chapter was to test the effect of externally imposed institutions along with their endurance in a manufactured common property setting. The other was to examine the impact of social capital on the emergence of institutions in this setting. While there is evidence of the significant impact of institutions on behavior and the more vulnerable impact of social capital, attention needs to be paid to the processes and powers replaced and reconfigured by attempts at decentralization of groundwater management.

Further extensions of this study could be to include corporate capital in CPR extraction situations for the future of groundwater governance.

Singular dimensions of social capital should be eschewed and like all endeavors before it more attention needs to be paid to the direction of interrelationships and different forms of capital a la Bourdieu. Social capital is currently firmly in the neo-liberal agenda of exhorting individuals within 'communities' to band together and govern their actions including their resource use. It is important to note that there is a role for positive and negative effects of social capital and more attention needs to be paid to the context of the commons under question when designing policy interventions. While thinking of social capital it is important to realize that as any resource it is subject to inequalities and contestations. Possession of a network and norms is not enough, it is the agency and their power and reach that matter for outcomes (Krishna 2002).

The ability of external agencies that provide funding for development and now environmental governance projects or of the communities themselves does not usually result in perfect monitoring and enforcement in the usage of stressed CPRs. Overcoming this problem depends on the availability, and importantly, the ability of individuals to use social capital. While there is no model yet for power in public goods/CPR games that can produce prescriptive policies, agencies of development continue to undertake development projects, states continue to govern and people continue to be people. Social capital, measured in a context specific way in this study does matter however it is marginal at best. What seems to be important is the role of institutions in the form of a commonly accepted truth. It is precisely these conceptual relationships that need to be further understood in order to govern the commons effectively. There is a need for an interdisciplinary understanding of knowledge, power, structures and institutions to expand the area of focus to encompass complex environmental goods such as groundwater that exist across boundaries (political, institutional and internal) and continue to challenge any attempts at governance.

Chapter 4:

What people bring to the game: beliefs, preferences and experience among three groups in the common pool resource experiment

4.1 Introduction

Human cooperation in social dilemmas has been deeply theorized and tested and much work has involved the conditions under which such cooperation evolves though no robust theory has been developed yet to explain the mystery of human cooperation (White and Runge 1995; Henrich 2006). By cooperation I mean the reduction of one's own benefit so that related others increase benefit (or fitness). This phenomenon has also been called altruism or strong reciprocity (Gintis 2000). The goal of this project is to move beyond proving the existence of cooperation to understanding possible reasons for its emergence. Such a project would also shed light on an equally important question of why humans sometimes do not cooperate when it is in their interest to do so (Bardhan and Ray 2008)

As this chapter shows, heuristics can be a very important dimension in agency and it is tempting to ascribe these 'rules of thumb' to the amorphous and fuzzy concept of culture. I outline a few treatments of culture but restrict myself to an analysis of the different beliefs, preferences and experience used to make decisions in a common pool resource (CPR) experiment and the difficulty in attributing these to culture. This paper compares participant groups based on the difference in their lived experience and their livelihoods with the hypothesis that groups in varied livelihood setting will differ in extraction decisions in the CPR experiment.

Culture has been defined as "a set of contested attributes, constantly in flux, both shaping and being shaped by social and economic aspects of human interaction" (Rao and Walton 2004). There is an increasing recognition of the role of culture on self consciousness with culture taking the form of collective cognition (or collective thinking) that has a marked effect on behavior. Mary Douglas calls culture "the moral and intellectual spirit of a particular form of organization" (2004 :104). Richerson and Boyd define culture as "information capable of affecting individuals' behavior that they acquire from other members of their species through teaching, imitation, and other forms of social transmission' (2005 :5).

I do not envision distinct and disconnected cultures here but differences through the interconnectedness of culture. What I mean more by culture is what Gupta and Ferguson call 'identity of a place' (1992 p:8) with identity being always in flux and 'always constituted within, not outside, representation " as Hall finds (2003 p:222). This paper compares decisions in different contextual settings that are diverse though not insular or cohesive. As Solow puts it (pg:8): "But it may be that different subcultures, with different instilled behavior patterns can coexist, either because the competition between them is not very stiff, or because neither set of behavior traits is noticeably more functional than others". The puzzle then is how culture and cognition matter in action.

Accordingly, "we need to give up naïve ideas of communities as literal entities, but remain sensitive to the profound bifocality that characterizes locally lived lives in a globally interconnected world, and the powerful role of place in the near view of lived experience" (Gupta and Ferguson 1992 :11).For example, among my rural participants, some had relatives who lived in America or the Middle East, and plenty had family specially children that lived in cities in India. Some had served in the Indian armed forces as drivers and cooks and retired to their village to farm, others worked in the fish markets of Mumbai for part of the year, one received a call from his brother in Germany during a post game interview and a couple had worked as laborers in Saudi Arabia. One woman in Kutch had been to Italy for an exhibition of her embroidery work with the help of the local NGO. However, in all six villages many (particularly women) had never travelled further than the state boundaries. Among the student respondents there were Chinese and Taiwanese, Middle Eastern, African American, Indian and American students in

Michigan and students from diverse backgrounds and fields of study in both Ann Arbor and Delhi. While students in Michigan and students in Delhi probably experience similar student experiences they might have different lived experiences and so also the distinction between Indian students and farmers who share their 'Indianness' but not necessarily their occupation or livelihood based experience. The approach here is a middle ground that recognizes that there is no such thing as 'traditional culture' but that individuals who are imbedded in a whole do have limited agency that is carried out in a certain context of experience (Douglas 2004; Rao and Walton 2004 p:14). Similarly Geertz has argued that culture must be seen as the 'webs of meaning' within which people live (1987).

People exhibit preferences, beliefs and experience in their decision making that can be traced to the large whole that is itself fluid. While the definitions provided above all provide a generic idea of culture I restrict myself to a definition of culture as practice primarily defined by livelihood occupation and how it translates to behavior for the purposes of comparing decision making between groups. Practice is contextualized and therefore bounded and it provides heuristics that are largely successful in multiple situations and practice theorists have found room for individual behavior within cultural constraints (Ortner 1984; Bourdieu 1990).

By heuristics I mean rules of thumb that are learned. Individuals are not themselves culture but are embedded in structuralist networks, that is they are part of Bourdieu's 'habitus'(1990). This in turn "affects their sense of the possible (Rao and Walton 2004 p:15). As this chapter goes on to show, it is abundantly clear that people can be willing cooperators, what matters is an institutional environment that improves the ability to cooperate or as Appadurai calls it the 'capacity to aspire' (2004). However, while my results show marginal differences in how people make decisions depending on who and where they are, it is difficult to interpret this as an effect of culture. Instead, I outline the difference in behavior based on beliefs, preferences and experience used as reasons for extraction decisions from the post game interviews.

4.2 Tools of study for common pool resource governance

Reasons for lack of cooperation in CPR extraction are mainly attributed to what Olson calls, their "scope, domain, or clientele" ((1965)1971 p: 170) In terms of these three aspects, common property theory has been circumspect on the issues of large groups in general making the claim that they are doomed[38]. However, as some researchers have found there is also evidence of cooperation in larger networks of Kuhls or Ahars in India (Baker 2005; Sengupta 2006). While there is evidence to support the claim that small groups are more likely to maintain cooperation it is unclear why some groups, large or small persist in mismanagement of their commons. Also, the concept that groups will be able to provide their resources collectively does depend on the fluidity (scope) of the resource and the clientele that has access. With largely invisible and mobile resources like groundwater this is an important consideration. In this work, I study the emergence of cooperation and its evolution when considering a large resource user base and a governance challenged resource like groundwater using the CPR experiment.

[38] There is however ample evidence of cooperation in smaller groups the world over. Starting with Ostrom 1990 the evidence is continually growing. However, a behavioral theory for cooperation still remains elusive (Gintis et al. 2008).

Experi-mental Treatment	Stage 1 (10 rounds)	Stage 2 (10 rounds)		Villagers	Michigan Students	Delhi Students
		New Rule	*Rounds 11-20*			
Baseline Information Provision	$X_1, X_2, \ldots, X_{10}$	Information on social optimum + No rule change	$X_{11}, X_{12}, \ldots, X_{20}$	[5 villagers] x [4 sessions] x [6 villages]	[5 students] x [3 sessions]	[5 students] x [5 sessions]
Endogenous Vote No Cost (FXR)	$X_1, X_2, \ldots, X_{10}$	Information on social optimum + Inspection of 3 out of 5 players in each round: p=3/5; f=10 (overextraction)	$X_{11}, X_{12}, \ldots, X_{20}$	[5 villagers] x [4 sessions] x [6 villages]	[5 students] x [3 sessions]	[5 students] x [5 sessions]
Endogenous Vote With Cost Cost = 50 points (CXR)	$X_1, X_2, \ldots, X_{10}$	Information on social optimum + Inspection of 3 out of 5 players in each round: p=3/5; f=10 (overextraction)	$X_{11}, X_{12}, \ldots, X_{20}$	[5 villagers] x [4 sessions] x [6 villages]	[5 students] x [3 sessions]	[5 students] x [5 sessions]

Table 4.1 Experimental design, treatment and location.

Experiments on decision making involving CPRs have been carried out for decades and are usually based on American undergraduate students. (Cardenas and Carpenter 2008; Henrich et al. 2010). The CPR game is a type of public goods game where participants are faced with a social dilemma of extracting from a commons where individual benefits are in contest with group benefits (Ostrom et al. 1994). The major contribution of experimental work on CPRs is to provide empirical evidence of theories of collective action, reciprocity and fairness. By developing a theoretically robust prediction it has been possible to study individual factors (everything else held constant) in explaining behaviors in a wide variety of situations. Applying CPR experiments to the field, we have gained insight in to the working of institutions and motivations underlying much of social theory (Fehr et al. 2002; Henrich and Smith 2004; Cardenas 2005). It has been found time and again that cooperation is possible in spite of costs and that institutions can be effective in ensuring sustained collaboration (Jodha 1986; Berkes 1989; Ostrom 1990; Ostrom et al. 1992; Ostrom et al. 1994; Sethi and Somanathan 1996; Agrawal and Chhatre 2006; Janssen et al. 2010). However, the comparison of outcomes of experiments across characteristics of the participants, allows identification of the complex

interactions between participants and contextual variables in commons dilemmas. Using conventional lab experiments with artefactual field experiments allows an understanding that is not restricted to WEIRD[39] participants (Henrich et al. 2010). Next, I outline the CPR experiment used in this study.

The CPR experiment conducted for this study involved individuals making decisions on groundwater extraction as part of a group of five players in both a laboratory and an artefactual field experiment (Harrison and List 2004). Payoffs for this game were converted into cash and calibrated to reflect a whole day's wage, a common method of conducting experiments in the field (Henrich and Smith 2004; Cardenas 2005; Lansing and Miller 2005). Using such experiments, researchers have shown how cooperation to achieve goals of collective action is possible (Ostrom et al. 1994). Most field experiments conducted in recent years have concentrated on the trust, ultimatum and dictator game particularly those conducted in developing countries (see Carpenter and Cardenas 2005 for a summary). Important work on the public goods games (most similar to the CPR games) has also been conducted with subjects in rural communities (Ensminger 2000; Barr 2003; Carpenter et al. 2004; Karlan 2005). Cardenas and Ostrom took early steps in the empirical testing of the CPR game in field settings with actual resource users. Their empirical model was based on one proposed by Ostrom, Gardner and Walker and assumes computational abilities on the part of subjects which may not be reasonable (1994). Cardenas subsequently conducted multiple CPR experiments in the field and his model of endogenous and exogenous regulation is adapted and used in this study (2005; Rodriguez-Sickert et al. 2008). Henrich and Smith use a simple model based on extraction and non contribution to the CPR (2004). Henrich and Smith tested the baseline CPR experiment and provided valuable insight to the differences in game strategies between participants in rural communities and students in American universities(Henrich 2000). American undergraduates are a much relied on control group for many game experiments due to the volume of data collected on their levels of trust, reciprocity and contributions (Carpenter et al. 2005; Henrich et al. 2010; Henrich et al. 2010).

[39]Western, Educated, Industrialized, Rich, and Democratic (**WEIRD**) societies have formed the bulk of experimental subject groups according to Henrich (2010).

This work incorporates a nuanced contextual aspect by making comparisons between student groups in America and India and non student farmers in rural India (Table 4.1). Using the same baseline model, the experimental design includes a treatment of external regulation to be used with all three groups in two situations: free and costly. After playing 10 rounds of the CPR game in participants were given information on the socially optimal extraction of 1 token each but how free riding could occur at the expense of other groups members (this is the baseline information treatment). In treatment FXR, after being given the information participants were offered the opportunity to vote for external enforcement by majority and if the vote passed, the external monitor (in these cases the experimenter) would examine three out of five extraction levels randomly and anonymously. Over extractors get fined 10 times the amount of over extraction. Treatment CXR is the same as FXR except that if they vote for the rule and hence the external monitor 50 payoff points were deducted from each participant's total points as a cost of the institution. Appendix III and table 4.1 provide the experimental instructions and design. The treatments capture the emergence of collective action for self regulation of CPR use.

Other studies conducted on inter-cultural comparisons between students in Colombia and the US playing a common-pool resource game together provide insight into the contextual effects of the game though it could be hard to separate these out (Cardenas 2005). Colombian students extract twice as much when exploited by Americans than with other Colombians and Americans reduce their extractions when playing with Colombians (Carpenter and Cardenas 2004). More empirical work is required to evaluate the evolution of institutions and their role in decision making. Hence, comparing two types of student population to a non student population further attenuates the role of beliefs, preferences and experience in decision making. I do this by testing the rise and evolution of cooperation particularly under the imposition of an incomplete external regulation which is a way to model the role of the state or any other external regulatory authority in many natural resource management settings. In a similar design but using the Dictator and Ultimatum games, Carpenter et al conducted experiments with

two student population and workers in Kansas and Middlebury and were able to demonstrate the effect of 'social framing' of the workplace (2005)[40].

Why do different groups behave differently? The behavior of individual decision makers has been modeled as different 'informational layers' consisting of individual identity, group context and material payoffs that internalize the payoffs from a game round (adapted from McCabe and Smith 2003; Cardenas and Ostrom 2004). The identity layer is the information players have of themselves (i.e. wealth, assets, gender, age, education, experience, prior participation, values towards others). The group context layer consists of shared norms, group identity and inequality and heterogeneity. The material payoffs layer consists of net payoffs for that round (including changes in amount of resource available), the feasible strategies, costs, reciprocity, reputation and learning. While it is difficult to say exactly which layer takes precedence when making decisions or if all count in certain combinations Chapter 3 has shown the different power of the layers with social capital (group context) being marginally significant while institutional rules in the game being very significant. Henrich and Henrich find that instead of reciprocity (theories of which are abundant currently) it is more the group context that affects decisions (2007). They find that noise (errors) and group size have a much stronger impact on the power of reciprocity than previously thought. Therefore there seems to be no all purpose reciprocity machine that explains the evolution of human cooperation since the phenomena is too complex. Hence, I turn to the theory behind beliefs and preferences using the post game interviews and surveys as evidence. I distinguish between preferences, beliefs and anecdotes as more or less 'strategic' in decision making and show how the different participant groups behave on average by location and occupation.

4.3 Results: Comparing participant groups

In this work I examine the differences in behavior observed with three distinct groups: students in Ann Arbor, Michigan and students in New Delhi and agriculturalists in six different villages in three states of India (Gujarat, Madhya Pradesh and Maharashtra) in

[40] Much comparative analysis has looked at ultimatum and dictator games played in field settings (Oosterbeek et al. 2004)

the common pool resources experiment. The same experiments were carried out in all three locations. Table 4.1 refers to the type of games played and the locations. In both treatments (FXR) and (CXR) play pauses after round 10 for a brief announcement where the monitor announces out loud the purpose of the new regulation (to help keep extractions at 1 unit, the social optimal) and about the opportunity to vote (and the cost in CXR games). Hence, the willingness of participants to cooperate by extracting less is significantly affected by the new institution proposed. Work elsewhere has shown this effect to be very robust (Cardenas and Carpenter 2005). From examining aggregate decisions across groups in figures 4.1 and 4.2) it is apparent that groups differ in their extraction decisions by treatment. This difference was further tested using a linear mixed model that was clustered at the session level[41].

[41] An REML model was fit in STATA and the standardized residuals were normally distributed see appendix IV. Based on prior literature the REML analyses were replicated using random effects tobit models (given the truncated nature of the dependent variable) and primary inferences did not change.

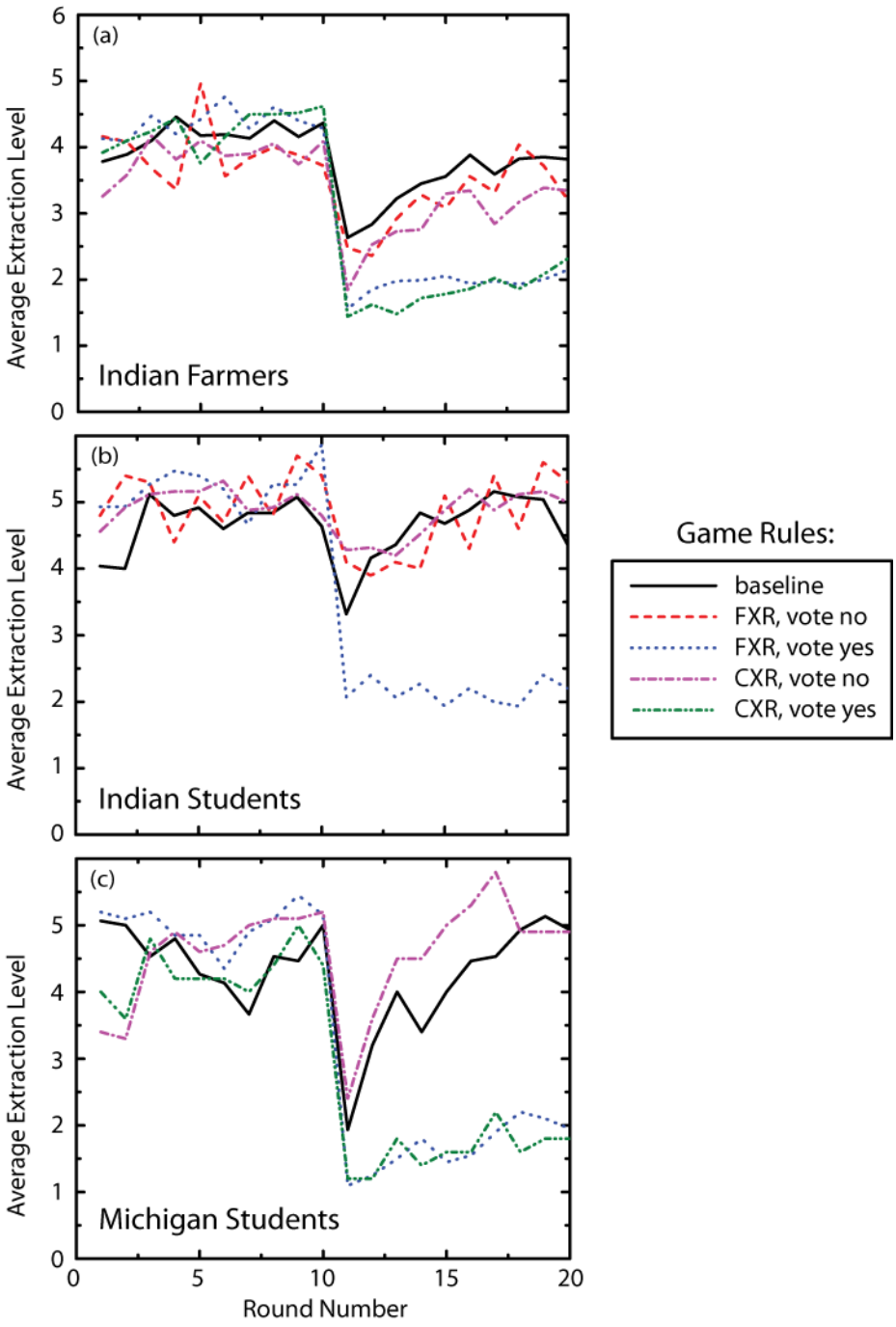

Figure 4.1: Average extraction level vs. round number for the various sets of game rules from game data for (a) Indian farmers, (b) Indian students, and (c) Michigan Students.

In the baseline experiment, the standard prediction is that players converge to the Nash equilibrium (five tokens according to the game parameters) quickly and definitely by the last round. Also, the socially optimal level of extraction (one token) is not

predicted to persist. We find ample evidence for this from figures 4.1 and 4.2. Also, based on results from other experimental findings in the field, actual resource users (Indian farmers) could be less socially efficient[42] and be closer to Nash predictions as compared to the two student groups (Cardenas 2005). The initial hypothesis was that student groups will differ in efficiency but will not vary highly from each other. Hence, the greater the exposure to groundwater extraction under an open access regime the more non-cooperative(or closer to Nash extraction levels) a person is. For this hypothesis to hold extraction amounts should be higher for Indian farmers as compared to the student groups. As can be seen from figures 4.1 and 4.2 and table 4.2 this was not the case. In fact the highest extraction rates were those of the Indian students. Table 4.4 outlines social efficiency by group which is calculated as the distance from the socially optimal extraction level of 1 token. The farmers were the most socially efficient of all groups. I discuss the findings below.

[42] I define socially efficient here as the distance from the socially optimum level of extraction (one token according to the experimental parameters).

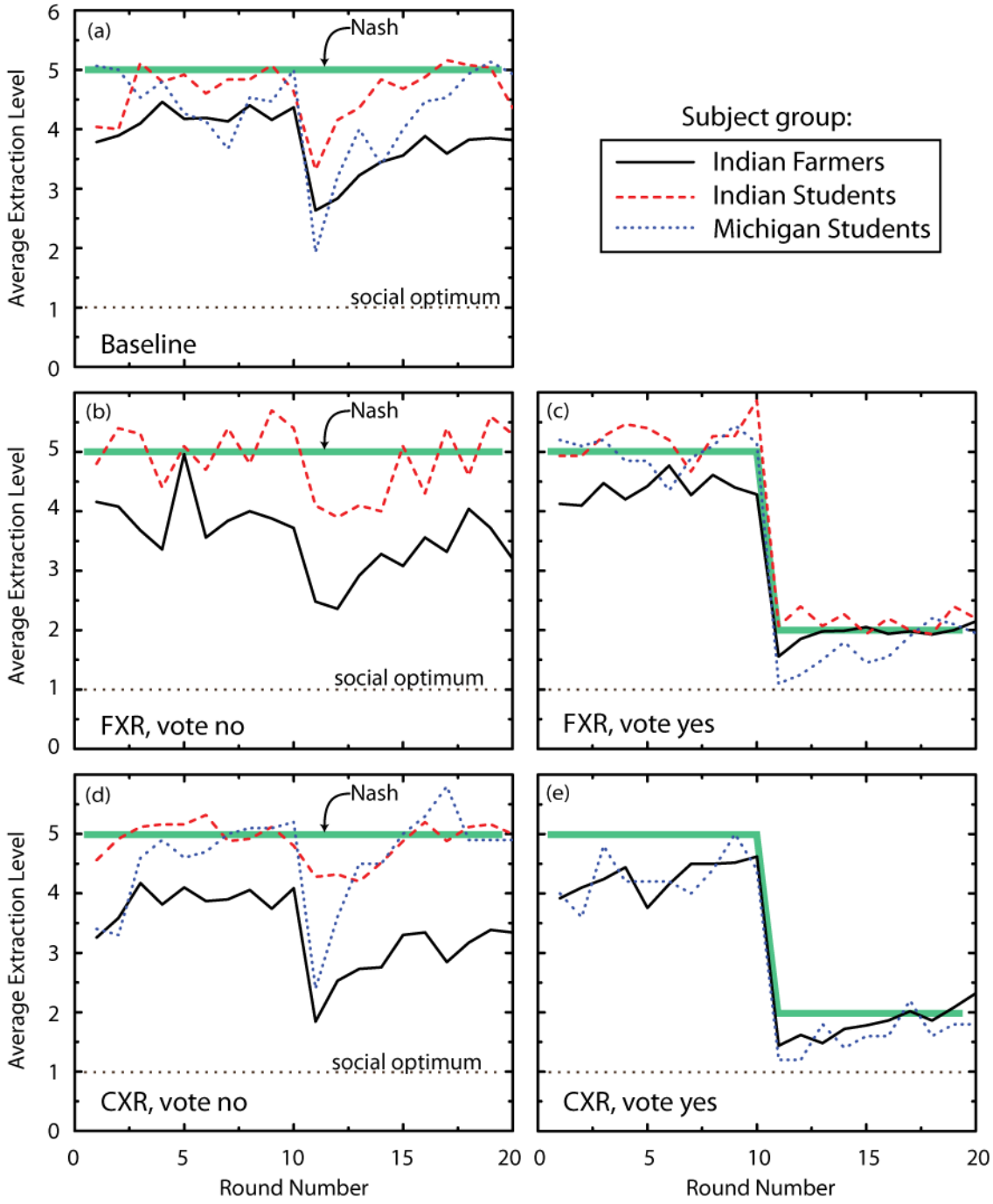

Figure 4.2: Average extraction level vs. round number for the different subject groups from game data for the (a) baseline game, (b) FXR treatment with regulation rejected, (c) FXR treatment with regulation accepted, (d) CXR treatment with regulation rejected, and (e) CXR treatment with regulation accepted.

4.4 Explaining decisions

> 'the peasant is born into a society and culture that provide him with a fund of moral values, a set of concrete relationships, a pattern of expectations about the behavior of others, and a sense of how those in his culture have proceeded to similar goals in the past' (Scott 1976 p: 166)

Two comparisons were made: one between student groups to test the difference in behavior keeping occupation constant and next comparing Indian students to Indian farmers where occupation was different. One hypothesis is that the student groups should not differ between each other and the second hypothesis was that farmers will tend to be less socially efficient (higher extraction) and differ significantly from the Indian students. While I find evidence for the first hypothesis I find that farmers were the most socially efficient extractors and differed significantly from the others.

Table 4.2 presents estimates of fixed effects in a linear mixed model with random effects of individuals within sessions and within individuals across two stages of the experiment for independent variables potentially affecting extraction amounts. The dependent variable is amount extracted in each round per individual and the independent variables are the type of game (baseline, FXR or CXR), the round stage (pre is the referent level and post is displayed), an indicator for round 11 (immediately after treatment was administered), the type of subgroup (Indian farmers, Indian students, Michigan students) along with demographic variables of age, gender and education. Interaction terms of game type and subgroup as well as post and subgroup and game type were also included to see if certain effects vary depending on levels of other factors. The round 11 dummy variable is included to account for the general effect of the dip in extraction levels seen in figures 4.1 and 4.2 in round 11, the first round after the treatment was administered. The mixed effects included allow different individuals within a session and also the same individual to have different means in pre and post stages. Hence, the model was used to control for correlation within a person and between people within a session.

Variables	Coefficient (Std. Error)
Game type 2 (FXR)	0.319 (0.184)*
Game type 3 (CXR)	-0. 2010(0.184)
Indian Students	0.398 (0.331)
Michigan Students	0.488 (0.402)
Post (Baseline)	-0.548 (0.065)***
Round 11 (Dummy)	-0.839 (0.082)***
Age	-0.002 (0.005)
Gender	-0.072 (0.123)
Education	-0.004 (0.014)
FXR x Indian Students	0.076 (0.418)
FXR x Michigan Students	-0.403 (0.490)
CXR x Indian Students	0.820 (0.418)**
CXR x Michigan Students	0.328 (0.519)
Post x Indian Students	0.673 (0.095)***
Post x Michigan Students	-0.195 (0.112)*
Post x FXR	-1.744 (0.085)***
Post x CXR	-0.751 (0.085)***

Table 4.2: Output from linear mixed model (fitted using REML[43] estimation). Dependent variable - number of units extracted per round. *, **, and *** signify statistical significance at 0.1, 0.05, and 0.001 levels.The symbol x denotes interaction.

[43] A restricted maximum likelihood or REML is considered appropriate here since the observations are clustered at the session level and the dependent variable "took" is a repeated measure in 20 rounds of the experiment. See appendix IV for model fit and post estimation results

The results presented in table 4.2 imply that Indian students and Michigan students extract more than Indian farmers but the significant difference occurs only in the costly external regulation. Indian and Michigan students take more out (0.398 and 0.488 tokens respectively on average) in the baseline experiment in the pre treatment stage. Also, the effect of Indian students taking out more than Indian farmers changes by 0.820 tokens in the CXR treatment. This means that the net effect of Indian students relative to Indian farmers becomes larger by 0.398 + 0.820 = 1.218 tokens in the CXR game. Interaction coefficients are not indicating the effects in a particular group, but rather changes in the effects relative to a reference group.

The post effect (-0.548) is for the reference categories of subgroup (Indian Farmers) and game type(Baseline). Significant effects found are of the post stage of the baseline experiment as well as the round 11(the main effect of being in round 11 versus any other round). This means that participants took less post treatment of information provision in the baseline experiment and also across all three treatment types in round 11. This is evidenced by the dip in extraction amounts seen in figures 4.1 and 4.2. The 0.32 significant effects is the difference between FXR and the baseline experiment for Indian farmers in the pre-treatment stage. The 0.673 is the change in the difference between Indian students and farmers for the post stage relative to pre-treatment irrespective of game type (0.673+0.398 = 1.071). Similarly the -0.195 shows that the gap between Michigan students and farmers is becoming narrower at the post stage relative to the pre-treatment stage irrespective of game type (0.488-0.195=0.293). Finally, relative to pre-treatment, both FXR and CXR differences from the baseline game type are becoming more negative. Both 0.319 and -0.201 are becoming wider in the negative direction in the post stage so extraction levels in both FXR and CXR are significantly lower in the post stage. Figures 4.1 and 4.2 attest to this.

Treatment	% Groups that passed the rule			% Individual votes (yes)		
	Indian Farmers	Indian Students	Michigan Students	Indian Farmers	Indian Students	Michigan Students
FXR	79	60	100	72	52	70
CXR	42	0	33	52	28	53
Total	60	30	71	62	40	63

Table 4.3: Distribution of voting by treatment and subject group.

Since the comparison of extraction levels is difficult given the essentially five different games that develop, I move to the description of voting for treatment by group. An overall breakdown of voting percentages is presented in table 4.3. While one explanation for differences in voting percentages could be experimenter effects precautions were taken to rule these out and the author was the main experimenter in all locations[44]. For the treatment that involves regulation by vote, all groups offered a costless vote should vote for the regulation. As the vote is costless and the enforcement is incomplete, players who want to maximize payoffs and are willing to take a risk will free ride as they expect others to follow the rule and they do not expect to be inspected (Cardenas 2005). I find that groups do vote for the costless external enforcement with a range of 60 to a 100 percent. Another prediction was that Indian farmers would vote for the regulation more than the comparable student group (Indian students). It turns out that Indian farmers at the individual level vote 'yes' 52 percent of the time compared to 28 percent among students in FXR and 62 versus 40 percent across both treatments (Table 4.3). From figure 4.2 it is also clear that groups that vote for the external regulation will see higher levels of cooperation overall than groups that played the baseline treatment and those that rejected the vote and reverted to the baseline in stage two of CXR and FXR (see figures 4.1and 4.2).

[44] All experimental instructions were translated into a prepared script and back translated for consistency. Experimental protocol was maintained in the same manner across all locations. See appendix for experimental instructions.

Subgroup	Average Total Earnings	Social Efficiency
1	1372.52	85%
2	1272.65	79%
3	1335.86	82%

Table 4.4: Social efficiency by subgroup (Nash = 1300/1620 = 80 %).

4.4.1 Beliefs, preferences and experience: effects of social framing

In the past few decades there has been a concerted effort from within the field of economics and without (from anthropology, sociology and psychology) to modify the standard preference model of human behavior (Charness and Rabin 2002; Gintis et al. 2008). In the basic standard model utility U(xi | s) depends only on one's own payoff xi. However much evidence has found that subjects care about inequality of outcomes (fairness) and also the intention of others (reciprocity) and yet others have provided the model of altruism. So that utility should look more like the utility of subject 1 defined as a function of their own payoff (x1) and other-player's payoff (x2) adapted from (DellaVigna 2009)45:

$$U_1(x_1, x_2) \equiv \begin{cases} \rho\, x_2 + (1-\rho)\, x_1, \text{ when } x_1 \geq x_2; \\ \sigma\, x_2 + (1-\sigma)\, x_1, \text{ when } x_1 < x_2 \end{cases}$$[46]

Adjustments to the standard model of behavior are required to explain findings that include sacrifice. For example in this study an extraction strategy of zero occurred 170 times out of a total of 9700 across all groups(1.75%) while the social optimal was always set at one token i.e. participants would not harm others by taking at least one 'unit' of water. Fischbacher and Gachter find that beliefs about the contributions of others matter and that people have different cooperative preferences (some prefer to free ride while others will cooperate conditionally) (2010). During the post game interviews it was apparent that subjects were using beliefs, preferences and experience that can be mapped on to the 'informational' layers approach. While material benefits of the

[45] See DellaVigna 2009 and Rabin and Charness 2002, Rabin 2002 for a list of different changes to the standard model from assumptions of time inconsistencies to attitudes to risk and uncertainty and non-expected utility

[46] This is for a standard two person game.

immediate decision-making environment will play a large role in strategy, other external variables constrain the actual choices made. As described above the main finding is that all three groups behave similarly except in the treatments that involved the costly external monitor (CXR).

Individuals are often faced with interdependencies between themselves and others particularly when they share environmental resources. "The political economy of a natural resource is meaningful only through the wider networks of cultural politics in which it is embedded" (Baviskar 2008 p:3). Elster records three kinds of interdependencies: the rewards of each depend on the rewards of all, the rewards of each depend on the choice of all, the choice of each depends on the choice of all (2007). Hence, when individuals are involved in 'strategic conflict' they must choose strategically based on their expectations of the actions of others. They must also be aware that outcomes are a product of mutual choices with their choices affecting the choices of others. However I find that strategies can range from the strategic to the preference oriented to those of experience. Individuals have preferences based on beliefs and these can lead to either strategic actions or sincere actions. Also people might have unrelated (to the experimental model) heuristics from their experience to act a certain way. While I could only compare session level reasoning to group behavior it is possible to get a sense of the predilections of individuals to make certain decisions based on where (and when) they are making them and this is an important methodological insight in the conducting of field and laboratory experiments.

I now discuss these findings with the help of the post game interviews and surveys collected from participants. The Indian farmers and students differ in treatment CXR and this difference can be related to how decisions were made during the game Over 60 percent of students reported that they were paying attention to the behavior of others (62%) and that their decisions were affected by those of the others (66%). Whereas only in 18 out of 65 coded group interviews did farmers mention the influence of what others were doing. More common at 44 out of 65 sessions was the relation of actual life experience unrelated to the information or parameters provided in the game for making decisions. Since the same instructions and procedure were followed at all sites and the same experimenter was present in each session (along with a translator/game master in

the village sites) the difference in reasoning can be attributed to the experience of being a farmer that uses groundwater daily to generate income versus a student that has a more removed relationship with the resource.

Table 4.5 provides an outline of the different reasons participants gave organized by group. The experience based reasons (R2, R3 R4) are those to do with climate (over extracting because it was hot or under extracting because it rained), what the participant did earlier (over extracted in earlier rounds so under extracting in future rounds) and crop type (high water varieties needing more water) are unexpected. This signifies that rural participants cognitively translated the exercise into a continuous exercise by 'manufacturing' information not provided as part of the experimental protocol. While the difference in reasoning does not seem to cause a difference in outcomes of the baseline treatment or the free institution treatment (FXR) across all three groups it does show how the practice of groundwater extraction as an everyday transaction for some results in different paths of arrival at similar outcomes. Particularly the Michigan students and the Indian farmers are not significantly different in their extraction levels in all three treatment types but their reasons are. This provides added nuance to the concept of social framing. Based on the reasons in table 4.5 it seems that students tend to use more strategic beliefs in their decisions versus farmers who rely on preferences to cooperate and their experience with farming. It is important to note that while preferences and beliefs are related it is almost impossible to extract the underlying beliefs from preferences between extraction levels (Fischbacher and Gachter 2010) .

Reasons for Extraction	Indian Farmers (65 sessions coded)	Indian Students (15 sessions coded)	Michigan Students (10 sessions coded)
R1 (others behavior)	18/65	13/15	10/10
R2 (climatic)	10	0	0
R3 (previous behavior by themselves)	9	0	0
R4 (crop type)	25	0	0
R6 (based on payoff table)	62	15	10
R7 (to save water/cooperate with each other)	63	1	1

Table 4.5: Reasons for extraction by group.

Since the only significant difference between farmers and students is in the costly external institution treatment: Why do farmers vote for the enforcement in spite of cost?[47] Experience and therefore reasoning makes a significant difference in outcomes between the Indian student and farmer groups. However, of the farmer groups that did vote for this external and costly enforcement a large number violated the rule. The violators included people that had voted for the rule. There seems to be a mix of expressions of wanting to self regulate and also those of trying to ensure others will under extract for fear of monitoring all the while hoping to take one's chances by over extracting. In fact in some cases individuals were extracting large amounts of tokens that they later said was to make up for the fines they had to pay in earlier rounds.

Reasons for rejection of external enforcement:

> "because we would each lose the 50 points to pay for the rule and if we took more and got caught we'd be fined…and now we have a drought going on so it is very hard to only take 1 when you need more."

> "I thought that it should be like a panchayat raj where we do everything together but in our village it is failed..the sarpanch does what he wants"

Reasons for accepting external enforcement:

> "If we have a juth (unity), then we have sampathi (wealth) and that is good and if our village is one we can get work done from the taluka (block level of government) and if our tehsil is fully one we can get work from the district even"

[47] I cover this question extensively in chapter 2

> "I voted yes so that everyone gets water equally and there is more saving in spite of the cost of 50 points. It was only cut one time not again so it was okay"

Reasons for over-extracting in spite of the rule:

> "First I put an extra token and didn't get caught and the second time when I put extra I got caught and the third time I didn't get caught"

-transcripts of post game interviews with farmers

Indian students did not accept the vote for costly external enforcement in any of the five sessions that included this treatment. The main reason was an unwillingness to pay for an incomplete external enforcement. "I'd rather take my chances" was a common refrain.

Finally, why does cooperation start out high and then steadily decline? When we look at the general trend in behavior across all groups and treatments (figures 4.1 and 4.2) we see a gradual climb towards the Nash equilibrium towards the later (an particularly the last) round of play. This is an extremely robust finding across the literature (Ledyard 1995; Fischbacher and Gachter 2010; Ostrom 2010). Learning and backward induction have been disproved so it could be fatigue (Charness and Rabin 2002). However, Rodriguez-Sickert et al find that the 'mechanics of unraveling' hold when no rule of enforcement or fines (high or low) are instituted and it is not so much material deterrence but what they call moralization[48] (2008). Similarly, I find a trend towards lower levels of extraction in groups that voted for the external institution. Newer evolutionary game designs have shed light on the phenomena and others have found that social investments can sustain cooperation (Janssen et al. 2010). Beliefs about others' behavior matters along with preferences to cooperate if others do or to free ride (Fischbacher and Gachter 2010). Others have hypothesized that the incorporation of a fine free cooperative players of the need to retaliate against uncooperative players. It is not possible to say from the data at hand which of the reasons takes precedence in decisions to cooperate or defect in later rounds of the game and further experimental protocols to test the changes in attitudes towards rules of the game (enabling or disabling environment) are required.

The policy implications of these findings are manifest. The lack of self-governance found among inter-dependent groundwater users is not because of their

[48] Moralization in their simulation is the externally induced change from a selfish to cooperative type player.

unwillingness to cooperate. There are ample examples of well partnerships to manage supply in India (Aggarwal 2000; Birkenholtz 2009) The experimental evidence reported here shows that farmers who most rely on groundwater for a large part of their livelihood (as compared to urban students) are able to achieve higher levels of cooperation. This is borne out even more in the treatment CXR where the Indian students did not vote for the costly external enforcement at all and 42% of the farmer groups did so (table 4.3). Almost all experimental work on the ever-shifting commons have found similar results (Cardenas and Carpenter 2008). This sheds much light on what Douglas calls 'irrational culture effects" or the thinking that culture impedes development (2004). The mainstream argument that the gains from development are so large that the local traditions lose out and people can no longer trust each other is limited since in reality people are not stuck between development and their traditional (nonexistent) culture, they adapt their heuristics to take advantage of so called development.

Out of the village cases, the village with the most codified rules for groundwater governance where consensus points to successful governance, there are still voices of dissent and sometimes significant time is spent 'convincing' dissenters of the benefit of the proposed rules (field notes 2008). As others have found the role of the state in pushing watershed development in the semiarid regions of India are preferential to some at the cost of others (Baviskar 2008, Mehta 2005, Birkenholtz 2009). Non state actors in India have also shown a reserve when it comes to setting up institutions that would curtail the access of many to groundwater in a situation of open access and limited collective action or even water trading. There are quite a few examples where local NGO field workers complained in a similar vein: "what to do, they never come to the meetings and then they complain" or "they insisted on getting their well first and they don't maintain it at all" (field extension worker KMVS, Kutch in reference to a particular sub-group of the village).

External factors mostly related to the institutional void exacerbated by the absence of the state, the presence of confounding state policies in related agrarian matters (horticulture subsidies) along with the influence of agricultural markets explains the lack of cooperation for self governance particularly demand/needs management found in groundwater access in S. Asia (COMMAN 2005; Mukherji and Shah 2005; Birkenholtz

2009). It is noteworthy, when faced with findings presented here, that actual resource users who have been exposed to this situation of 'anarchy' (Shah 2009) are still able to cooperate to self govern and are even willing to accept the role of the state in governance.

This work helps answer the question about the process through which a rule become the socially shared standard in a community. According to Knight, the key to understanding the effects of institutions on strategic choice is the formation of social expectations that do so by providing information and sanctions (1997 p:49). If we find behavior that is caused by the crowding out of socially optimal strategies, it is the improper design of institutions that we must examine, not only an individual's willingness to cooperate (Cardenas 2005). This is not to say that groundwater extraction in reality is not deeply politicized. A significant percentage of farmer groups voted for a costly but imperfect external monitor with the belief that in spite of the costs, the monitoring would mitigate at least some extraction. However, why more Indian farmers did not vote for an external monitor (costly or not) is also indicative of different experiences of institutions. The reason of institutional apathy could be rational as development is not always in the best interests of its subjects.

In the scholarly work on groundwater governance in India or south Asia where the resource is not regulated by the state there are a lack of examples of the types of self-governance witnessed in other CPRs like forests and surface irrigation that explicitly manage demands on the resource (Shah 2009). This is because, in situations involving scarcity (manufactured or otherwise) groundwater provides an assurance of access to water irrespective of 'social institutions' (Dubash 2002; Mehta 2007). Where power and inequality have played a significant role in access it is not surprising to find a lack of self governing institutions that regulate the use of groundwater though there are many partnerships involved in sharing the cost of access (Birkenholtz 2009). There has been work, previously mentioned, on the role of external institutions on decision-making on the commons that found that introducing a regulatory constraint on participants' behavior made them seek out more self-interested (or Nash) extraction levels (Cardenas 2005). This has been attributed to the poor design of external regulation that tends to crowd out other regarding preferences. While the results presented here are contrary in that they show the imposition of an external monitor was voted for a significant amount of time in

the rural cases it was not the most prevalent strategy and did not reduce extraction as much as predicted.

4.5 Conclusion

The results presented here show that all groups do not make similar decisions in social dilemma settings and provide external validity of the results in the common pool resource game. Depending on livelihood occupation as it relates to natural resources, decisions are more or less cooperative. The Indian farmers were much more socially efficient than the Indian student groups in extraction decisions and they cognitively transform the game to a continuous decision based on their real life experience. While the farmer groups voted for external enforcement at higher rates than the students, they did not always follow this up with lower extractions once the rule was in place. Again, experience was a significant reason for variable extraction levels.

Groundwater as a resource is biophysically a limiter and a liberator. It can provide insurance or it can be devastating by its scarcity. It is time to move forward from the experimentation on user's decisions and test how actual policies and projects to manage natural resources with the enabling of the state and civil society (in hybrid forms of governance) actually change decision making and behavior.

Chapter 5:

Conclusion

5.1 The Future of Groundwater Governance in India

The future of groundwater conservation and governance in India rests on what Zimmerer refers to as "environmental globalization" (2006). This trend over the past two decades is characterized by the increased role of "globally organized management institutions, knowledge systems and monitoring, and coordinated strategies aimed at resource, energy, and conservation issues" (Zimmerer 2006 :1). It involves the state establishing private property rights (even those of common property) that commodify water to allocate transferrable rights and other market solutions to actively decentralizing environmental governance. However, in practice, decentralized environmental governance has been more the devolution of state oversight accompanied by elite capture of local decision making.

Hence environmental governance is slowly shifting to a trend of globalization that raises questions about the sustainability and opportunity of continued local access to groundwater and the functioning of decentralized democratic institutions. Establishing private property rights to groundwater and the ability to trade water making it fluid capital in based on problematic assumptions. First, some authors have found 'tubewell partnerships' in the most severely affected parts of the country, Rajasthan and Gujarat. However, the trading that occurs in these cases is highly inequitable (Dubash 2002) In the field sites studied here there are a range of individual owners, partnerships (though these tend to be mostly caste based) and community owned systems.

Neoliberal strategies of market solutions assume away these diverse sets of institutional arrangements among dryland farmers. Forcing a system of individual ownership of tubewells could also create opportunities for some at the extent of others Similarly, moving towards a common property framework of rights requires intense negotiation of these rights from users who have been left out of previous collective arrangements

This dissertation has shown that groundwater could be governed by a common property institution but that this institution affects social preferences differently. So while it could seem that establishing private property rights and MAFIs would be easier for the state, there are actually many instances of partnerships and sharing of the resource that could be leveraged towards better resource governance. Farmers share a lot of other costs jointly, including dealing with crop disease and the impacts of drought as well as group weddings. There is a role in this process for NGOs that are already a large part of rural India. However, in India since there is no groundwater regulatory body that could be decentralized, NGOs and farmers mostly react in trial and error methods to the lack of state presence in this sector. While NGOs do work to promote conservation and efficiency-enhancing technologies, such as drip irrigation systems they are unable to effectively challenge current governance of private extraction without state intervention to secure common property rights or conservation goals. Also, the work of donor agencies through grassroots and field based personnel is an effective by-passing of the state which further exacerbates democratic concerns.

The existing Irrigation department or the groundwater monitoring cells in different states are the only water related state bodies that farmers interact with and they provide services of groundwater or irrigation water development. In some of the field sites the District Collector wielded the power to grant tubewell permits. Under ‘special permission’ calculated according to alleged need in spite of an overall ban on new tubewells. This is a glimpse of the situation to come if private property rights to individual groundwater extractors are put in to regulation. The relationship of farmers to the state is one of distrust and suspicion making their inclusion in decision making processes challenging. As many have found with watershed governance in India, the state finds ways around these requirements of participation (Baviskar 2004, 2008).

Finally, this dissertation has achieved three goals related to testing the applicability of collective action theories in a groundwater extraction economy in India The strong possibility of future decentralization in India makes this a very relevant exercise. First, it looks at the relationships of farmers with the state and their willingness to accept external institutions and the effect of the institution on social preferences for cooperation. Second, it incorporate the concept of social capital in looking at the effects of this much vaunted concept in inducing cooperation in CPR dilemmas and compares this to the role of institutions in affecting behavior. Third, it provides external validity of CPR theories by testing the results of the behavioral experiment in three spatially distinct populations.

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Appendix I

NVivo Coding Scheme

	Reasons for making / changing extraction strategy (R_)	Reasons for voting Yes or No (V_)	Post treatment behavior (T_)	Rules in the village (RV_)	Relationship between game and individual's life (G_)
(1)	Others' behavior (others were taking more or less)	Expensive to vote (elections are costly)	Rule Compliance (we made a rule so I followed it)	Rules about water sources	Yes
(2)	Climatic (it rained, or it was hot)	Constrained by rule (I thought the rule would make us earn less)	Others' behavior (I was following what others did)	Rules about common land, forest, other environmental resources	No
(3)	Previous behavior by individual (I saved so now I took more)	Imperfect monitoring (You were not going to check everyone)	Risk (Only a 3/5 chance of being caught)	No rules	
(4)	Crop type (I planted sugarcane (gehu), so I needed more (less) water)	Possible to evade the rule (I could earn more because others would follow the rule, and I could cheat and escape checking)	Effect of monitoring (I got punishied / checked so I went back to 1)		
(5)	Irrigation sequence (first irrigation versus the third one)	Restriction of resource (I was afraid I couldn't get more water if I needed)	Effect of fine (I got fined so I needed more to make up the fine)		
(6)	Based on payoff table (to make more points)	Other	Need for water (more or less because of crop type or climate)		
(7)	To save water (prefereance to save or cooperate)		Other		
(8)	Other				

Figure I.1: NVivo coding scheme for post-game interviews.

Appendix II

Social Capital Survey Questions

Social Capital Questions (the variable name in italics are presented in table 3):

(Structural)
Dealing with common cattle drinking ponds [cattle]: Who is responsible for maintaining the cattle drinking ponds of this village? – No one is responsible (score = 1)
- The government now and then gets the job done (score =2)
- Once in a while, as things get bad, the village people take on the responsibility (score=3)
- The village has identified people who are regularly responsible for this (scored = 4)

Dealing with crop disease [cropdis]: If a crop disease were to affect the entire standing crop of this village, then who do you think would come forward to deal with the situation?
- Everyone deals with the situation by themselves (score =1)
- Neighbors would help each other (score =2)
- The village leader would get together (score=3)
- The entire village would work together to resolve the problem (score=4)

Protecting common pasture land [coland]: Who in this village looks after the common pasture lands?
- No one does anything to protect these lands (score = 1)
- There are old customs which are followed here (score = 2)
- Our leaders take decisions which we all follow (score = 3)
- A village committee exists which takes the decisions (score = 4)
- We discuss this as a village in our meetings and decide jointly (score = 5)

(Cognitive)
Trust in others[trust]: Suppose someone from this village had to go away for a while, along with their family. In whose charge would this person leave their fields?
- Someone from their extended family (score = 1)
- Someone from their same caste (score = 2)

- A neighbor (score = 3)
- They could trust anyone in the village for this purpose (score = 4)

Solidarity [solid]: Some children of the village tend to stray from the correct path, for example they are disrespectful to elders, they disobey their parents, etc. Who in this village feels it right to correct other people's children?
- No one (score = 1)
- Only close relatives (score = 2)
- Relatives and neighbors (score = 3)
- Anyone from the village (score = 4)

Credit: Compared to other villages, how much do people of this village trust each other in matters of lending and borrowing?
- Absolutely not (score = 1)
- Less than other villages (score = 2)
- The same as other villages (score = 3)
- More than other villages (score = 4)

Decisions as a community [decision]: Once a decision is taken by the village leaders, we must all contribute either money or labor to implement these decisions. To what extent do you agree or disagree with this statement?
- Strongly agree (score = 1)
- Agree (score = 2)
- Disagree (score = 3)
- Strongly disagree (score = 4)

Appendix III

Instructions for Common Pool Resource Experiment

Exercise Instructions

Thank you for participating in today's exercise on group decision making. This is part of a study intended to provide insight into certain features of decision processes. If you follow the instructions carefully and make good decisions you may earn a considerable amount of money at the end of the experiment. At a minimum you will earn the show up fee even if your earnings in the game are zero. At the end of the exercise we have a short survey for you to fill and receive any cash prizes you have earned including a $5 show up fee.

During the exercise, we ask that you please do not talk to, or make any gestures or eye-contact with each other. If you have a question, please raise your hand and an experimenter will assist you.

- **Introduction**: This exercise attempts to recreate a situation where a group of people must make decisions about how to use a water resource, such as a public well or any other case where communities use

a natural resource. You are part of a group of five people in this exercise. The exercise in which you will participate now is different from the ones others have already participated in, thus the comments you may have heard from others do not apply necessarily to this exercise.

Each of you has a folder containing a blue Payoffs Table, a green Decisions Form, a few pink slips and a white Instructions Sheet. Each of you will have an ID number assigned to you on the pink slips. **Do not reveal this ID number to anybody but the organizer**

- **Rounds and Matchings**: The exercise has a number of **rounds**. You will be interacting with the **same** group of people in all rounds.

- **Interdependence:** The decisions that you and the other people make will determine your earnings.

- **The Decisions:** At the beginning of each round, there are 40 tokens (resource units) in the common area, representing the water resource you and others can extract. You must decide how many tokens to take from the common pool. You cannot take more than 8 tokens in any given round. You cannot see the number of tokens others decide to take while making your decision, and vice versa.

  More specifically, each participant will circle a number between zero and eight (including zero and eight) on a Pink slip, and pass it to the experimenter. The experimenter will add up the total number of tokens taken from the pool, and announce the total number of remaining tokens.

- **Value of the resource:** Your value from the resource has two parts. First, the number of tokens you take has value to you. However, the value of each additional token decreases as you take more. Second, the total number of remaining tokens gives value to every participant equally. The value of the remaining tokens is **twice** the number of

tokens left. **Your earning each round:** Your earning in each round is the sum of the value from the number of tokens you take and the value from the remaining tokens after everyone takes. It is summarized in your blue payoff table.

- **Payoff table:** Your blue payoff table summarizes your earning each round, which depends on the number **of tokens** you take (row) and the number of tokens left after everyone has removed some tokens (column). For example, if you take 3 tokens, and the number of remaining tokens is 20, you can find your payoff at row 3 and column 20, which is ….

- **Total number of rounds:** There will be a total of 20 (time permitting) rounds.

- **Total earnings**: Your total earning for the experiment is the sum of your earnings from all rounds, divided by the exchange rate, plus a Rs 100 show up fee.

- **Conversion rate**: **$1** = **100** payoff points.

- **Decision Form**: Each round, we ask that you record the number of tokens you take, the number of remaining tokens and your payoff points for that round on the green decision form.

Feel free to earn as much money as you can. Raise your hand if you have any questions.

Review questions:

1. True or false: My earning for each round depends only on my decision.

2. If I take 7 tokens and the number of remaining tokens is 20, my payoff is _____.

- **Practice Rounds:** The next two rounds do not count as actual rounds for the game. They are meant to just give you some practice with the exercise. Please proceed to write down your extraction on your pink slips and wait for me to collect them.

We will now proceed with the actual rounds that count towards your total payoffs.

Stage 2 Directions For Baseline Treatment:

Stage 2: Please pay attention for a minute without changing your position

Now you have had the experience of playing the game for a few rounds. You might have realized the following: The more tokens the group takes as a whole the worse you do. The best everyone can do is for all to take out **1 token** of the resource each. However, if everyone did this someone could extract more tokens and make a much higher payoff at the expense of the rest of the group.

With this new information please continue to play the game as before:

Use the **blue Payoffs Table** to calculate your payoff points.

Use the **green Decision Form** to record your extraction, the resource tokens left and your payoff points.

Use the **pink Slips** to enter your decisions and hand them to the monitor.

Stage 2 Directions for FXR Treatment:

Stage 2: Please pay attention for a minute without changing your position

Now you have had the experience of playing the game for a few rounds. You might have realized the following: The more tokens the group takes as a whole the worse you do. The best everyone can do is for all to take out **1 token** of the resource each. However, if everyone did this someone could extract more tokens and make a much higher payoff at the expense of the rest of the group.

Voting

You can vote to have the 1 token extraction level enforced. This means that if you vote yes by a majority (at least 3 out of 5 participants) then in each round I will examine the extraction levels of 3 out of 5 participants at random. After you are done writing your extraction level on a pink slip in each round I will collect the slips. Without looking at the slips I will announce the three ID numbers that I will monitor. You are **not required to**

do anything if your number is picked. If I find that a participant has extracted more than 1 token, I will fine them 10 times the amount they have over extracted. For example, if someone extracts 3 tokens they will be fined 20 payoff points: (3-1) tokens multiplied by 10. Remember that there is a three in five chance of being caught. **No one but I will know whose extraction was monitored**. I will keep a track of the fine for each participant per round which will be subtracted from you final payoff points.

With this new information please continue to play the game as before:

Use the **Blue Payoff Table** to calculate your payoff points.

Use the **Green Decision Form** to record your extraction, the resource tokens left and your payoff points.

Use the **Pink Slips** to enter your decisions and hand them to the monitor.

Please feel free to raise your hand if you have a question.

Please **enter your votes** on a pink slip and hand them to me.

Stage 2 Directions for CXR Treatment:

Stage 2: Please pay attention for a minute without changing your position

Now you have had the experience of playing the game for a few rounds. You might have realized the following: The more tokens the group takes as a whole the worse you do. The best everyone can do is for all to take out **1 token** of the resource each. However, if everyone did this someone could extract more tokens and make a much higher payoff at the expense of the rest of the group.

Voting

You can vote to have the 1 token extraction level enforced. This means that if you vote yes by a majority (at least 3 out of 5 participants) then in each round I will examine the extraction levels of 3 out of 5 participants at random. After you are done writing your extraction level on a pink slip in each round I will collect the slips. Without looking at the slip I will announce the three ID numbers that I will monitor. You are **not required to do anything** if your number is picked. If I find that a participant has extracted more than 1 token, I will fine them 10 times the amount they have over extracted. For example, if someone extracts 3 tokens they will be fined 20 payoff points: (3-1) tokens multiplied by 10. Remember that there is a three in five chance of being caught. No one but I will know whose extraction was monitored. I will keep a track of the fine for each participant per round which will be subtracted from you final payoff points.

Cost of Enforcement: The enforcement mechanism described above will cost each participant **50 payoff points**. If your group votes for the

enforcement each participant will pay 50 points from their total points up to round 10. This subtraction will be made at the conclusion of the game.

With this new information please continue to play the game as before:

Use the **blue Payoffs Table** to calculate your payoff points.

Use the **green Decision Form** to record your extraction, the resource tokens left and your payoff points.

Use the **pink Slips** to enter your decisions and hand them to the monitor.

Please feel free to raise your hand if you have a question.

Please **enter your votes** on a pink slip and hand them to me.

Payoff table:

TOKENS LEFT / MY TOKENS	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21
0	80	78	76	74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42
1		89	87	85	83	81	79	77	75	73	71	69	67	65	63	61	59	57	55	53
2			96	94	92	90	88	86	84	82	80	78	76	74	72	70	68	66	64	62
3				101	99	97	95	93	91	89	87	85	83	81	79	77	75	73	71	69
4					104	102	100	98	96	94	92	90	88	86	84	82	80	78	76	74
5						105	103	101	99	97	95	93	91	89	87	85	83	81	79	77
6							104	102	100	98	96	94	92	90	88	86	84	82	80	78
7								101	99	97	95	93	91	89	87	85	83	81	79	77
8									96	94	92	90	88	86	84	82	80	78	76	74

TOKENS LEFT / MY TOKENS	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0
1	51	49	47	45	43	41	39	37	35	33	31	29	27	25	23	21	19	17	15	13	11
2	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20
3	67	65	63	61	59	57	55	53	51	49	47	45	43	41	39	37	35	33	31	29	27
4	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32
5	75	73	71	69	67	65	63	61	59	57	55	53	51	49	47	45	43	41	39	37	35
6	76	74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36
7	75	73	71	69	67	65	63	61	59	57	55	53	51	49	47	45	43	41	39	37	35
8	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32

Figure III.1: Payoff table for common pool resource game.

Appendix IV

Residual Diagnostics of REML Model

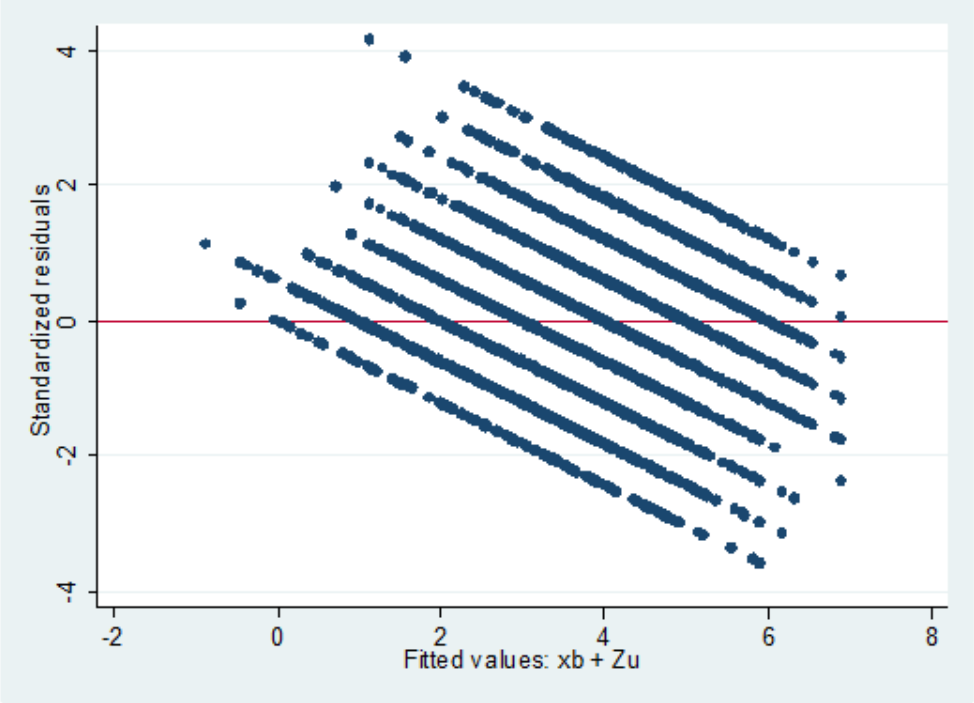

Figure IV.1:Fitted-residual plot based on the fit of model in table 4.3.

Output is presented for the model from chapter 4 but similar diagnostics were obtained for the model in chapter 3 and were omitted.

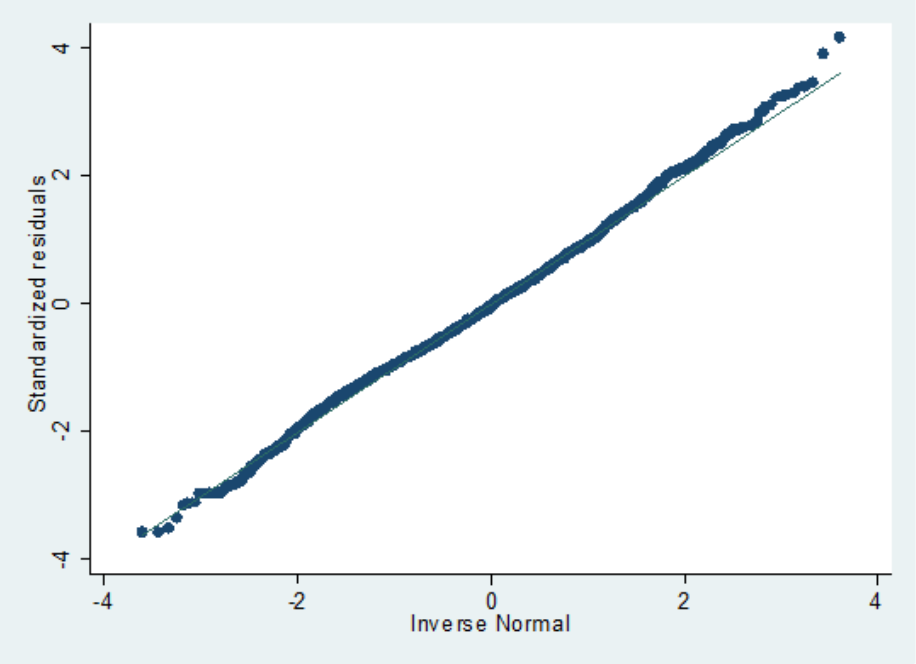

Figure IV.2:Normal Q-Q plot of the standardized residuals

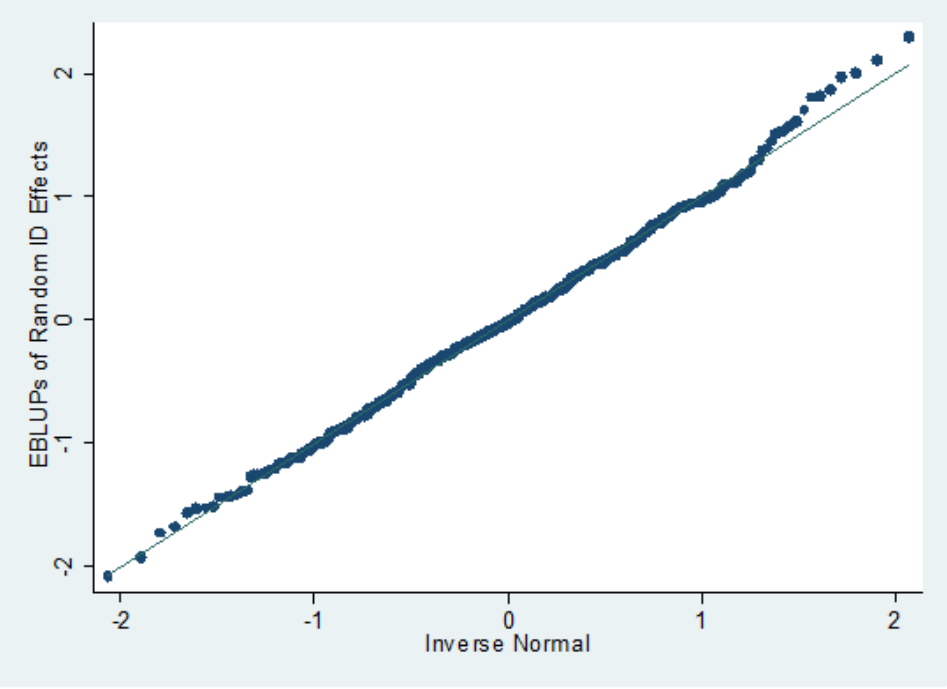

Figure IV.3:Normal Q-Q plots for the EBLUPs of the random ID effects

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