THE LOGIC OF LABOR EXCHANGE IN A DOMINICAN VILLAGE: COMPETITIVE ALTRUISM, BIOLOGIC MARKETS, AND THE NEXUS OF MALE SOCIAL RELATIONS

BY
SHANE J. MACFARLAN

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Department of Anthropology

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of Shane J. Macfarlan find it satisfactory and recommend that it be accepted.

_____
Robert J. Quinlan, Ph.D., Chair

_____
Barry S. Hewlett, Ph.D.

_____
Edward H. Hagen, Ph.D.

_____
Michael S. Alvard, Ph.D.

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THE LOGIC OF LABOR EXCHANGE IN A DOMINICAN VILLAGE: COMPETITIVE ALTRUISM, BIOLOGIC MARKETS, AND THE NEXUS OF MALE SOCIAL RELATIONS

Abstract

by Shane J. Macfarlan, Ph.D.
Washington State University
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Chair: Robert J. Quinlan

Peasant societies rely on labor exchange because agricultural inputs surpass what small landholders can perform on an individual basis and wage labor is not feasible. Anthropologists suggest reciprocity causes labor exchange; however, only a single test imperfectly confirms this proposition. Competitive altruism may also be operating if: 1) people differ in ability; 2) ability predicts reputations; and 3) individuals make choices about partnership formation based on reputations or ability, where people with the greatest ability can demand asymmetric rewards from partnerships. Secondly, anthropologists suggest males negotiate social relationships through labor exchange; however, no data exists concerning this relationship's direction and effect size. Lastly, the link between labor exchange and social affiliation has yet to be contextualized within a broader framework of Caribbean male behavior. Ten months of labor exchange data collected from a Dominican village is presented from the village's primary cash opportunity, Bay Oil Distillation. Results indicate competitive altruism predicts labor exchange, not reciprocity. In Dominica, men differ in ability and ability predicts altruistic

reputations. Altruistic reputations predict group sizes willing to assist in distillation. Group size positively predicts the amount of labor others give. Greater days labor given, as well as living proximity, predicts reciprocal partnership formation. Labor given has a "concave-up" quadratic relationship with labor received, as the majority of dyads do not form reciprocal partnerships. Men with the best reputations form the most same-sex partnerships. A QAP test confirms economic anthropological assumptions that labor exchange is predicated upon pre-existing social relationships. Lastly, an MRQAP test confirms previous Caribbean ethnographic research suggesting male same-sex social affiliation is based on residential proximity, land access discrepancies, reputational similarity, but not age matching. Lastly, females are attuned to male reputations, as females are more likely to be romantically involved with men who have reputations for hard working but not altruism. Bay oil distillation appears to be a biologic market for male relationships signaled through separate reputational systems for either same-sex (altruistic reputations) or between-sex (hard working reputations) partnerships. Public policy implications are considered in light of biologic market theory and competitive altruism.

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Dedication

This dissertation is dedicated to all who helped me along this journey.

CHAPTER ONE

INTRODUCTION

Humans are an unusually cooperative species. Although we are members of a relatively social *taxon*, the scope of human cooperation is far greater than any primate. In fact, we cooperate with a greater number of individuals under a greater variety of contexts than any animal. We cooperate with close kin, distant kin, fictive kin, sexual partners, non-related acquaintances, and complete strangers. The time frame of human cooperation ranges from single instances that are never repeated to repeated interactions lasting entire lifetimes and sometimes, across generations. Additionally, humans manage cooperative relationships in dyadic and multi-person contexts for a variety of goals, including finding mates, raising offspring, and economic production. When individuals consistently fail to cooperate with others despite their individual interest to do so, it is termed pathological (American Psychiatric Association 2000), indicating our cooperative tendencies are a stable feature of the human phenotype (Richerson, Boyd, and Henrich 2003; Smith 2003). The study of cooperative behavior can be used to create healthier families and communities, make economies run more efficiently, and is fundamental to understanding the human condition.

One aspect of cooperative action receiving considerable attention from researchers is organizational behavior in economic production (Olson 1965; Goran, Kurzban and Rapoport 2003; Price 2006). The rationale is simple: collective action is ubiquitous throughout human social and economic life (Ostrom 1990). This includes first-world societies where individuals work in corporate settings, as well as economic behavior in small-scale forager, pastoral, horticultural, and peasant populations. Understanding why people organize themselves into

particular configurations to achieve economic goals facilitates management and allows analysts to predict how changes to labor environments will effect production and intra-group social dynamics (Schermerhorn, Hunt, and Osborn 2008).

Currently, the world's largest social group is smallholder agriculturalists in the developing world (Wilk 1996). According to a 2005 UN estimate, approximately 1.3 billion adults alone exist in this condition (UNCTAD 2008). There is tremendous diversity within this social group caused by variation in geographic location, regional histories, cultural traditions, and social and economic inputs (Wolf 1955; Rosenberry 1989). However, many researchers agree smallholder agriculturalists share some characteristics (Wolf 1955; Redfield 1969; Cancian 1989). They are relatively poor, rely on a mix of subsistence agricultural and petty commodity production, and exist in an inferior position to international markets (Cancian 1989). These communities tend to exploit a single commodity for sale in distant markets for cash (Wolf 1955; Cancian 1989); however, the modal adult systematically engages in a number of economic activities, which form an integrated economic complex (Comitas 1964). Research focused on the mechanisms that promote or inhibit cooperation in this population facilitates our understanding of how most people live and can be used to guide effective and humane economic programs in the developing world. This is no trivial matter as recent estimates suggest more than 6 trillion dollars (US) in foreign capital investment has been dedicated to developing nations for social and economic programs designed to alleviate poverty and improve quality of life in this social group (UNCTAD 2009).

A common feature of smallholder agriculturalists in the developing world is cooperative labor (Erasmus 1956; Moore 1975; Wilk 1996; *Africa*: Mayer 1951; Swindell 1985; Geschiere 1995; Ponte 2000; Shiraishi 2006; Suehara 1983; 2006; *Asia*: Povinse 1937; Kuchiba and

Tsubouchi 1968; Gilligan 2004; *Caribbean and Latin America*: Metraux 1951; Cohen 1955; Erasmus 1956; Manners 1956; Horowitz 1960, 1967; Guillet 1980; Hames 1987; Chibnik and de Jong 1989; Trawick 2003; *Europe*: Homans 1941; Groger 1981; *North America*: Kimball 1949). People engage in cooperative labor when land ownership/tenure is vested in a single individual; however, labor inputs are greater than that which can be accomplished by one person working individually (Moore 1975). As a result, groups consisting of extended kin or community members will assist an individual in production. Land managers have two recourses to motivate others to assist in labor under these conditions: 1) host a labor event that relies on large quantities of food and drink, with no commitment on the part of organizing individual to return labor in the future (referred to as *festive labor*); or 2) rely on mutual aid generated through social networks and performed with the understanding that labor will be performed in-kind for individuals who participate (referred to as *labor exchange*) (Erasmus 1956; Moore 1975; Ponte 2000). Smallholder farmers also can commodify labor by purchasing another's labor rights using cash, under a contractual basis (referred to as *contractual labor*); however, this is considered non-cooperative (Moore 1975), is based on market principles, and is an inferior alternative to cooperative labor under a variety of economic conditions (Ponte 2000; Gilligan 2004).

Economic anthropologists are fascinated with cooperative labor because it presents a solution to an economic problem that contrasts sharply with solutions applied in the developed world. Agricultural production in the developed world relies on large capital inputs and contractual labor compensated by cash. Contracts are created by centralized authorities and backed by institutional structures that facilitate action between parties that may or may not know one another (Cook, Hardin, and Levi 2005). When contracts are broken, labor laws can

be consulted, the appropriate course of action pursued, and only the relationship between parties is affected.

Cooperative labor in developing smallholder agricultural societies is based on non-contractual social arrangements where work is compensated by labor in-kind and incentivized by goods such as food, alcohol, and tobacco (Erasmus 1956; Moore 1975; Shiraishi 2006; Suehara 2006). Exchange relationships are based on individuals who know one another intimately (Erasmus 1956); however, kinship is not a prerequisite (Ponte 2000; Trawick 2003). Community norms for appropriate behavior coalesce out of the de-centralized action of individuals (Acheson 2002) and labor exchange relationships fail when social relationships fail. Additionally, when labor relationships deteriorate, the ramifications can be felt throughout the entire community, not necessarily just between labor partners (Ponte 2000). Cooperative labor is predicated on existing social relationships and can be a medium for forging new ones (Dirks 1979). Decisions to engage in cooperative labor in peasant societies are embedded in the complex matrix of community social life and as such agricultural production becomes a lens for examining gender relations, family functioning, and interpersonal social dynamics (Horowitz 1967; Redfield 1969; Sahlins 1972; Stanfield, Carroll, and Wrenn 2007; Wolf 1966; Swindell 1985).

Labor exchange is a particularly interesting agricultural institution because it persists despite the presence of active labor markets (Guillet 1980; Groger 1981; Chibnik and de Jong 1989; Gilligan 2004). Some researchers assume this practice is a remnant of traditional peasant life; people simply are unresponsive to changing economic conditions (e.g. Rogers 1969). However, recent analyses by transaction cost economists suggest labor exchange is preferable to wage labor when markets are inefficient, cash rare, or credit unavailable (Guillet 1980;

Chibnik and de Jong 1989; Gilligan 2004). Labor exchange is more resilient than its sister cooperative form, festive labor, in the face of labor markets (Erasmus 1956; Moore 1975; Ponte 2000). Unlike wage labor, labor exchange minimizes within community economic inequality (Ponte 2000) and smallholder agriculturalists report greater positive satisfaction from labor exchange than from wage labor (Geschiere 1995). Labor exchange forms an important component of many smallholder farmers suite of strategies for generating income under economic uncertainty. Several countries (e.g. Peru, Bolivia) have tailored economic development programs around the institution of labor exchange because it is less costly than subsidizing labor through cash or credit at the national level; however, this is not the norm (Guillet 1980).

Despite the importance of labor exchange for peasant farmers throughout the developing world, anthropologists, behavioral ecologists, and economists have not precisely identified the mechanisms responsible for its occurrence. All researchers implicitly assume labor exchange is reciprocal (e.g. Erasmus 1956; Metreaux 1951; Horowitz 1960; 1967; Moore 1975; Suehara 2000). Despite several decades of research on the topic (Erasmus 1956; Moore 1975; Swindell 1985; Ponte 2000; Suehara 2006) only a single paper has attempted to test this proposition empirically (Hames 1987). Hames' approach, although innovative at the time, suffered from a lack of statistical controls and could not benefit from recent theoretical advances concerning the evolution of cooperation (e.g. *Costly Signaling*: Gintis, Smith, and Bowles 2001; *Biologic Markets*: Noe and Hammerstein 1994, 1995; *Competitive Altruism*: Roberts 1998; Hardy and Van Vugt 2006; Van Vugt, Roberts, and Hardy 2007; Barclay and Willer 2007). As a result, it is debatable whether reciprocity explains labor exchange. Understanding the mechanism(s) responsible for behavior is important for effective public

policy, as policy designed without regard to people's values, preferences, and constraints can cause projects to fail and may adversely affect entire communities (Tucker and Taylor 2007). Evidence-based research is more appropriate than speculation for achieving this goal.

Most researchers agree some combination of economic, social, historical, technological, and/or ecological conditions causes labor exchange groups *between* communities to vary in unique ways, affecting community organization and inter-personal relationships (Wolf 1955; Erasmus 1956; Moore 1975). Sadly, there has been no attempt to explain variation in labor exchange groups *within* communities despite evidence of variation along group size and demographic dimensions (e.g. Suehara 1983; Ponte 2000; Horowitz 1967). A baseline understanding of labor exchange group variation within communities can be a valuable tool for contrasting performance outcomes of economic or social development programs (Ponte 2000).

Finally, although researchers agree implicitly a relationship exists between personal social networks and labor exchange, none have attempted to measure it precisely. Understanding the nature and effect size of this relationship is a useful tool for assessing the vulnerability of a community to stochastic events such as natural disasters or economic shocks (Ponte 2000). The rationale is individuals from small communities rely on personal social networks in times of crisis for economic and psychological support. A small effect size between labor exchange and social network characteristics suggests a community may be particularly vulnerable and markets only imperfectly have penetrated a rural area (Gilligan 2004).

The research presented here pursues three goals using data generated from ten months of labor exchange in a Caribbean peasant community located on the Commonwealth of Dominica: 1) precisely identify the mechanism(s) responsible for labor exchange; 2) explain

variation in labor exchange group size and composition; and 3) identify the direction and magnitude of the relationship between labor exchange and same-sex social network structure.

To address these goals properly, a contextual framework is required. This chapter provides it in the following fashion. First, the closed corporate peasant community will be discussed along with its agrarian institution of labor exchange. Next, evolutionary theories on cooperative group formation will be considered and used to generate hypotheses concerning its occurrence and variation. Following, Caribbean peasant life will be examined and its dominant themes identified, including a consideration of the sparse literature on Caribbean male social networks and the social consequences of labor. Based on this context, predictions unique to Caribbean communities will be generated concerning the relationship between labor exchange and social life in this cultural milieu.

THE CORPORATE PEASANT COMMUNITY

Corporate peasant communities are geographically and territorially bounded, partially closed social systems, which rely on a mix of subsistence agriculture and petty commodity production (Wolf 1955; Redfield 1969; Cancian 1989). Membership tends to be restricted to individuals who are born and raised within the community (Wolf 1955). Land is owned in common by kin groups in a corporate fashion and individuals have usufruct land rights. Although within community differences exist (Rosenberry 1989), corporate peasant communities are relatively socially homogeneous; most are poor and minimal institutional stratification the norm (Canican 1989). These communities tend to exploit a single commodity for sale in distant markets for cash (Wolf 1955; Cancian 1989); however they exist in an inferior position to these markets (Bardhan, Bowles, and Wallerstein 2005). Uncertain economic opportunities cause the modal

adult to systematically engage in a number of economic activities, which form an integrated economic complex, a situation known as occupational multiplicity (Comitas 1964). These groups tend to be socially intense (Cancian 1989), where the majority of social and economic interactions occur within the community (Wolf 1955). Not surprisingly, closed peasant communities tend to be endogamous (Hororwitz 1960).

Many authors attribute a unique cognitive orientation to peasant farmers living in closed communities. The suite characteristics include: 1) a reverent attitude to land; 2) the idea that agricultural work is good and commerce not so good; 3) productive industry as a prime virtue; 4) restraint on individual self-seeking in favor of family and community; and 5) suspicion towards town and town people (Redfield 1961). Statements such as "We are all one" or "We are family" are not uncommon in peasant communities and reflect the inward-focus of its inhabitants, strengthening affective relationships within and distancing relationships between communities (Horowitz 1960). Some authors suggest these communities tend to resist change (e.g. Wolf 1957, Foster 1965); however, others show this social group to be dynamically responsive to economic and technological change (Guillet 1980; Geschiere 1995; Gilligan 2004). Gossip operates as mechanism to negatively sanction those who seek to increase wealth or social standing in the community relative to others (Foster 1965) and a norms of reciprocity and filial obligation mandate members assist one another when help is needed (Erasmus 1956; Horowitz 1960; Moore 1975; Geschiere 1995; Suehara 2006; Shiaishi 2006). Help is frequently needed in agricultural production, as labor inputs generally exceed what landholders can perform individually. As a result, labor may be exchanged between community members to make land productive (Horowitz 1960; Wilk 1996).

WHAT IS LABOR EXCHANGE?

Labor exchange is known by several terms – reciprocal labor, collective labor, traditional work groups, exchange labor (Moore 1975) work sharing (Gilligan 2004), or beer parties (Swindell 1985). Researchers disagree about the origin of labor exchange as an agrarian institution. Some authors (e.g. Swindell 1985) suggest it is a relatively recent phenomenon, while others (e.g. Homans 1960) provide evidence of its occurrence at least since the thirteenth century. Although anthropologists noted the occurrence of agricultural exchange relationships in peasant societies since the 1930s (e.g. Malinowski 1935; Provinse 1937), Erasmus (1956) and Moore (1975) were the first to contextualize it in a cross-cultural perspective. It has been defined as " the joint performance of a task, or series of sequentially-related tasks, by a group of persons practicing a minimal division of labor whose relationship to the beneficiary…of their work is other than that of employer to employee" (Moore 1975:271). However, Moore, unsatisfied with his own definition, suggests a better approach to understanding labor exchange is to describe its primary characteristics. Most accounts suggest labor exchange is: 1) an arrangement of rural community members, who; 2) organize into groups that are small in size (no more than 10 individuals); 3) by members of the same sex (usually males), where laborers are all; 4) farmers with similar land holdings; 5) who live in close proximity; 6) are relatively poor, but 7) not necessarily close kin; additionally, 8) the host member provides either no reward for assistants, or at most a standard everyday meal; and 9) the implicit assumption is labor will be reciprocated at some point in the future (Erasmus 1956; Moore 1975; Swindell 1985). Violations of exchange relationships involve informal social sanctions; however, these sanctions are seen as extremely effective and motivate obligations to reciprocate (Moore 1975). The primary sanction is exclusion from future reciprocation. Exclusion is effective because it

makes it nearly impossible for the non-reciprocator to make their land productive. Labor tends to be unspecialized and groups may be composed of a mix of individuals, some who are recruited through cash on a contractual basis and others through a labor exchange basis (Erasmus 1956).

Moore (1975) suggests labor exchange groups are of two varieties: individual exchange labor and group exchange labor. Individual exchange labor is a situation where two individuals "A" and "B" work for another "C" but do not work for each other. Group labor exchange is a situation where individuals "A" "B" and "C" work together as a team on the land of each individual in turn. As such, group labor exchange is similar in form and function to rotating savings and credit associations (Besley, Coate, and Loury 1994; Gilligan 2004). Group labor exchange has greater organizational demands than individual labor exchange, generally requires that all individuals require the same type of labor, have identical land access (Moore 1975), and may be predicated on cognitive adaptations for *n*-person exchanges (Tooby, Cosmides, and Price 2006).

Generally, individuals must meet two conditions to reap the benefits of labor exchange. One must be a member of the closed community and maintain active social relationships within it (Guillet 1980). The second is a cost to the extent time and energy must be expended to maintain a personal network of individuals from which labor exchange partners will be recruited. Labor exchange, like many forms of exchange in small-scale societies, creates a sense of mutual obligation on the part of both parties (Mauss 1990). In times of crisis, this relationship may be accessed for assistance in domains outside the labor context (Ponte 2000; Trawick 2003). Erasmus (1956) suggests labor exchange is predicated on a distinct cognitive frame central to reciprocal relationships: the centripetal personal type – a cultural frame that is

redistributive in character, where knowledge is an outgrowth of primary experience, and interpersonal contacts are highly repetitive and marked by empathy.

Interestingly, many authors suggest an unlikely link between labor exchange and kinship (Horowitz 1967; Dirks 1972; Geschiere 1995; Trawick 2003). In fact, it is normative in several communities to create labor exchange partnerships only with distant or non-kin (Trawick 2003; Geschiere 1995). It is not that kinship is unimportant in these groups, especially since social interactions in corporate peasant communities often involve kin in some fashion. Rather, kinship as an organizing principle is not necessary for labor exchange to operate (Trawick 2003).

Many societies link the construct of "labor exchange" with the construct "handedness." For example, in Colombia labor exchange is described as *cambio de mano* (change of hands), in Chile *vuelta mano* (hand return) (Erasmus 1956), in Mexico *dar mano* (to give a hand) (Foster 1942), in Martinique *coups-de-main* (a military term meaning stroke or blow of the hand) (Horowtiz 1967), and in Dominica *hand-in-hand* (author's field notes). It is not known whether this pairing of ideas is a product of some universal human capacity to equate exchange with hands or if it is unique to the cultural history of Latin American and Caribbean corporate peasant communities; however Mauss (1990: 62) indirectly implicates the former.

Most authors suggest that labor exchange has several desirable qualities (e.g. Erasmus 1956; Moore 1975; Ponte 2000; Gilligan 2004). It can be more productive when the nature of the task requires speed or strength. Five people working one person's land for one day can be more efficient than one person working their own land for five days if consumable output is determined by the rate at which the task is completed or if the arduousness of the task makes fatigue likely (Erasmus 1956; Moore 1975; Swindell 1985). Secondly, labor exchange obviates

the need for cash, allowing even extremely impoverished individuals to participate (Moore 1975). Third, where no landless work force exists, labor exchange may be the only way to mobilize a large non-family labor contingent for a limited time (Moore 1975; Swindell 1985). Additionally, labor exchange can be cheaper than wage labor (Mayer 1951), especially if the cost of wage labor is more than the cost of food or alcohol used to incentivize work. Lastly, many authors suggest labor exchange has positive psychological effects. Exchange laborers report a greater subjective sense of wellbeing and productivity when work is accomplished in groups than alone or for cash (Malinowski 1935; Moore 1975; Swindell 1985).

Reportedly, labor exchange as an institution in the developing world has been on the decline for some 60 years (Erasmus 1956; Moore; 1975; Ponte 2000; Shiraishi 2006). However, several studies show labor exchange is quite resilient and can exist alongside cash-based labor markets, especially when global markets have imperfectly penetrated rural areas (Guillet 1980; Chibnik and de Jong 1989; Gilligan 2004). A combination of factors has been implicated in the decline of labor exchange, including: population growth, technological change, labor specialization, the emergence of a rural proletariat, and monetization (Moore 1975; Ponte 2000). Ponte (2000) reports the transition to wage labor has had a negative impact on economic and social relationships in the developing world (Ponte 2000). Specifically, moving from labor exchange to contractual wage labor has coincided with an increase in social and economic inequality within peasant communities. Additionally, whole communities, and poorer households specifically, have become more vulnerable to natural disasters and economic shocks because social networks normally created through labor exchange relationships, which act as a safety net during times of crisis, are no longer present (Ponte 2000).

The egalitarian ethos of corporate peasant communities, coupled with the small land holdings per individual, and labor inputs that require collective action, results in labor exchange groups led by a single individual, known as a "chief-for-a-day" (CFAD) (Horowitz 1967). The CFAD decides how work will be completed and directs those who assist. This leadership role does not extend to any other aspect of village life. Because labor groups rotate between CFADs, all individuals who participate are eligible to make their land productive.

Under labor exchange, the CFAD owns all goods produced from the labor event. As a result, the products of a labor exchange event do not represent a true collective action problem, common-pool resource, or public good. Rather, it is a private good produced through collective action. In the terminology of the theory of collective action, goods produced by labor exchange groups are *excludable* – that is, individuals can be excluded from consuming the good – and *rivalrous* - that is, consumption by one party prevents simultaneous consumption by others (Apesteguia and Maier-Rigaud 2006).

Reciprocity has been proposed as the mechanism responsible for labor exchange. However, the only example I am aware attempting to test this proposition empirically is Hames (1987). Hames demonstrates garden labor exchange among the Ye'Kwana is a form of reciprocity biased by genetic relatedness. His research, although ground breaking at the time, suffers from a lack of appropriate statistical controls (largely because they were not widely available yet) and could not benefit from recent theoretical advances concerning the evolution of cooperation (e.g. Competitive Altruism, Cultural Group Selection). Thus it is debatable whether reciprocity is responsible for labor exchange.

Several mechanisms, each with a unique set of assumptions, predict the formation of groups. However, each mechanism assumes individuals will engage in collective action only if

the benefits for cooperating in a group outweigh the cost of acting alone (Nowak 2006). Identifying the correct mechanism responsible for labor exchange is important as each assumes different constraints and underlying motivations for behavior. It is possible a mechanism other than direct reciprocity may be responsible for labor exchange.

THEORIES OF GROUP FORMATION

Productive groups are evolvable via several mechanisms: 1) Kin Selection (Hamilton 1964); 2) Mutualism (Smith 1991; Alvard and Nolin 200); 3) Group Selection (Henrich and Boyd; Gintis and Bowles); 4) Reciprocity (Trivers 1971); and 5) Costly Signaling/Competitive Altruism (Roberts 1998; Gintis, Smith, and Bowles 2001). Kin selection suggests genes for social action can spread in a population if individuals share some critical percentage of genes. This has been formalized by the equation $C<Br$, where the cost C of performing an act must be smaller than the benefit B discounted by some measure of the degree of relatedness r. Thus, a group of individuals may help a focal individual if the focal individual is closely related to each. However, kin selection is an unlikely candidate mechanism for labor exchange as previous ethnographic research suggests kinship is not a prerequisite for its occurrence (Horowitz 1967; Trawick 2003).

Mutualism - joint action for mutual benefit - predicts groups will form in production when the net rate of energy acquisition gained by a group of n individuals is greater than that achieved by solitary effort for a group of energy-limited individuals (Sosis 1996; Smith 1985, 1991; Alvard and Nolin 2002). This has been expressed by the equation $R_n > R_1$. However, mutualism cannot explain labor exchange as only one individual reaps the benefit of group

production at any one moment, the CFAD. Mutualism requires all members obtain some simultaneous benefit from the event.

Group selection, whether by genetic (e.g., Sober and Wilson 1998; Bowles and Gintis 2003) or cultural (e.g., Boyd and Richerson 1985; and Henrich and Boyd 1998) mechanisms, suggests a group of cooperators might be more fecund or less likely to go extinct than a group of defectors. Thus individuals may form groups and cooperate indiscriminately with themselves if it causes them to outcompete other groups. This mechanism requires groups be fairly stable over time and selection weak at the individual level. Cooperation can evolve by group selection if the following inequality holds $b/c > 1+(n/m)$ where n is the maximum group size and m the number of groups (Nowak 2006). However, group selection is an unlikely candidate mechanism for labor exchange as labor exchange groups tend to be ephemeral, generally have no formalized normative structure, and last only as long as the work event itself. Group stability, the mechanism that allows group selection to occur, simply is not present (Dirks 1972).

Cooperation can evolve via direct reciprocity if an altruistic act provided by a donor to a recipient is directly reciprocated at some point in the future (Trivers 1971). Although Trivers (1971) was the first to demonstrate the evolvability of reciprocity, it was Axelrod and Hamilton (1981) who made the proposition mathematically rigorous by modeling it as an iterated Prisoner's Dilemma. Reciprocity requires individuals encounter each other repeatedly, both are able to provide assistance, and the cost of providing assistance by the donor is less than the benefit derived by the recipient (Nowak 2006; Trivers 1971). This has been formalized by the equation $w>c/b$, where the probability of future interaction w must be greater than the ratio of cost c to benefits b (Nowak 2006). Theoretical (Boyd 1990; Winterhalder 1986) and empirical

(Gurven 2006) treatments indicate that direct reciprocity need not be of the tit-for-tat variety for it to evolve. Direct reciprocity via unequal exchange can evolve as long as individuals act in a contingent manner (Gurven 2006). Boyd and Richerson (1988) show reciprocity can evolve in groups. However, group sizes need to be small because the probability a group of reciprocators contains a defector is quite large as group size increases, thus making it increasingly difficult for reciprocity to evolve in sizable groups. When close kinship is included in models of group reciprocity, it operates in a synergistic fashion allowing groups as large as ten to fifteen individuals to be evolutionarily stable (Boyd and Richerson 1988). Johnson and colleagues (2008) re-analysis suggest group reciprocity is evolvable in groups as large as 500 individuals, if it is modeled as a continuous prisoner's dilemma.

Traditional modeling approaches to the evolution of reciprocity assume individuals have an equal probability of interacting with anyone. That is, these models assume well-mixed populations. This assumption may not be met in real-life scenarios. Game theoretic models show reciprocity can evolve under variety of more realistic conditions. Both Hruschka and Henrich (2006) and Ohtsuki, Hauert, Lieberman and Nowak (2006) show reciprocity evolves when populations are not well mixed. Populations can become poorly mixed because of spatial structure (Nowak 2006), social networks (Ohtsuki et al. 2006), partner preference (Hruschka and Henrich 2006), or greenbeard dynamics (Dawkins 1976; Price 2006). Thus, naturally occurring assortment mechanisms can stabilize reciprocity, resulting in cliques who reciprocate with themselves, but are hesitant to reciprocate with others.

If reciprocity explains labor exchange then there should be a positive rectilinear relationship between labor given and labor received. Secondly, if naturally occurring assortment mechanisms facilitate reciprocity there should be a positive relationship between

labor received and living proximity and/or some dimension of friendship. Direct reciprocity makes no strong prediction concerning group size other than they should not exceed ten individuals and possibly it is facilitated by close kinship.

An important extension of traditional reciprocity models considers whether individuals actually differ in their ability to cooperate (Leimar 1997; Roberts 1998; Lotem, Fishman, and Stone 1999, 2003; Fishman, Lotem, and Stone 2001; Leimar and Hammerstein 2001; Sherratt and Roberts 2001). Under these conditions the act of cooperating can serve as a signal of individual quality, thus allowing reputations for cooperativeness to form (Alexander 1987; Zahavi 1995; Nowak and Sigmund 1998; Price 2006). Behavioral variability for cooperation can stem from several sources: genetic predispositions (Foster and Kokko 2006; McNamara et al. 2008), phenotypic flexibility (e.g. Sherrat and Roberts 2001), developmental trajectories (e.g. infancy versus adulthood), or stochastic events (e.g. becoming injured). Mathematical models show when individuals differ in this regard, cooperation can evolve under a variety of conditions, including: 1) dyadic (Nowak and Sigmund 1998; Lotem et al. 2003) and *n*-player contexts (Gintis, Smith, and Bowles 2001; Leimar and Hammerstein 2001); 2) repeated (Leimar and Hammerstein 2001) and non-repeated interactions (Nowak and Sigmund 1998; Gintis et al. 2001; Lotem et al. 2003) and 3) through alternative paradigms to cooperation, such as the continuous Snow Drift Game (McNamara et al. 2008), Iterated continuous Prisoner's Dilemma Game (Gintis et al 2001; Leimar and Hammerstein 2001; Lotem et al 2003; ; McNamara et al. 2008), and Iterated Prisoner's Dilemma Games on Graphs (Fu et al. 2008). Both Gintis and colleagues (2001) and Lotem and colleagues (2003) demonstrate when signaling benefits are introduced to a population where individuals vary in cooperative abilities, the population will evolve to a stable state where high quality individuals cooperate

unconditionally, while low quality individuals either defect (Gintis et al. 2001; Lotem et al. 2003) or play a tit-for-tat strategy (Lotem et al. 2003). On the other hand, Leimar and Hammerstein (2001) demonstrate cooperation can evolve via a different route, such that high-quality individuals only reciprocate with individuals who exist in the same state as themselves, a condition known as state-dependent reciprocity (Leimar and Hammerstein 2001).

When individuals vary in cooperative ability and actors can use others' level altruism (McNamara et al. 2008) or reputations for altruism (Fu et al. 2008) as a choice criterion for interactions, then cooperation can evolve because actors compete to be more generous than others (Roberts 1998; McNamara et al 2008), a condition known as competitive altruism (Roberts 1998; Barclay 2004; Barclay and Willer 2007). Formal models show the range of conditions where altruism is stabilized under these scenarios is dependent on the level of variability that exists in the population (Foster and Kokko 2006; McNamara et al. 2008) the mortality rate (McNamara et al. 2008), the rate at which partner switching occurs (Fu et al. 2008), or the cost to switching partners (Foster and Kokko 2006; Fu et al. 2008), such that greater variability, lower mortality, higher rates of partner switching, and lower costs expands the range of conditions where cooperation is favored. When partner choice operates via the mechanism of competitive altruism, a positive correlation will exist between an individual's ability to cooperate and their choosiness, such that highly altruistic individuals will be the most choosy leading to a positive assortment of altruistic types (Nesse 2007; McNamara et al. 2008), a necessary feature of many mechanisms of cooperation (McNamara et al. 2008).

When high quality altruists are rare in a population, people will compete for access to them, resulting in a biologic market for altruists (Noe and Hammerstein 1994, 1995; Barclay and Willer 2007; Nesse 2007), where the benefits provided by the high quality person can be

individually reaped. Because all people desire to partner with high quality altruists, individuals with the greatest ability or best reputations will form larger audiences (Roberts 1998; Barrett et al. 1999; Gintis et al. 2001). However, when high quality individuals are in limited supply, they can be selective with whom they choose to form private partnerships. Thus high quality altruists will discriminate amongst potential partners and potential partners must compete to curry favor of high quality individuals (Nesse 2007). When individuals compete to curry favor of altruists, bidding wars can ensue. Market forces of supply and demand will determine the exact value of each altruist (Noe and Hammerstein 1994, 1995). When group sizes are large actors must increase the amplitude of the signal to outcompete others in partnership formation. Partnerships come in at least two varieties, same-sex exchange relationships and between-sex sexual relationships (Noe and Hammerstein 1994, 1995; Bliege Bird, Smith, and Bird 2001; Gintis et al 2001). Once partnerships are formed, if one of the two or more party members fails to behave cooperatively, market forces may cause individuals to dissolve partnerships and search for individuals who provide better returns on investment.

If competitive altruism predicts labor exchange, then: 1) the amount of labor given to others will be a positive predictor of one's reputation for altruism; 2) group size will vary as a function of reputation; 3) as group size increases, people will send stronger signals of commitment to a CFAD by offering more days of service; 4) a quadratic relationship will exist between labor given and labor received, as only a subset of all interactions will result in cooperative partnerships; 5) reciprocal dyads will be more likely to form as the number of days given to a CFAD increases; and 6) males with good reputations will be more likely to form same- and opposite-sex relationships.

The evolutionary mechanisms presented provide competing hypotheses about labor exchange. Each suggests a different motivation for behavior. Direct reciprocity predicts people will help one another because this will ensure future reciprocation. Competitive Altruism/Costly Signaling predicts people will cooperate with others because they can afford to do so and this act serves as a signal of one's ability or intent. The reputation that accrues for cooperators is then used by others to make decisions about possible future relationships, whether exchange or sexual in nature.

Although evolutionary mechanisms provide a lens for assessing why labor exchange occurs and group sizes vary, they shed minimal insight as to how labor exchange is related to intra-community social dynamics other than predicting living proximity and friendships may facilitate its occurrence and romantic relationships a possible precipitate. Many researchers have noted labor exchange is the medium whereby community members negotiate social relationships for use outside the labor context (Ponte 2000; Suehara 2006). However, the form and function of within community social relationships is itself the product of unique historical forces, ecological conditions, cultural traditions, and economic constraints. As such, different communities will a have a unique chain of causality between labor and social relationships (Erasmus 1956; Geschiere 1995). To understand the relationship between labor and social relationships in small agricultural societies one must contextualize the institution of labor exchange within the socio-cultural context that it occurs (Geschiere 1995). The Caribbean socio-cultural area forms that context.

THE CARIBBEAN AND PEASANT SOCIETY

The Caribbean is a unique socio-cultural area (Horowitz 1960) comprising some 36 million people (UNCTAD 2009) in a land area no larger than 91,000 square miles (Boswell 2003). Hillman (2003) suggests the Caribbean can be divided into five geographic regions: 1) **the Greater Antilles** (Cuba, Hispaniola, Jamaica, and Puerto Rico); 2) **the Lesser Antilles** (*Leeward Islands*: Montserrat, Antigua and Barbuda, St. Kitts and Nevis, Saba, St. Eustatius, St. Martin, St. Barthelemy, and Guadeloupe; *Windward Islands*: Dominica, Martinique, St. Lucia, St. Vincent and the Grenadines, and Grenada); 3) **the Insular Caribbean** [U.S. and British Virgin Islands, Barbados, Trinidad and Tobago, and the Netherlands Antilles (Aruba, Bonaire, and Curacao)]; 4) **Islands in the region but not in the Caribbean Sea** (Bahamas, Bermuda, and the Turks and Caicos Islands); and 5) **mainland countries with Caribbean attributes** (South America: Guyana, French Guiana, Suriname, and Enclaves in Venezuela and Colombia; Central America: Panama, Costa Rica, Nicaragua, Honduras, and Belize; and U.S.: Miami and South Florida).

Despite geographic separation and ethnic, linguistic, and religious heterogeneity, the Caribbean is unified by a shared colonial history, the experience of plantation slavery, and a current reliance on natural resources for the generation of export earnings (Pantin 2003). With the exception of Bermuda, the Caribbean exists completely within the tropics. This causes the Caribbean to share a similar climate, soil, and vegetation pattern, which affects clothing and food and serves as a homogenizing agent (Boswell 2003). The majority of Caribbean peoples are smallholder farmers. In 2005 alone, nearly 4 million adults existed in this condition (UNCTAD 2009). However, nearly 50% of consumed food is imported from foreign countries, indicative of the Caribbean's dependent status (Boswell 2003). This unique juxtaposition is

due to the many communities relying on single cash crops or the production of petty commodities for sale on regional and international markets (Pantin 2003).

Horowitz (1960) suggests rural Caribbean communities can be conceived along a continuum from "lowly" to "highly" integrated. Land tenure and exploitation practices best explain where a community falls along this continuum. The former is produced in communities where, 1) large population sizes exist; 2) land holdings are very large (e.g. plantations) and owned by few individuals; 3) individuals must sell there labor in an industrial manner; and 4) community norms for mutual assistance based on kinship do not develop. The latter consists of communities where, 1) populations sizes are small; 2) individual land holdings are small (less than an acre of land), but most own something; 3) land holdings are exploited by the household group or small groups of distantly related individuals seeking mutual aid; and 4) they are bonded by kinship (both real and fictive) and mutual assistance. Highly integrated communities are simply the Caribbean manifestation of the closed corporate peasant community.

A common theme in highly integrated Afro-Caribbean peasant populations is poverty, economic vulnerability, and a unique community organizational form: the matrifocal household. The causes of poverty are debated, but seem to stem from some combination of an imperfect transition away from colonial plantation agricultural (Pantin 2003) and relocation of peoples after slavery to marginal lands such as hillsides and valleys (McGregor 2003). Communities that developed in these marginal areas turned to a mix of subsistence agriculture and cash cropping for survival (Barker and McGregor 1988). Many communities still rely on this mixed economy; however they exist in an inferior position to national and global markets and are vulnerable to minor fluctuations in the pricing and demand of commodities (Pantin

2003). Living arrangements on marginal lands compounds economic vulnerability because these areas have greater susceptibility to natural disasters (e.g. landslides, hurricanes, erosion) (McGregor 2003). Matrifociality may be an adaptive response to poverty and economic vulnerability inherent in peasant Caribbean society (Barrow 1999; Quinlan 2006).

Matrifocality is a cultural complex occurring in impoverished communities, where females in their roles as mothers are the focus of relationships within households (Smith 1996; Barrow 1999). Although males may be present, mothers have dominance and authority over economic decision-making within a household and mothers and daughters form the core of affective social relationships (Gonzalez 1970; Barrow 1999). These female-headed households accommodate a variety of mating and child-rearing practices (Barrow 1999); however, households typically include a mother, her daughters, and their children. Female social relationships focus on interactions within the household or between households amongst female kin (Dirks 1972). In general, economic opportunities favorably bias females (Quinlan 2005) as such, males are considered economically and socially marginal to the domestic unit (Smith 1996). Some have extended the concept of male marginality to society in general; however, very little research has focused on the exact nature of male social and economic roles (see Wilson 1971 for a critique).

With the exception of Wilson (1969, 1971, 1973) and Dirks (1972), male same-sex social relationships in the Caribbean are an area of under-research. Relatively little attention has been devoted to the social and economic consequences of male labor and male friendships. This may be due to research bias fixated on matrifocality (see Wilson 1969, 1971). Sex differences in interpersonal social relationships are reported to exist in Afro-Caribbean peasant communities (Wilson 1969; Dirks 1972). Although minimal quantitative data exist, several

qualitative ethnographic studies by Wilson (1969, 1971, 1973) and Dirks (1972) support this thesis. Based on their research, the following conclusions can be drawn about male and female same-sex social relationships. Sex differences in same-sex social relationships are reportedly adaptive responses to uncertain economic opportunities (Dirks 1972). Female same-sex social relationships are affectively close, long lasting, and predicated upon kinship, the domestic unit, or church groups (Dirks 1972). Engaging in exchange relationships in domestic tasks, such as child rearing, cleaning, and food preparation, strengthens female social bonds and results in matrifocality. Whereas females' relationships are based on kinship and centered on the household, males' relationships are orthogonal; they exist irrespective of kinship and center outside the household.

Males form highly flexible, short-term individual alliances with other men who, most likely are not close kin (Wilson 1969). Men's friendships are based on age, living proximity, work relationships, and reputations (Wilson 1969, 1971; Dirks 1972). They tend to be affectively close but informal and center on drinking. Male friendships are ego-centered, that is, they are a series of individually managed relationships extending outward from a single individual (Dirks 1972). Ego-centered social networks provide flexibility and allow for rapid decision-making in response to economic opportunities when they arise. As such, male relationships center on stochastic work opportunities. When work occurs, males tap into existing networks and escalate social relationships or attempt to forge new relationships that may improve economic opportunities (Dirks 1972). Not surprisingly, men with greater access to work opportunities are reported to build larger social networks and tend to increase in social standing as most other men vie for the opportunity to create a partnership with them. Work

opportunities are the arena where men negotiate same-sex social relationships, and labor exchange, the medium whereby relationships are managed. As Dirks (1972: 573) puts it:

> The 'friendship bond' … goes into the building of a man's network. Such a relationship can be found between men who may not be closely related to one another by kinship. This type of link between two men undergoes a continual selective process and can only remain viable through repeated symbolic exchanges. These latter exchanges include information related to work opportunities, [and] the actual exchange of labor…

Many anthropologists report that reputations are central to Caribbean male social life (Wilson 1969, 1973). Like many peasant societies, closed corporate communities in the Caribbean have very little formal institutions that confer recognition and achievement upon community members, especially males (Wilson 1973). To outsiders it may appear that communities are composed of social equals (Wilson 1969). However, within community status differentials do exist, which may appear trivial to outsiders. Reputations are the mechanism that allows men to differentiate themselves amongst their peers and are derived from a complex amalgam of sexual prowess, procreation, alcohol consumption, conspicuous spending, and labor (Wilson 1969; Dirks 1972). Although construed as wasteful expenditures both in terms of time and money, engaging in reputation formation may be prudent social investment (Dirks 1972), especially if it leads to employment opportunities in the future. Although few empirical data exist, Wilson's (1971, 1973) analysis of Caribbean men's peer groups suggest social relationships are based on reputation matching. That is men tend to become friends with men who have similar reputations as themselves.

Male gendered behavior is envisioned as explicitly stereotyped. The ideal man is aggressive, highly mobile, and socially flexible (Wilson 1969, 1973). He exists in a world of

changing interpersonal ties set against a backdrop of economic uncertainty. Labor and alcohol are his social medium. He is generous and his achievement is based on his reputation amongst men (Dirks 1972). This sociocultural backdrop provides a texture to the nature of male and female social relationship; however, these propositions require empirical testing.

Several predictions emerge about the nature of Caribbean male same-sex social relationships and labor exchange: 1) males who live in close proximity to one another, are similar in age, and have similar reputations will be more likely to be friends; 2) these individuals should be more likely to engage in a labor exchange relationship; 3) men with greater access to land resources, and thus have greater economic opportunities, will have larger ego networks than those with minimal land access; and 4) men with greater access to land will become friends with men who have less land at their disposal.

CHAPTER SUMMARY

This chapter began by reviewing the literature on corporate peasant communities and its agrarian institution of labor exchange. Researchers are in unanimous agreement that labor exchange is based on the mechanism of reciprocity. However, little empirical research exists to confirm this proposition. Competitive Altruism is a potential mechanism explaining its occurrence. Contingent reciprocity and competitive altruism make unique predictions concerning the nature of labor exchange. Contingent reciprocity predicts a positive rectilinear relationship between labor given and labor received. Competitive altruism predicts a curvilinear relationship. Contingent reciprocity makes no strong prediction concerning group size other than groups should be no larger than ten individuals and close kinship may facilitate exchange. Competitive altruism predicts group sizes will vary with respect to reputations for

altruism. Contingent reciprocity, but not competitive altruism, makes predictions concerning naturally occurring assortment mechanisms that facilitate exchange, namely: living proximity and friendship. However, competitive altruism, but not direct reciprocity, predicts males in good reputation will be able to accumulate better partnerships including same- and between-sex relationships.

To understand the non-labor social dimensions of labor exchange, one must know the social and environmental forces shaping interpersonal relationships within a community. A unique set of historical, ecological, and economic conditions affect the texture of male social relationships in the Caribbean. Males reportedly create minimally dense same-sex social networks based on fluctuating economic opportunities. As such, males with the greatest access to work opportunities (i.e. land access) should form the largest social networks and become friends with those who have less access to land. Additionally, males are predicted to form friendships based on similarities in reputation, age, living proximity, and labor exchange.

The remainder of this dissertation proceeds in the following fashion: chapter two provides an in depth examination of the field site, Bwa Mawego, and its institution of labor exchange as it is practiced in the community's primary cash crop, Bay Oil Production; chapter three reviews the methods implemented to assess hypotheses and summarizes the results; chapter four discusses and contextualizes the results of labor exchange and Caribbean men's social networks through the theory of biologic markets and offers recommendations for public policy related to labor exchange; chapter five concludes the dissertation.

CHAPTER TWO

STUDY SITE AND ORGANIZATION CONTEXT

INTRODUCTION

The village of Bwa Mawego (village name is a pseudonym) is located on the southeast coast of windward side of the Commonwealth of Dominica - an independent nation in the Lesser Antilles that exists between the French overseas territories of Guadeloupe and Martinique. It is rugged, mountainous, and one of the most underdeveloped communities in the country. The village is situated in a geologic landscape characterized as a senescent volcanic pile – erosion has reduced volcanic piles to a series of narrow, rounded ridges with relatively wide valleys in between (Figure 1) (Lang 1967). Within these valleys exist streams of permanent to semi-permanent running water supplied by the nearly 100-150 inches of rain per year (Quinlan 2004). Nearly all of this land has been cultivated despite the difficulties associated with steep terrain and boulders; however, settlement is dispersed (Lang 1967; Quinlan 2004) with people residing in twelve hamlets.

Figure 1: The community of Bwa Mawego Dominica at sunrise.

According to a 2007 census, the village has a population of 408 individuals, with 500-600 full to part-time residents (Macfarlan and Quinlan 2008). Population sizes fluctuate as a result of village and island emigration; however, women, compared to men, are more than twice as likely to leave the village (Quinlan 2005) resulting in a population that is numerically male biased. Nearly all residents are related to one another either through consanguineal or affinal ties. Social relationships are navigated through these dimensions of kinship (Quinlan 2004; Quinlan and Flinn 2005). Although inheritance is patrilineal, village life has a matrifocal orientation (Quinlan, 2006), similar to many other Afro-Caribbean populations (Smith 1996). Females, across the life-course, experience parental resource favoritism (Quinlan 2006; Quinlan, Quinlan, and Flinn 2005), which has been interpreted as a potential cause of matrifocality (Quinlan 2006). Due to the scarcity of resources and matrifocal orientation of village life, men experience local resource competition within households (Quinlan and Flinn 2005). The combination of local resource competition between brothers and female-biased parental investment, compounded by the limited number of females in the community, leads to: 1) male difficulties in achieving reproductive success (Quinlan and Flinn 2005); 2) greater alcoholism and poverty rates in men (Quinlan 2006); and 3) cultural models of fairness, such that men with a large male presence within a household become more generous while females become less so (Macfarlan and Quinlan 2008). For an in depth review of the community see (Quinlan 2004).

Based on a Dominica-wide survey of farm types (Ehret 1995), Bwa Mawego is considered a community of small, part-time farmers. Small, part-time farmers tend to invest minimal time into production (~25 hours per week), generate limited yearly revenues (~$3000 Eastern Caribbean per year), do not own a vehicle, and do not invest in banana production as a

commercial enterprise (Ehret 1995). The economic goals of small, part-time farmers are food production and modest income generation (Ehret 1995). Unlike the majority of small, part-time farmers in Dominica, kin groups in Bwa Mawego communally own land in a corporate fashion with individuals having land rights on a usufruct basis (Flinn, Leone and Quinlan 1999). The average land area managed for cultivation by villagers of Bwa Mawego (~0.3 acres – R. Quinlan personal communication 2008) is less than that managed by other small, part-time farmers in Dominica (1.8 acres - Ehret 1995). Village economy relies on a mix of slash and burn horticulture and small-scale commercial activities. The primary crops cultivated include a variety of root tubers for personal consumption and the West Indian bay tree [*Pimenta racemosa* (Miller) J.W. Moore] (Figure 2). The primary cash opportunity is bay leaf farming and distillation of bay oil (Quinlan 2004), a common Dominican enterprise with its center on the SE coast (Honychurch 1995).

Figure 2: Bay tree just prior to harvesting (right) and immediately after harvest (left).

BAY OIL

Bay (also known as Myrcia oil) is an essential oil produced by steam distillation of the leaves from the indigenous Caribbean bay tree (Honychurch 1986; ISO 2004). Bay oil has a dark brown color, spicy odor, a specific gravity of 0.962, and a flash point of 64°C (the minimum temperature at which it can vaporize to form an ignitable mixture in air) (ISO 2004). The oil can be stored indefinitely and has been difficult to synthesize in laboratories, thus allowing small farmers to continue to produce this product. The oil primarily is used in the cosmetic industry as an ingredient in perfumes and soaps; however, locally it is used to treat rheumatism and sprains (Quinlan 2004). The primary constituent of bay oil is eugenol (ISO 2004) a substance known to inhibit platelet activity (Tisserand and Balacs 1995); however, modest amounts of methyl eugenol gives bay oil antiseptic properties (Saenz et al 2004) when applied by direct contact (Delespaul et al. 2000). It has known antifungal (Delespaul et al. 2000), antibacterial (Burt and Reinders 2002; Saenz et al. 2004), antinociceptive (García et al. 2004), anti-inflammatory properties (García et al. 2004) and has mixed evidence for insecticidal properties against the human head louse (*Pediculus humanus capitis*) (Yang et al. 2004). Village residents state that bay oil also has insecticidal properties against fleas; however, this has not been validated by laboratory tests.

The production of bay oil historically has been the primary cash opportunity for this village and several others on the island. Village residents disagree on the exact date bay leaf farming was introduced to Bwa Mawego; however, most estimates place it at or near the start of the 20th century, with the first distillation factory operating by 1925. Prior to 1925, residents report their ancestors transported bay leaves by boat to an un-named city on the island where essential oil distillation occurred. These oral histories appear accurate, as essential oil

distillation technology did not reach Dominica until approximately the 1890s, where it was used to distill essential oil of lime (Trouillot 1988).

Bay oil production largely is a male task, although women do participate, and is a major component of daily social life, as the physical demands of labor require collective action. Local informants who farm bay trees and distill bay oil state that the work is a source of pride as it provides them a sense of cultural continuity, linking themselves to the landscape and with their ancestors who have worked the land in generations past. However, some young men and women in the community state the work is too hard and dirty and is seen as an inferior occupation to work that can be done in offices or shops. This has caused tensions between older and younger generations who have different values concerning the maintenance and production of this oil.

HARVEST PHASE OF BAY

Production has two phases, a harvest phase and a distillation phase. The first phase consists of a one-month to two-week period where bay leaves are harvested and bundled from individually owned plots of land (Figure 3) and then carried on foot to one of eight village factories for distillation. These are factories in name only, and are no more than a shack with two walls, a roof, and an approximately six foot still for distillation (Figure 4). Although no formal sexual division of labor is present, residents agree females are better suited to bundling bay leaves, while males are better at weeding, carrying bay leaf bundles, and carrying wood.

Figure 3: Plots of land containing bay tree farms of various stages of growth.

Figure 4: Example of a bay oil factory.

Logwood fuel is required to heat the stills. This is obtained from primary and secondary growth tropical forests located on the periphery of the village or is purchased outside of the village and brought into the community by truck. The former is practiced more often because of the considerable cost related to transport; however, the latter is more desirable since it reduces the amount of work one must invest. Several types of wood are harvested by machete or chainsaw from the tropical rainforest: 1) Mahoe Piment [*Thymelaeaceae Daphnopsis americana* (Miller) J. Johnston], an extremely tough and fibrous tree that grows in secondary forests, the leaves of which were used by indigenous Caribs to protect against evil spirits; it

smells of pepper when burned; 2) Mango [*Anacardiaceae Mangifera indica*], an non-native species introduced from SE Asia that has a dense wood; 3) Bwaden (Bay of the Indies) [*Pimenta racemosa*]; 4) Bwa Riviére [*Rubiaceae Chimarrhis cymosa*], a common rainforest species that grows well in montane environments close to rivers; 5) Fijyé [*Moraceae Ficus citrifolia*], a medium to large tree that is considered the most common tree species in Dominica; 6) Bwa Dyab (Devil's Wood) [*Chrysobalanaceae Licania termatensis*], a large canopy tree with a dark colored and very hard wood that is known for ability to burn "hot" for a long period of time; and 7) Blue Mahoe [*Malvaceae Hibiscus elatus*] a medium sized tree known for its fast growing timber (Lack et al., 1997; Honychurch 1986). Village residents state men well versed in the art of bay oil distillation will obtain some combination of these tree species to ensure the fire burns at the correct temperature and the correct duration. However, young men or men who do not work much in bay oil distillation, and as such are not as proficient, may secure only one or two species, thus making it more difficult to attain or maintain correct temperatures.

The harvest phase is extremely energetically taxing. To distill a single batch of oil, approximately 2200 pounds of bay leaves and 1500 pounds of logwood fuel must be carried on foot from individually managed plots of land to the distillation factories (a distance that can exceed 2 miles, on mountain slopes that can exceed a 50 percent grade). Bay leaf bundles can weigh as much as 110 pounds. Residents state weeding one's bay tree farm is the most difficult processes related to harvesting as it exposes them to direct sunlight for several hours per day (over several days) and to a variety of vectors that cause pain and exhaustion, including: scrapes, cuts, insect bites, lower back pain, and heat exhaustion. Additionally, it requires people to use a machete on difficult terrain.

BAY OIL DISTILLATION PHASE

The second phase is a one to six day distillation period where the bay leaves are steamed and the essential oil is produced. For an example of a typical distillation event see Appendix 1. When an individual desires to distill oil, he/she does not solicit help. Instead, according to local informants, the individual will begin by working alone or will announce to others in public that they plan to distill bay oil. Because the village is small and people discuss the actions of others, word travels quickly throughout the community concerning who is preparing for work. People who owe labor to the individual readying for work are supposed assist; however, nothing obligates the person to work except for a village-wide norm that suggests labor be provided if it is owed. Telling another person that they must reciprocate work would violate rules of decency in this village (Quinlan 2004) and could result in one being labeled "Makko" – a derogatory term indicating one is encroaching on the business of others. People other than those owing work may show up to provide assistance. Labor like this is provided for one of two reasons: 1) the individual gives labor with the hopes of receiving labor in-kind in the future on a reciprocal basis (defined by the term "Hand-in-Hand"); or 2) the individual has no intentions of receiving labor in-kind in the future (defined by the term "Koudme"). The individual desiring to distil oil is the Chief-for-a-day (CFAD) and directs all operations [there is no local name for this position, as such, the name used by Horowitz (1967) is applied]. The CFAD usually provides cigarettes, rum, and food to keep the group content. The group that is formed is ephemeral, lasting only as long as the distillation event, is not named, and does not compete with other groups. As such, work groups in Bwa Mawego are similar in form to those reported in Martinique (Horowitz 1967) but different from the work societies of Haiti (Metraux 1951). The kinds of tasks people perform within the factory include chopping wood, loading wood

into wood burning stoves to heat the still, monitoring the still's temperature and water levels, loading the still with bay leaves (locally referred to as "ramming"), repairing the still if leaks are spotted, and cooking food. Village members state they seek to make as much bay oil possible for as little effort possible. All oil (and subsequently, money) that is produced from the distillation event is owned by the CFAD, except for one 0.75 milliliter bottle of oil, which must be paid to the factory owner per distillation event (~$75 EC).

To distill a single batch of bay oil requires a quarter acre of land which nets approximately 7.5 liters of oil (approximately 15 pounds); however the total oil produced depends on several factors including: 1) the quality of leaves; 2) whether the still was heated properly; and 3) how much vapor was lost to defects in the still (e.g. holes). Additionally, one must be present in a factory for twelve to 16 hours to maintain temperatures and ensure sufficient water exists in the still for proper distillation. Many individuals prefer to distill several batches at a time (six batches are the most any person has attempted over the past three years – author's notes). When not monitored properly, the oil can be ruined, or worse, the still could explode causing injury or death. Although the work is hard, it can take on a festive atmosphere when all male groups are present; they will drink, smoke, sing songs, tell stories, and joke with each other to pass the time.

Village residents are in almost unanimous agreement the least desirable distillation task is "ramming" bay leaves into the still (Figure 5). Although the time requirements for ramming bay leaves into a still is approximately one hour, it is difficult because it exposes people to tremendous heat and bay vapor. One is capable of compressing more leaves into the still if the wood burning stoves that exist below the still are already burning. However, to compress more bay leaves into the still, one must be inside the still, "ramming" leaves using their legs while

another person hands bay leaf bundles to be rammed. This process can cause serious burns if not done properly. Additionally, the vapor that is generated while the leaves are being rammed (because they are undergoing the process of steam distillation) is highly irritating, causing expectoration, the eyes to tear, and mucosal membranes to secret their fluid through the throat and nose. Many people agree that at least three individuals are ideal for ramming bay leaves, as this allows one person to hand bay leaf bundles to the person in the still, the person in the still rams the leaves, while the third can catch their breath, gain relief, and become ready again to assist in either of the other two tasks. Generally, all three will rotate positions. A person who must perform this task alone will have great difficulty completing it. Residents fear this possibility. To ensure this situation does not obtain, one must remain in good standing in the community and maintain a personal network of individuals who can be relied upon to assist with labor when it is needed. Many people engaged in bay oil production state achieving group sizes of two to four people is most desirable for the distillation phase. This is because it reduces the overall work an individual must perform and limits their obligations to others who require they be repaid with labor in the future.

Figure 5: “Ramming” bay leaves into a still.

Once a bay oil distillation event is finished, the CFAD collects all the oil produced. The still must be emptied of the spent bay leaves that exist inside of it. The process takes approximately one hour and is quite arduous (Figure 6). The leaves are removed using a long wooden pole with a metal hook. Spent leaves are pushed into a ravine that exists adjacent to each distillation factory. Although these leaves are wet from the process of distillation, they are extremely hot and can spontaneously combust into flames on exposure to air. Leaves will smolder for approximately two to three weeks, upon which, the ashes are bagged, and either used in the village or sold outside the village as fertilizer.

Figure 6: Offloading spent bay leaves from the still.

After production, the oil can be sold to the Dominican Essential Oil and Spice Cooperative for $16 (US) per pound twice a year – a week before Christmas and the second week in August. The oil can be sold only if it is of sufficient quality, which is determined by a hydrometer. If the specific gravity of the oil is less than 0.96, it is considered poor quality and will not be purchased. If this circumstance occurs, it is extremely unfortunate as the oil is not salvageable, one's time is wasted, and one must wait for approximately nine months to harvest and distill again. If a small amount of oil is obtained or if the oil is of poor quality two reasons

are given, either the factory is of poor quality or witchcraft has occurred.

At least two plant species are used for protection and to enhance the bwaden leaves' capacity to generate oil: 1) Pipe Zandoli (Lizards' Head) or Pipe Zombie – [*Lobeliaceae Hippobroma longiflora*] (Figure 7); and 2) Estroi Fragile [*Polygalacae Polygala paniculata*] (Figure 8). These plants are placed on top of the compressed bay leaves prior to the distillation process just before one caps the lid of the still so the leaves can be steamed. Native Caribs used both plants for ritual purposes and for sponging off their canoes after fishing expeditions. Local informants state these plants ensure good luck during the distillation process such that a large amount of high quality oil is produced. These plants also may be used during the harvest phase and placed on top of bay leaf bales while they exist in the open field. Placing these plants within or on top of bay leaf bales is thought to prevent evil mischief that may be done to it as a result of witchcraft or the evil eye.

Figure 7: Pipe Zandoli

Figure 8: Estroi Fragile

CHAPTER SUMMARY

This chapter provides a texture to intra-village social dynamics and the process of the bay oil production as currently practiced in Bwa Mawego. The semi-closed community of Bwa Mawego is similar to other smallholder agricultural communities in the developing world – it is a highly-integrated, semi-closed corporate village, social relationships are navigated by kinship, and the institution of labor exchange is present. Additionally, Bwa Mawego is similar in form to other Afro-Caribbean populations – the community has a matrifocal orientation and males exist in a marginal position compared to females. As such, the community of Bwa Mawego is an ideal setting to test predictions about labor exchange and the nature of Caribbean male social networks.

CHAPTER THREE

METHODS AND RESULTS

INTRODUCTION

This chapter is organized into two sections, methods and analysis of labor exchange and male social networks. In each section I review techniques and time frames for data collection and identify key quantitative demographic characteristics necessary for evaluating hypotheses derived from the separate, but interrelated themes of labor exchange and male social relationships.

LABOR EXCHANGE

Group Size and Composition

Following the protocol of Hames (1987), one village resident and myself performed daily instantaneous scan samples of the village's eight factories over a ten-month period (July 10, 2007 – April 30, 2008). During factory scans we recorded the number of people present, their sex, the CFAD, and all individuals providing assistance. Additionally, we collected the name of the hamlet where each individual resides (there are 12 hamlets within the village), their age, and whether they were in a romantic relationship with a member of the opposite sex. Ages were obtained by either consulting genealogic records or through interviews.

244 bay oil distillation events were recorded over the ten-month period, of which 236 involved two or more persons. 114 people (94 men and 20 women; approximately one quarter of the village's population) participated in factory work. A total of 758 person days were recorded (Table 1). There was no statistical difference in the mean age of males and females

engaged in bay oil production (t=1.1; d.f.=97; p=0.26). Age did not predict the number of days spent distilling bay oil (ρ=0.002; p=0.98; N=99). The age of twelve men and three women were not obtained, three of whom (all men) lived outside the village.

Table 1. Descriptive statistics for sex distributions in bay oil distillation.

	Age Male	Age Female	Male Days Worked	Female Days Worked	Male Days as CFAD	Female Days as CFAD	Male Days Helping	Female Days Helping
N	82	17	94	20	59	5	81	17
Mean	41	45	7.3	3.5	4.3	3	5.4	3.2
Median	40	45	4	2.5	3	3	3	2
SD	14.3	12	8	2.7	3.7	2	5.8	2.9
Min	16	29	1	1	1	1	1	1
Max	71	66	38	9	20	5	31	9
Total	-	-	690	68	255	15	435	53

There were 64 people who acted as CFAD (25 events of 244 had two chiefs acting jointly). Two CFADs lived outside the village. Men outnumbered women as a CFAD (59 men, 5 women). Every time a female was a chief she was assisted by a member of the opposite sex (usually a conjugal partner or a close male relative), the opposite was not true for males. Age did not predict the number of days working as a CFAD (ρ=0.09; p=0.52; N=59).

There were 98 people who assisted a CFAD (representing 81 men and 17 women). Two people who assisted a CFAD lived outside the village. Of the 98 people who assisted, 34 were themselves a CFAD (32 men and 2 females). Age did not predict the number of days assisting a CFAD (ρ=-0.08; p=0.47; N=86).

Approximately 61 acres of land was used for bay oil production. CFADs converted on average one acre (Median=0.75; SD±0.9; N=64) of land for bay oil. Per CFAD land used was obtained by multiplying the number of times an individual acted as a CFAD by quarter acreage (the amount of land required to make a single batch of bay oil). This is not necessarily the

amount of land an individual has tenure over, as some land tenants in the community ask others to make their land productive for them. When this occurs the CFAD and the land tenant split all cash from the distillation event at a usual rate of "fifty-fifty;" however, rates of two-thirds (CFAD) one-third (tenant) have been recorded. Age was not a predictor of land use (ρ=0.09; p=0.5; N=59).

There are two peaks in the production of bay oil: 1) July; and 2) November/December (Figure 9). This is not surprising as the Dominica Essential Oils and Spice Cooperative purchases oil in August (a week before primary and secondary school begins) and in December (a week before Christmas Holiday).

Average group size (based on the 244 per distillation events) is 3.1 individuals. A non-parametric test reveals female CFADs formed larger group sizes to distill bay oil (Mann Whitney U: z=-2.2; p=0.03). For group size and sex composition descriptive statistics see Table 2. A mixed-effects linear regression analysis using the CFAD as the random effects component, revealed age as a moderately significant predictor of group size (Wald X^2=3.7; B=-0.02±0.01; N=238; p=0.056), but did not predict number of males present per group (Wald X^2=1.07; B=-0.01±0.01; N=238; p=0.3). Female presence as a helper did not predict group size but did have a negative effect on the number of males present per group (Wald X^2=21.1; B=0.7±0.1; N=250; p<0.001) (sample size adjusted for groups with dual CFADs). When females were present as a helper, the CFAD almost always was her conjugal partner or close male relative (49 of 53 interactions). Due to the small sample of women represented as a CFAD, the remaining analyses are run on males only.

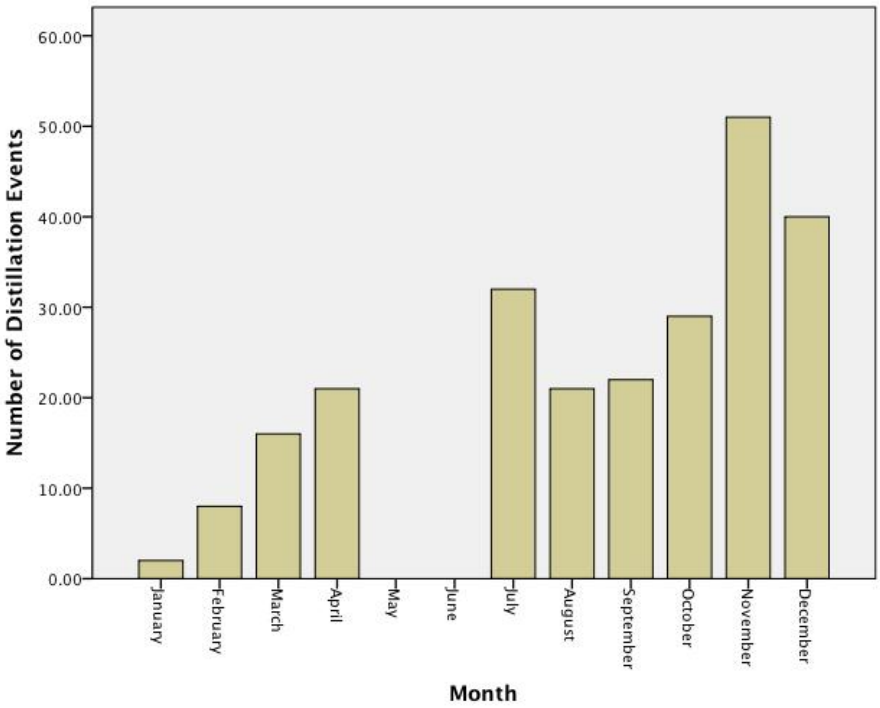

Figure 9: Histogram of Bay Oil Distillation Events by Month

Table 2. Group composition and sex distributions of bay oil distillation events

	N	Mean (SD)	Median	Min	Max
Group Size	244	3.1 (1.2)	3	1	11
# Males per group	244	2.8 (1.3)	3	1	11
# Females per group	244	0.3 (0.5)	0	0	2
Ave. Group Size (Male CFDA)	59	2.9 (0.9)	2.9	1.5	3.5
Ave. Group Size (Female CFDA)	5	3.9 (0.6)	4	3.2	4.8
Ave. # Males Helpers (Male CFDA)	59	1.7 (1)	1.7	0	4
Ave. # Males Helpers (Female CFDA)	5	2.5 (0.8)	2.2	2	3.8
Ave. # Females Helpers (Male CFDA)	59	0.2 (0.4)	0	0	1
Ave. # Females Helpers (Female CFDA)	5	0.4 (0.5)	0.4	0	1

Labor Exchange Characteristics

There were 290 dyads (145 unique pairs) representing 59 men. Of those, 82 dyads (41 unique pairs) showed evidence of contingent labor exchange. 33 unique dyads showed a single

instance of contingency (e.g. a situation where "A" gave to "B" followed by "B" giving back to "A"); eight had prolonged contingency (e.g. "A" gave to "B", then "B" gave back to "A", followed by "A" giving to "B", etc.). The average time for contingency to occur was 35 days (Median=8.5 days). The data takes the form of a Poisson distribution suggesting that most individuals repay work within a short time interval (minimum = one day, maximum = 148 days). One cause for long delays in reciprocating work is due to the interval for re-harvesting bay (approximately 9 months). If an individual owns a quarter acre of land (the amount needed to boil a single batch) he may need help only once every nine months. The majority of dyads demonstrating contingency (46 of 58) occurred on the first opportunity possible (total adjusted for eight dyads with multiple rounds of contingency). That is, even though it may have taken 120 days for an individual to reciprocate work to another, it occurred on the first instance the reciprocal partner made bay oil.

Reputations

Two types of reputations were acquired, reputations for hard working and reputations for altruism. Two key informants stated the former was important, while the latter is important given the literature on competitive altruism. To determine reputations for hard working, a five-point Likert scale was used. Both informants suggested true "hard-working" individuals are those work diligently when they are present and are competent, while the least "hard-working" are those who are present at a bay oil distillation event but work poorly when they are present and/or are not competent. Three village members (two female, one male) rated 80 men on the five-point scale (5=hardest working; 1=least hard working) in 2008.

Models examining the evolution of cooperation specify that reputations for altruism are central for its evolvability. Although village residents did not specify this kind of reputation was important directly, reputations for altruism using the term "Koudmen" (the term is a shortened version of the French patios phrase "coup de main") was collected by a fellow researcher (Mark Remiker). Village residents state that "Koudmen" means one who gives labor freely to others with no expectation of receiving work in the future. It is a tradition widely acknowledged by Dominicans (Ehret 1995). Three village members (two female, one male) rated 53 men on a dichotomous scale (1=would give Koudme; 0=would not give Koudme) in 2009.

Consensus on men's reputations was evaluated using the cultural consensus routine of UCINet Version 6.239 via the method developed by Romney, Weller, and Batchelder (1986). Cultural consensus modeling is based on a factor analytic approach for measuring agreement in the structure and distribution of knowledge within a population. Principal components analysis determines the extent to which individuals share a single cognitive model of information within a domain. Cultural consensus is achieved if a single latent factor explains a large proportion of variance (Weller 2007). Conventions in cultural consensus modeling suggest strong consensus exists if the ratio of the first two eigenvalues is greater than three and if individual factor scores (referred to as "competency scores") are non-negative (Bang, Medin, and Atran 2007; Weller 2007).

Cultural consensus was achieved for hard working (ratio of the first two Eigenvalues=4.18; no negative competency scores) and altruistic reputations (ratio of the first two Eigenvalues=4.33, no negative competency scores). Reputation scores were averaged via the method described by Weller (2007) using the "answer key" that is obtained from the

cultural consensus model. Mean hard-working reputation is 3.2 (SD1.0; Median 3.1). Mean altruistic reputation score is 0.69 (SD=0.34; Median=0.76). The number of days spent as a CFAD, but not number of days assisting a CFAD, predicted hard working reputations (R^2=0.27; n=73; p<0.0001; Days Spent as CFAD: β=0.4; B=0.1±rse=0.02; p<0.001; Number of days assisting a CFAD: β=0.2; B=0.03±rse=0.02; p=0.1), indicating that reputations for hard working capture a man's competency (or his ability to generate income), but not his propensity for altruism. The number of days assisting a CFAD, but not number of days spent as a CFAD, predicted altruistic reputations (R^2=0.22; n=48; p=0.0003; Days Spent as CFAD: β=0.08; B=0.007±rse=0.008; p=0.4; Number of Days Assisting CFAD: β=0.4; B=0.02±rse=0.006 p=0.001), indicating altruistic reputations capture a man's altruistic tendencies, but not his competency (or wealth). Age was significantly associated with altruistic reputations (r^2=0.14; B=-0.01 ±rse0.003; N=53; p=0.005), but only moderately so with hard working reputations (r^2=0.03; B=-0.01±rse0.008; N=78; p=0.08). However, number of days helping a CFAD (altruistic reputations) and number of days as a CFAD (hard working reputations) mediated the effect of age on reputations, respectively (Table 3), indicating reputations truly capture a man's behavioral tendencies within each domain, irrespective of the influence of age (for a population who ranges in age from 16-71 - roughly the age frame of human male reproductive viability). Thus, reputations appear salient.

Table 3. Multiple regression models explaining altruistic and hard working reputations.

Altruistic Reputations	Model Statistics: R^2=0.28; N=48; p=0.0001			
Predictor	**B(rse)**	**β**	**T**	**P**
Constant	0.9(0.2)		4.8	<0.001
Days Labor Given	0.02(0.005)	0.37	3.6	0.001
Age	-0.007(0.003)	-0.27	-1.9	0.07
Hard Working Reputations	Model Statistics: R^2=0.27; N=78; p=<0.0001			
Predictor	**B(rse)**	**β**	**T**	**P**
Constant	3.3(0.34)		9.6	<0.001
Days as a CFAD	0.14(0.02)	0.5	6.2	<0.001
Age	-0.01(0.007)	-0.2	-1.8	0.09

Labor Exchange: Contingent Reciprocity or a Form of Partner Choice Based on Competitive Altruism?

As argued in chapter one, the mechanism of reciprocity is thought to underlie labor exchange practices. Formal models demonstrate the evolvability of direct reciprocity is dependent on some level of contingency (Boyd 1990; Winterhalder 1986). If this is the case there should be a positive rectilinear relationship between labor given and labor received in bay oil distillation. Additionally, formal models show naturally occurring assortment mechanisms, such as living proximity or some dimension of friendship facilitates reciprocity (e.g., Hruschka and Henrich 2006; Ohtsuki et al. 2006). As such, living proximity or friendship should be predictive of whether or not a dyad exchanged labor in a contingent manner.

However, it is possible differences in cooperative abilities play an important role shaping farmer decisions to form reciprocal partnerships via the mechanism of competitive altruism. As argued in chapter one, when individuals vary in cooperative ability and actors can use others' level of altruism (McNamara et al. 2008) or reputations for altruism (Fu et al. 2008) as a choice criterion for interactions, then cooperation can evolve because actors compete to be more generous than others (Roberts 1998; McNamara et al 2008). This results in assortment of high quality individuals with one another. When high quality individuals are in rare in a

population, market forces of supply-and-demand will cause high quality altruists to be differently valued compared to low quality individuals. Because everyone desires high quality individuals for partnerships, high quality individuals should form larger audiences and more partnerships. However, as group sizes increase, signals can become muted or the probability altruists exist in the group increases. As such, when groups are large, individuals must increase the amplitude of the signal to outcompete others. If this is the case, 1) the amount of labor given to others will be a positive predictor of one's reputation for altruism; 2) reputations for altruism will predict group size; 3) as group size increases, people will send stronger signals of commitment to a CFAD by offering more days of labor; 4) the greater number of days an individual gives to a CFAD will increase his likelihood of forming a reciprocal partnership with the CFAD; however, 5) a quadratic relationship will exist between labor given and labor received across all dyads, as only a subset of all interactions will result in reciprocal partnerships; and 6) males with good reputations will be more likely to form same- and opposite-sex relationships.

Reciprocity Hypothesis 1: A positive rectilinear relationship exists between labor given and labor received - Two problems exist for any analysis of reciprocity: 1) datasets have perfectly correlated data points; and 2) analyses routinely violate the assumption of independence of errors for OLS regression (Gurven et al 2000). Dyadic data is perfectly correlated because the amount of labor given and received between "A" and "B" is perfectly correlated to the amount of labor given and received between "B" and "A." However, there is no natural ordering of these points. Choosing to use either person "A" or "B" as the receiver or giver removes information that is used for obtaining parameter estimates. As such, both are required for

analysis. However, structural auto-correlation caused by data redundancy can bias estimates of the second moments, negatively affecting type I errors of *t*-statistics, and thus rendering significance tests meaningless (Dekker Krackhardt, and Snjiders 2007). Furthermore, errors terms between data points can be correlated if the amount "A" gives to "B" is associated with the amount of work "A" gives to "C" because "A" has some common underlying property that causes him to be cooperative, such as, a gene for cooperation or a dimension of personality (e.g. extraversion). As such, multi-level mixed models are required to account for data auto-correlation (Rabe-Hesketh and Skrondal 2008). For the bay oil labor exchange data specifically, labor received took the form of a Poisson distribution, necessitating the use of a mixed-effects Poisson modeling procedure (implemented with STATA version 10).

When the random effects of dyad and the giver's ID are modeled, labor given has a positive, moderately significant relationship with labor received (Wald X^2=3.4; p=0.06; Log Likelihood=-416.7; Days Given: B=0.08±0.04).

Reciprocity Hypothesis 2: Naturally occurring assortment mechanisms facilitate contingent reciprocity - Spatial structure and friendships are naturally occurring assortment mechanisms. Spatial structure was operationalized as a dummy-coded presence/absence, living proximity variable (1=dyad live in the same hamlet; 0=dyad do not live in same hamlet). Friendship was operationalized as the "In Degree" relationship between two men (Hanneman and Riddle 2005) as evaluated by two peer-reviewers[1]. When living proximity and friendships are included in the multi-level mixed model with "days given," the model as a whole is significant (Wald

[1] Values ranged from positive one (peer reviewers agree two men are friends) to negative one (peer reviewers agree two men are not friends) in increments of 0.5. See section below titled, "Male Social Networks" for social network data collection and calculation.

X^2=31.0; p<0.0001; Log Likelihood=-257.2; N=176), both living proximity (B=0.9±0.2; z=4.4; p<0.001) and the presence of a pre-existing social relationship (B=0.6±0.2; z=3.02; p=0.003) predict labor received, while labor given has a significant negative effect (B-0.2±0.07; z=-2.7; p=0.008). The negative relationship between labor given and received is in the opposite direction predicted by contingent reciprocity. Using the "larger-is-better" information criteria, the second model appears more parsimonious. This suggests labor exchange is not based on a form of contingent reciprocity, but rather some other mechanism.

Competitive Altruism Hypothesis 1: Labor given predicts altruistic reputations - As was demonstrated above under the subheading "reputations," the amount of labor given to others was a positive predictor of his reputation for altruism (Figure 10). Altruistic reputations operate irrespective of age and are distinct from hard working reputations.

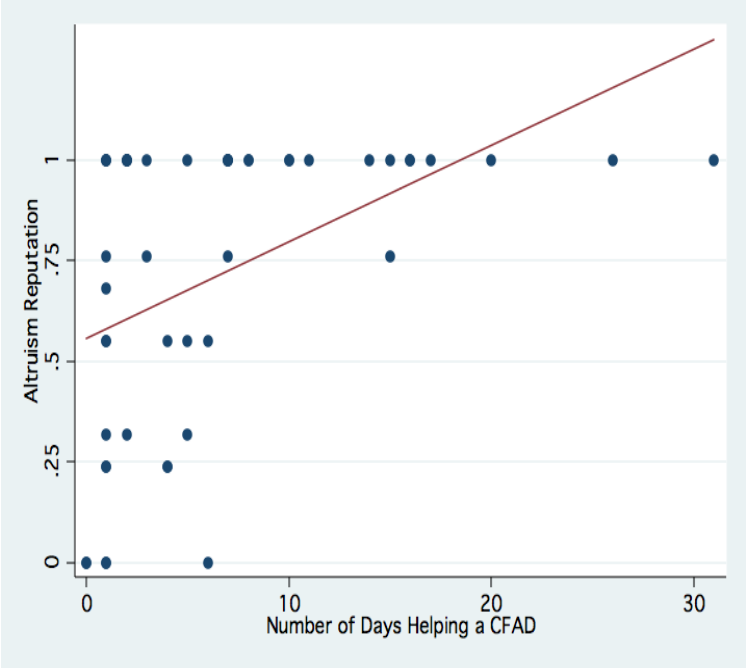

Figure 10: Relationship Between Number of Days a Person Helped CFADs and His Altruism Reputation.

Competitive Altruism Hypothesis 2: Altruistic reputations predict group size - When a CFAD distills more than a single batch of bay oil, group sizes may vary around that individual. To account for potential data autocorrelation, a generalized linear mix-modeling procedure was used with CFAD as the random component. Altruistic reputations predicted group size (B=1.2±0.35; z=3.43; p=0.001) (Figure 11). An independent analysis using the same random component reveals hard working reputations do not predict group size (B=0.23±0.13; z=1.7; p=0.09).

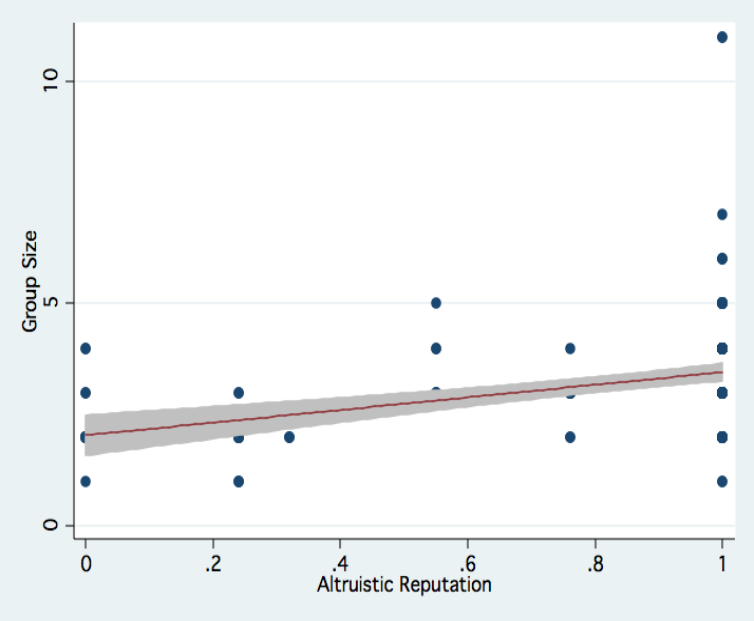

Figure 11: Relationship Between Altruistic Reputations and Group Size (Best Fit Line Includes 95% CI).

Because bay oil manufacture may represent a biologic market that operates via the mechanism of competitive altruism, number of males present per group may be a better indicator of the market for altruists compared to group size (which considers both males and

females). When age and female presence at a factory are included in a combined model with reputations to determine their effect on the number of male group members present, age is a positive predictor of the number of male group members present, female presence significantly decreases the number of males willing to assist, altruistic reputations are a significant positive predictor of male presence, while hard working reputations have no predictive power (Table 4). This model hints at the contextual nature of labor exchange practices, their effect on gendered relationships, and the market for social partners.

Table 4. HLM Multiple regression model explaining the number of males present per CFAD.

Model Statistics: Wald X^2=45.7; N=191; p<0.0001			
Predictor	**B(se)**	**z**	**P**
Constant	4.5(1.1)	4.1	<0.001
Age	-0.04(0.1)	-2.8	0.005
Female Presence	-1.3(0.2)	-5.3	<0.001
Altruistic Reputation	0.78(0.4)	1.8	0.045
Hard Working Reputation	-0.1(0.2)	-0.6	0.6

Competitive Altruism Hypothesis 3: Group Size predicts number of days given to a CFAD - A necessary condition for competitive altruism is that individuals actually compete to be more generous than others. To analyze this relationship I examined the maximum group size associated with each dyad (group size varies around a CFAD if he distills multiple batches of bay oil. If the same helper assists the CFAD multiple times, then group size will vary around each dyad). Maximum group size was chosen over minimum or average group size, because biological market theory specifically predicts the value of a currency to be directly proportional to the level of market competition (Noe and Hammerstein 1995; Barret et al. 1999). Larger group sizes should result in greater competition between individuals attempting to curry a CFADs favor, resulting in a bargaining war. Thus, the larger the group, the more labor others should offer a CFAD. This process ensures signal honesty because individuals must provide a

stronger signal (i.e. more cooperation) if they are to be chosen. A multi-level Poisson mixed effects model with "dyad" and "giver's ID" as the random effects components, shows maximum group size predicts days labor given to a CFAD (Wald X^2=5.8; B=0.1±0.04, z=2.4; p=0.02; N=288). This suggests males are calibrating the amount of labor provided to others based on its signal value, which is set by market forces for a particular CFAD.

Competitive Altruism Hypothesis 4: Greater days labor given to a CFAD or the Giver's Altruism Reputation increases the likelihood a reciprocal partnership forms - Reciprocal partnership was measured as a dummy coded contingency variable (dyad reciprocated labor contingently=1; dyad did not reciprocate labor contingently=0). A multi-level mixed model, with "dyad" and "giver's ID" as the random components, shows neither days labor given (Wald X^2=2.5; odds ratio=7.5±10.3; z=1.6; p=0.11; N=288), nor altruistic reputations (Wald X^2=0.05; odds ratio=0.4±1.6; z=-0.2; p=0.8; N=228), nor a combination of both (Wald X^2=1.5; p=0.5 N=228; Days Given: odds ratio=9.1±16.5; z=1.2; p=0.22; Giver's Altruistic Reputation: Odds Ratio=0.3±0.7; z=-0.5; p=0.6) predicts an increase the probability a reciprocal partnership forms. However, if living proximity is included in a combined model with Days Given and Altruistic Reputations, both days given and living proximity increased the probability of reciprocation (Wald X^2=12.3; N=228; p=0.006; Days Given: odds ratio=8.3±5.3; z=3.3; p=0.001; Living Proximity: odds ratio=20.7±32.0; z=1.96; p=0.05), while altruistic reputations do not (Altruistic Reputation: odds ratio=0.4±0.9; z=-0.4; p=0.7). Thus a synergistic effect appears at play: reciprocal partner choice in labor exchange is negotiated via signaling and facilitated by a naturally occurring assortment mechanism, as predicted by traditional models of contingent reciprocity. This analysis suggests the function of altruistic reputations (in this

population) is to attract larger group sizes, but is not a criterion for selecting reciprocal partners. The criteria for reciprocal partnerships appear to be the number of days given and living proximity.

Competitive Altruism Hypothesis 5: A curvilinear relationship exists between days given and days received - A multi-level, mixed Poisson regression model, with "Dyad" and "Giver's ID" as the random components, was used to evaluate if a quadratic relationship existed between labor given and received. When modeled as a quadratic relationship, labor given has a strong significant effect on labor received (Wald X^2=29.4; p<0.0001; N=288; Log Likelihood=-404.5; Days Given: B=-0.4±0.1; p<0.001; Days Given Squared: B=0.1±0.02; p=0.001) (Figure 12).

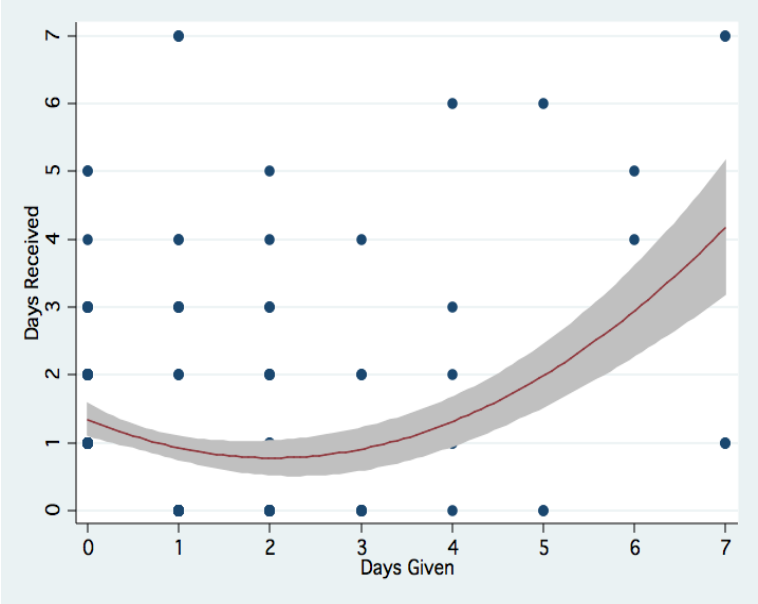

Figure 12: Quadratic Relationship Between Days Labor Given and Received (Best Fit Line Includes 95% CI).

To reaffirm the competitive nature of labor exchange, maximum group size was included in a combined model with "days given" and "days given squared" as independent variables, and "dyad" and "giver's ID" as the random effects components. This roughly asks the following question: "Does a CFAD receive more labor from any single person as the group size around that dyad increases, if we consider the effect of the CFAD giving labor?" The answer is yes. CFADs receive greater amounts of labor from a single individual if the maximum group size associated with that dyad increases and if the CFAD gave more labor to that individual (Table 5). Labor exchange appears competitive and the value of labor is based on the level of competition within the market (i.e. maximum group size), which varies by CFAD.

Lastly, the effects of living proximity were included in a model with the previous independent variables to determine their impact on days labor received. The model as a whole is significant (Wald X^2=46.8; N=288 $p<0.0001$). The amount of labor a CFAD receives is dependent on a quadratic relationship with days given (Days Given: B=-0.8±0.1; z=-6.0; $p<0.001$; Days Given Squared: B=0.1±0.02; z=5.2; $p<0.001$), and a positive rectilinear relationship with maximum group size (B=0.1±0.05; z=2.8; p=0.006) and living proximity (B=0.6±0.2; z=3.3; p=0.001). This analysis is consistent with the findings from the previous hypothesis. Many reciprocal partnerships do not materialize (as evidenced by the quadratic relationship). Giving a strong signal (many days of labor) in the presence of competition (maximum group size) increases the likelihood a reciprocal partnership forms. This process is facilitated by a second assortment mechanism predicted by models of contingent reciprocity: living proximity.

Table 5. HLM Multiple regression model explaining "The Number of Days Labor Received."

Model Statistics: Wald X^2=38.2; N=288; p<0.0001			
Predictor	**B(se)**	**z**	**p**
Constant	-0.2(0.16)	-1.4	0.2
Days Labor Given	-0.4(0.1)	-3.5	0.001
Days Labor Given Squared	0.1(0.02)	4.8	<0.001
Maximum Group Size	0.1(0.04)	2.5	0.01

Competitive Altruism Hypothesis 6: Men with better altruistic reputations will form more mixed and same-sex relationships - A positive relationship existed between altruistic reputations and the number of reciprocal partnerships a bay farmer formed (Poisson regression: Wald X^2=7.8; B=1.1±rse0.4; N=37; p=0.005) (Figure 13). However, the same was not true for men with hard working reputations (Poisson regression: Wald X^2=12.7; B=0.5±rse0.1; N=53; p=0.09).

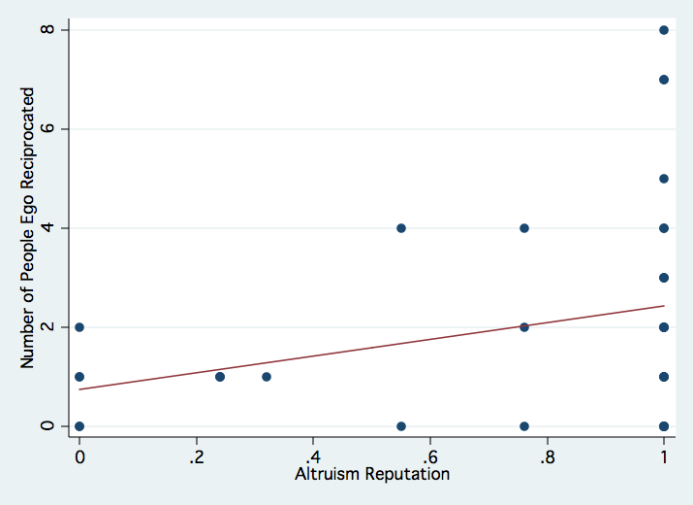

Figure 13: Relationship Between Altruistic Reputations and the Number of Contingently Reciprocal Partnerships Formed.

Logistic regression shows males are more than twice as likely to be romantically involved with a female if he has a reputation for hard working (Pseudo R^2=0.11; Wald=11.3;

z= 3.4; p=0.001; exp(B)=2.3; N=80) (Figure 14), but not altruism (Pseudo R^2=0.01;Wald=.54; z= 0.7; p=0.5; exp(B)=1.8; N=53). To control for the possibility that hard-working reputations simply are a proxy for wealth (in which case, females just prefer men who are more wealthy), both hard working reputations and number of days spent as a CFAD (which is a direct indicator of access to wealth) were included in the same model to determine their effects on conjugal partnership outcomes. Logistic regression shows men with hard working reputations are more than twice as likely to be associated with a conjugal partner, while days as a CFAD has no predictive power (Wald X^2=12.5; Pseudo R^2=0.11; p=0.002; Hard Working Reputation: Odds Ratio=2.2±rse0.7; p=0.008; Days as CFAD: Odds Ratio=1.0±rse0.1; p=0.8). The power of hard working reputations also operates irrespective of age (Wald X^2=12.7; Pseudo R^2=0.11; p=0.005; N=78; Hard working Reputation: Odds Ratio=2.2±rse0.7; z=2.6; p=0.01; Age: Odds Ratio=1.0±rse0.02; z=0.2; p=0.9; Days as a CFAD: Odds Ratio=1.1±rse0.3; z=0.3; 0=0.8). Thus hard-working reputations appear to affect *inter*-sexual partner choice, while altruistic reputations affect *intra*-sexual partner choice.

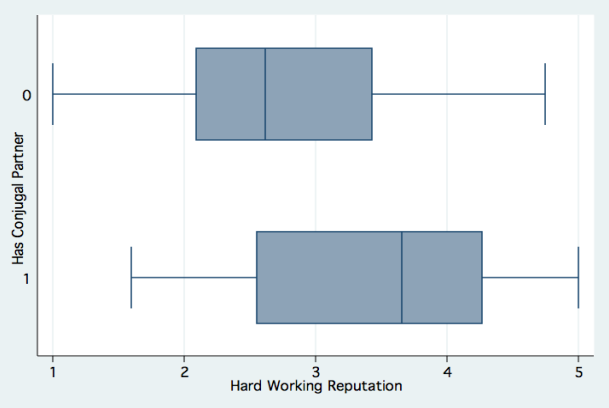

Figure 14: Relationship Between Hard Working Reputations and Presence of a Conjugal Partner (1=Has Conjugal Partner; 0=Does Not Have Conjugal Partner).

MALE SAME-SEX SOCIAL NETWORKS

Male bay farmer social network data was constructed using a peer rated pile sort task (Bernard 2002). Following Hanneman and Riddle (2005), a grouped ordinal scale of dyadic farmer relationships was created using laminated cards containing the name of individuals who were reportedly involved in bay oil production in 2007 (a total of 102 individuals). The author randomly selected 56 of the 102 individuals for social network evaluation. For descriptive statistics of the 56 individuals see, Table 6. Pairs of farmers were assessed as having a positive, neutral, or negative relationship. Two village members (one male, one female) rated men's social relationships over an eight-day period (four days for each individual). The peer rater was provided the name of a focal farmer and was asked to assess the relationship that existed between the focal farmer and all other individuals by placing the names each person into one of three piles (i.e., positive, neutral, or negative). Raters assigned individuals to a category using the following prompt: "If person X was in a time of need, would person "Y" provide assistance?" A positive rating indicated a person would always provide assistance. A neutral rating indicated a person might provide assistance, but only under certain conditions (e.g., if the person was asked directly by the focal individual). A negative rating indicated the person would never help the focal individual. The social categories were enumerated as follows: positive equals "+1," neutral equals "0," and negative equals "-1."

Table 6. Demographic Characteristics Associated with Social Network Data

	Age	**Hard Working Reputation**	**Altruism Reputation**	**Acreage of Land Used**
Mean (SD)	45 (13)	3.4 (1.0)	0.7 (0.4)	0.9 (1.0)
Median	43	3.5	0.8	0.5
Min	18	1.6	0	0
Max	80	5	1	5
Distribution	Normal	Normal	Normal	Poisson

Data analysis of social network characteristics was performed using the cultural consensus routine for ordinal level matrix data via UCInet software version 6.239 (Borgati, Everett, and Freeman 2002). Cultural consensus was achieved (ratio of the first two Eigenvalues=3.3 no negative competencies). Social network data was averaged via the method described by Hanneman and Riddle (2005), resulting in five ordinal categories ranging from positive one (both raters agreed person Y would help X) to negative one (both raters agreed person Y would not help X) in increments of 0.5. For frequencies and counts of the five social categories see Table 7. Univariate analyses reveal male social relationships in Bwa Mawego can be characterized as neutral to moderately antagonistic (Mean=-0.1±0.5; N=3080 observations).

Table 7. Frequency and Count of Male Social Relationship Types

	1	**0.5**	**0**	**-0.5**	**-1**
Frequency	7%	12%	47%	30%	4%
Count	219	376	1443	929	113

The relationship between labor exchange and personal social networks

As argued in chapter one, economic anthropologists hypothesize the exchange of labor in smallholder agricultural populations is embedded in the complex matrix of community social life. However, no empirical tests have attempted to demonstrate the effect size of this relationship. To determine this effect, matrix regression, using a quadratic assignment procedure (QAP) (Dekker et al. 2007), was implemented via UCInet 6.239. QAP permutes the data associated with the dependent variable for the purposes of constructing a null hypothesis – the null hypothesis being the test-statistic of association equals the expected value of the test-statistic under the permutation distribution (Dekker et al. 2007). The coefficients and statistics obtained by QAP are derived from the empirical sampling distribution under this null

hypothesis, with the sampling distribution accounting for structural auto-correlation in the data (Dekker et al. 2007). A significant positive relationship existed between labor exchange and whether two men were peer rated as likely to assist one another in a time of need (R^2=0.08; β=0.3; B=0.3±0.02; N=3080; p=0.0005). This confirms that labor exchange is tied to the social fabric of village social life; however, the effect size, although significant, is quite small.

The determinants of male same-sex social relationships in Bwa Mawego

As argued in chapter one, little empirical evidence exists concerning the nature of Caribbean male social relationships. However, qualitative ethnographic research suggests male relationships are predicated on living proximity, reputational matching, age matching, land access, and labor exchange (Wilson 1969, 1971, 1973; Dirks 1972). Because social network data exists in matrix form, matrix regression techniques (e.g. Dekker et al. 2007) are required to assess these propositions. However, many of the variables of interest exist as individual level demographic characteristics (e.g. "A" is 30 years old) and require some transformation to capture dyadic relationships. Altruistic reputations, hard-working reputations, age, and land access were transformed to reflect dyadic relationships by taking the absolute value of the difference between "A" and "B" along each dimension, respectively. For example, if "A" is 30 years old and "B" is 20, the absolute difference in age between "A" and "B" is ten years. Similarly, to capture reputational distance, the absolute value of the difference between individual reputations was calculated (e.g., if "A" has a reputation value of four and "B" a reputational value of three, they have a reputational distance of one). When matrix regression is performed on this type of data, negative coefficients indicate two individuals have a smaller absolute difference in that domain, while positive coefficients indicate greater absolute

differences. This conversion was performed for all 56 men, resulting in ($n\times(n-1)$) possible dyadic combinations (3080 combinations) per variable. These transformations cause matrices to contain redundant data and thus the possibility of structural auto-correlation. To account for this, the "Double Dekker, semi-partialing" method for multiple-regression quadratic assignment procedure (MRQAP) was used because it is robust to both data multi-collinearity and auto-correlation (Dekker et al. 2007).

No transformations were required for the variables "living proximity" (measured as dummy coded presence/absence variable: 1=both men live in same hamlet; 0=live in different hamlets) or "labor exchanged" as each has natural ordering within a matrix; however, living proximity suffers from data redundancy. Standards in social network analysis suggest labor exchange be ordered in the following manner: individuals identified by rows give labor to individuals identified by column (Hannamen and Riddle 2005). For univariate descriptive statistics for six of the seven variables under consideration, see Table 8. Because "living proximity" was dichotomized, calculating means and standard deviations has little interpretable value. Out of the 3080 possible combinations, 2544 dyads did not live in the same hamlet, while 536 did.

Table 8. Univariate descriptive statistics for social network analysis.

	Age Difference	**Labor Exchange**	**Reputational Distance: Hard Working**	**Reputational Distance: Altruism**	**Land Use Difference**	**Social Relation**
Mean (SD)	15 (11)	0.08 (0.5)	1.1 (0.8)	0.4 (0.3)	1.0 (1.0)	-0.06 (0.5)
Min	0	0	0	0	0	-1
Max	62	7	3.4	1	5	1
N	3080	3080	3080	2968[2]	3080	3080

MRQAP tests on the full suite of variables under consideration reveal men's social relationships are predicted by reputational matching, living proximity, land use discrepancy, and labor exchange, but not age matching (Table 9). The model explains 19 percent of the variance in male social relationships, suggesting other factors affect male friendships in this community. Reputational matching, living proximity, labor exchange, and land access operate as predicted: the closer two men exist in reputational and geographic space, and the more men exchange labor with one another, increases their peer-rating as friends. Greater discrepancies in land access between men predict a greater likelihood they have been peer-rated as friends

Table 9. Multiple regression model for Bwa Mawegan male social relationships.

Predictor	B(se)	β	P
Constant	0.06		
Altruistic Reputation Distance	-0.32(0.11)	-0.23	<0.001
Labor Exchange	0.18(0.17)	0.2	<0.001
Live in Same Hamlet	0.22(0.15)	0.18	<0.001
Hard Working Reputation Distance	-0.07(0.17)	-0.12	0.002
Land Use Difference	0.04(0.17)	0.09	0.048
Age Distance	0.0001(0.16)	0.003	0.5

Bargaining power and ego network size

As argued in chapter one, Caribbean ethnographers suggest male social relationships are ego-centered, that is, a series of individually managed relationships extending outward from a single individual and are based on stochastic work opportunities (Dirks 1972). Ego-centered social networks provide flexibility and allow for rapid decision-making in response to economic opportunities when they arise. Men with the greatest ability to generate wealth should have larger ego networks, as others will desire a relationship with them. The size of an individual's ego network was calculated using the "Ego Networks" routine of UCInet 6.239. Mean ego network size is 14 individuals (Median=13; SD=8.5; Min=0; Max=32; N=56). OLS

regression using robust standard errors, confirms men who have greater access to land to distill bay oil have the largest ego networks (R^2=0.16; β=0.4; t=4.2; p<0.001; N=56).

CHAPTER SUMMARY

This chapter reviewed the time frame and methods of data collection. It provided descriptive statistics for ten months of bay oil distillation and labor exchange practices in Bwa Mawego. Additionally, demographic characteristics associated with the sample populations were reviewed and used to test hypotheses concerning labor exchange and male social networks. Results indicate that labor exchange represents a biologic market for male relationships that is negotiated via costly signals of altruistic intent. The precipitate of this market is same-sex reciprocal partnerships. The formation of reciprocal partnerships is facilitated by a naturally occurring assortment mechanism predicted by traditional contingent reciprocity models: living proximity. However, females also are engaged in a market for male relationships, as reputations for hard working predict whether or not a man is partnered with a female in a conjugal relationship. Working as a CFAD signals competency (but not necessarily wealth through land access), which appears to be used by females for negotiating sexual relationships. However, giving labor to men signals cooperative intent, which is used by males for forming partnerships and friendships. This is the first quantitative dataset that demonstrates intra-sexual competitive altruism in a naturalistic human population.

Same-sex social relationships in Bwa Mawego, as analyzed through peer reports, suggest male relationships are on average, neutral to moderately antagonistic. When friendships are formed males assort along the dimensions of reputation, living proximity, labor exchange, and land access, but not age. Males with greater access to land resources have larger

ego networks as predicted by Caribbean ethnographers. This is the first quantitative account of Caribbean male, same-sex relationships. Results are discussed in the following chapter.

CHAPTER FOUR

DISCUSSION

This dissertation project sought to accomplish several goals: 1) determine the mechanism that allows labor exchange to operate in a smallholder agricultural society; 2) explain variation in labor exchange group sizes and demographic composition; 3) determine the effect size between labor exchange and non-labor social dynamics in a smallholder Caribbean society; and 4) identify the determinants of Caribbean, same-sex male social relationships. Each goal was motivated by either a lack of empirical data or sufficient tests of hypotheses. Although much ink has been spilled on the topic of labor exchange, only a single empirical test exists concerning the mechanism that underlies this phenomenon. Additionally, group sizes are known to vary within communities; however, few have attempted to explain the causes of such variation. Furthermore, most researchers agree a relationship exists between labor exchange and intra-community social dynamics; however, no effect size has ever been calculated. Lastly, Caribbean ethnologists agree labor exchange affects male, same-sex social relationships; however, few have attempted to situate this relationship within a broader framework of male sociality and none have tested the determinants of male sociality empirically. This project fills these knowledge gaps. The remainder of this chapter contextualizes labor exchange and Caribbean male same-sex social relationships within the theory of biological markets and its mechanism of competitive altruism, as well as with respect to known social and ecological conditions that occur within the community of Bwa Mawego. Additionally, this chapter reviews the study's limitations and offers practical suggestions for future research and public policy.

LABOR EXCHANGE IN BAY OIL DISTILLATION: A BIOLOGIC MARKET FOR MALE RELATIONSHIPS

Is labor exchange reciprocal? The answer to this question is "yes" and "no." Labor exchange in bay oil manufacture is reciprocal to the extent that men seek reciprocal partnerships and, in fact, some reciprocal partnerships occur. However, reciprocal partnerships in labor exchange do not emerge because of the mechanism of contingent reciprocity. If contingent reciprocity explained labor exchange, then any labor given to another should result in some positive amount of labor to be received contingently in the future. This result is not obtained as evidenced by the fact that only 28% of all dyads reciprocated labor in a contingent manner, causing a quadratic relationship to exist between labor given and received. Much of the labor that is given to others in the community of Bwa Mawego is never contingently reciprocated; however, some manage to negotiate reciprocal relationships. This begs the question: "Why do only some reciprocal partnerships emerge while others do not?" One theory in particular, Biological Market Theory, addresses this question.

Biological market theory (here after referred to as: BMT) proposes supply and demand forces that operate in human economic markets also operate in social and biological contexts (Noe and Hammerstein 1994, 1995). Markets exist whenever commodities (including reputations, individual abilities, or labor) are asymmetrically distributed in a population and gains can be made by commodity exchange. Commodity value is dependent on its supply and demand in the population. The extent to which market forces can affect a biological or social context depends critically on two assumptions: 1) commodities cannot be obtained by force (ensuring primacy of partner choice); and 2) cheating is effectively controlled (ensuring truth in advertising). When these conditions are met, BMT can become a powerful evolutionary force,

shaping mechanisms for evaluating differences in potential partners and preferences for specific qualities. Altruistic tendencies appear to be a quality shaped by biologic market forces, which has led to runaway selection pressures resulting in preferences for altruists and competition over access to them (Nesse 2007). It is this competitive context for altruism that gives BMT predictive power and maximum parsimony, as it provides a mechanism for integrating inter-sexual selection, inter-specific mutualism, and intra-sexual cooperation (Noe and Hammerstein 1994, 1995).

Competitive altruism describes a general competitive context in which signaling altruistic ability or cooperative intent may evolve as a mechanism for attracting cooperative partners (Roberts 1998; Barclay 2004). When individuals vary in cooperative propensities and actors have an ability to choose between individuals to form cooperative partnerships, then partner choice is known to have evolutionary consequences, such that preferences for altruists develop (Barclay 2010; Barclay and Willer 2007; Hardy and Van Vugt 2007) and competition over access to altruists ensues (Fu et al. 2008; McNamara et al. 2008; Barcaly and Willer 2007; Foster and Kokko 2006), resulting in asymmetries at the population level in cooperative partnership formation.

Competitive altruism also considers how competition intensity affects the level of investment in potential partners (Noe 2001). When an individual is in high demand (e.g. because they are the most altruistic), the level of competition between people to secure that individual also increases. High quality individuals are able to form larger audiences (Barret et al. 1999) and this leads to bidding wars between individuals who desire the high quality altruist. When bidding wars ensue, the altruist should select the individual that offers the best value. If this condition is not met, competitive altruism cannot operate because competitive

altruism requires greater altruistic action lead to some benefit – for example, partnership formation (Gintis et al. 2001). BMT, through the mechanism of competitive altruism, provides a rationale why cooperative relationships may develop asymmetrically in labor exchange.

Variation in cooperative abilities clearly exists in Bwa Mawego, as some men offer a large quantity of labor to others for bay oil distillation, while others offer little to none. The amount of labor one provides to others is directly related to his reputation for altruism. Individuals with better altruistic reputations form larger audiences when they themselves distill bay oil. According to BMT, when an audience is present, a CFAD must decide which of those individuals he will select for reciprocating labor. BMT suggests the CFAD should choose the individual(s) who offers the best price; however, the level of competition in the market determines price. Larger groups should induce greater competition and therefore higher prices. Indeed, this is found. CFADs who form larger groups receive greater amounts of labor per person, suggesting that males are calibrating the amount of labor given to a CFAD based on its signaling value. Individuals who offer the most labor to a CFAD should be chosen for partnerships because competitive altruism requires actors choose those individuals who either signal ability or have reputations for being high quality. If altruists are not chosen for partnerships, then altruism has no saliency and it should disappear from the population. In Bwa Mawego, CFADs are more likely to choose reciprocal partnerships with individuals who have provided the hard to fake signal (many days of labor) or who live in the same hamlet, but not necessarily with individuals who have the best altruistic reputations. Actions appear to have more value than reputations for the purposes of partner choice. That living proximity predicts the formation of reciprocal partnerships is consistent with models of contingent reciprocity, suggesting contingent reciprocity can emerge because of simultaneously operating assortment

mechanisms. This finding may provide a fruitful area of research for those game theoretic modelers who probe the boundaries of cooperation's evolvability. The biologic market for altruists in Bwa Mawego, in conjunction with living proximity, acts as a filtering mechanism, allowing high quality altruists to assort with one another, which permits the emergence of contingent reciprocity, but only for a subset of all dyads. Because a subset of dyads form reciprocal partnerships, labor given has a quadratic relationship with labor received. This is simply a mathematical consequence of many partnerships not forming and a few that do.

It is possible one could interpret the quadratic relationship between labor given and received as evidence for a combination of both contingent reciprocity and indirect reciprocity operating simultaneously in the population (Alexander 1987; Nowak and Sigmund 1998; Panchanathan and Boyd 2003). Indirect reciprocity is a mechanism for cooperation based on reputations for altruism, but requires agents never interact with the same partner twice (Nowak and Sigmund 1998; Panchanathan and Boyd 2003). Thus indirect reciprocity would predict when reciprocal partnerships do not form it is due to an individual helping another who is in good reputational standing. The results obtained in Bwa Mawego may be due to the population being comprised of two types of individuals each enacting one of two separate strategies (reciprocate contingently or use indirect reciprocity) or individuals facultatively switching between the strategies of reciprocating contingently or indirect reciprocity. Formal models exploring this scenario (Roberts 2008) show that both contingent reciprocity and indirect reciprocity can co-exist in the same population and remain stable under a variety of conditions. However, two features make this possibility unlikely in Bwa Mawego. First, individuals in Bwa Mawego do not fall discretely into one of two reciprocating types - actors reciprocate contingently with some individuals but not others (negating the first possibility). Secondly,

individuals in Bwa Mawego choose reciprocal partners based on the costly signal of cooperative intent (number of days given), but not reputations for altruism (see Chapter 3, subheading Hypothesis 4). If indirect reciprocity were an important mechanism for cooperation, then reputations for altruism should predict why reciprocal partnerships do not form. Thus indirect reciprocity cannot be a candidate mechanism for cooperation in the community of Bwa Mawego because reciprocating types are not present nor do altruistic reputations explain why reciprocal partnerships do not form. Altruistic reputations do have a function – it just happens to be that of group formation around a CFAD.

Lastly, competitive altruism predicts high quality individuals obtain more same-sex and/or between-sex partnerships (Barclay 2010; Gintis et al 2001). In Bwa Mawego, individuals with better altruistic reputations form more same-sex reciprocal partnerships, but not more between-sex partnerships. However, men with better hard-working reputations are more likely to form a conjugal relationship with females, suggesting that females prefer men who are considered more competent in bay oil distillation. This finding is consistent with anthropological and evolutionary psychological research demonstrating male reproductive success is dependent on competency in the culturally relevant economic context (e.g. Buss 1989; Smith 2004).

Interestingly, the number of males present per group who assist a CFAD is dependent on several contextual variables outside of CFAD altruistic reputation. CFAD's age and whether or not a female was present as a helper also predicted number of male helpers per distillation event. When a female was present at a bay oil distillation event as a helper, she was nearly always a CFAD's conjugal partner. Female presence in this capacity reduced the number of males present. One possible explanation for this phenomenon is men who work

with a conjugal partner require less assistance and therefore fewer men show up to help. On closer inspection, this logic is faulty, as some men form groups as large as eleven individuals. Because the community has a limited supply of females of reproductively viable age, males who work with conjugal partners may be signaling their exodus from the biologic market for same-sex male relationships. Opportunity costs in this environment may present a dilemma to men, either: 1) invest time and energy to develop an altruistic reputation that can be used to secure a large network of friends one can rely upon in times of crisis, but reduce investment in a conjugal partner and offspring; or 2) invest in a conjugal relationship, which leads to direct reproductive outcomes, but not necessarily a large safety net in times of crisis. Bwa Mawego is economically impoverished and bay oil distillation is the primary means for generating cash. To motivate male assistance, many people incentivize work with alcohol, tobacco, and food. Each of these can be expensive, and combined they decrease one's total budget available for other expenditures. Based on ethnographic interviews and firsthand experience in factories with men who work with a conjugal partner, men working with a conjugal partner do not incentivize labor with alcohol and tobacco. As such, males who distill bay oil with a conjugal partner may be attempting to maximize the amount of money available to their household; however, this strategy is likely to generate few males per distillation event and potentially, less help in times of need. Recent research from small-scale forager (Marlowe 2007) and forager-horticultural populations (Winking 2006; Winking et al. 2007) suggest a possible function of human pair bonds and male provisioning is to increase household productivity and/or joint reproductive outcomes (Quinlan 2008). The findings from Bwa Mawego are consistent with this research. Additionally, this interpretation suggests male gendered behavior is sensitive to context; not all males are marginal to the female-headed household. Some males may have a

substantial role in within-household social dynamics, especially, if they choose to leave the male same-sex social market behind. Future research should determine the extent to which Caribbean male marginality is dependent on asymmetries in the mating market in conjunction with asymmetries in sex-linked extrinsic risk (Quinlan 2006).

Lastly, younger men were able to form larger male audiences when they themselves distill bay oil. One possible explanation is younger men are novel additions to the male social relationship market. Those who already exist in the market may be sampling younger individuals' qualities to determine their respective value and the desirability of such men for partnerships. An alternative explanation is younger men simply have more friends, and thus a larger pool of individuals from which to acquire assistance. A post-hoc analysis of the male social network reveals younger men do have larger ego networks (R^2=0.11; β=-0.3; t=-3.14; p=0.003; N=56). However, if the impact of altruistic reputations is considered, altruistic reputations mediate the effect of age on network size, (Model R^2=0.41; p<0.0001; N=53; Age: β=-0.09; t=-0.9; p=0.4; Altruistic Reputations: β=0.6; t=5.4; p<0.001) suggesting this latter interpretation is incorrect (and by default the former, more plausible).

The fact that altruists are rated as having a greater number of people who would assist them in a time of need is consistent with research from anthropology and evolutionary social psychology which demonstrates people prefer altruists as social partners (Barclay and Willer 2007), prefer to bestow benefits upon altruists compared to non-altruists (Hardy and Van Vugt 2006), prefer to bestow rewards upon altruists in times of need (Sugiyama and Sugiyama 2003), and are more trusting towards altruists compared to non-altruists (Barclay 2004). Additionally, this result is consistent with the perspective that bay oil distillation represents a biologic market for male social relationships based on the mechanism of competitive altruism

(aside from the fact that it is an income generating enterprise). The exchange of labor in bay oil manufacture affects non-labor social dynamics.

LABOR EXCHANGE AND NON-LABOR SOCIAL DYNAMICS

The exchange of labor is tied intricately to the social fabric of village life as is evidenced by the social network analysis. A significant positive relationship existed between whether any two men engaged in labor exchange and whether they were peer rated as likely to assist one another in a time of need (R^2=0.08; β=0.3; B=0.3±0.02; N=3080; p=0.0005). Given the timing of the data collection (the social network was collected in 2007 and labor exchange data was collected between 2007 and 2008) a reasonable conclusion is men rely on pre-existing social relationships as a labor pool for bay oil manufacture. The relationship between a man's social network and labor exchange may best be represented as a feed-back loop, where men who are friends assist one another in labor exchange, which strengthens their bonds as friends, which increases the likelihood they will assist one another in the future.

The effect size of the relationship between labor exchange and male social relationships is quite small. This could indicate two possibilities: 1) the relationship between labor exchange and non-labor social dynamics has become weakened, due to an inefficient transition to wage labor; or 2) labor exchange has never been important for this community for developing non-labor social relationships. The latter seems unlikely given the history of labor exchange in this community and cross-cultural research that predicts a positive relationship between the two. The former appears more reasonable. Transportation from the community to larger commercial areas has become increasingly possible in recent years. A major force behind transportation to and from the community is the desire for wage labor opportunities in construction, the tourism

industry, and other commercial enterprises. The possibility of wage labor pulls people away from the community and situates labor into novel contexts involving individuals from outside the community. Thus it is possible the transition to a wage labor market has weakened the relationship between labor exchange and social relationships. However, since no baseline exists for this relationship, a firm conclusion is not possible. Thus an avenue for future research is to probe if and how this relationship changes in the future as a result of extra-community wage labor dynamics.

THE NATURAL OF CARIBBEAN MALE SAME-SEX RELATIONSHIPS

The nature of Caribbean male-same sex social relationships is an area of under-research. Outside of a few ethnographic descriptions, no empirical tests exist concerning the mechanism(s) that cause men to become friends with one another. Both Wilson (1969, 1971, 1973) and Dirks (1972) suggest age matching, reputation matching, labor exchange, living proximity, and land holding discrepancies are the basis for male sociality. The social network analysis indicates that each variable, except age matching, are criterion for same-sex male social relationships in Bwa Mawego. Men who had similar reputations for altruism and hard working, who had exchanged labor, who lived in the same hamlet, and who had greater discrepancies in access to land, were statistically more likely to be peer reported to assist each other in a time of need.

This analysis confirms Wilson's (1971, 1973) observations about men's peer groups - men are more likely to become friends if they have similar reputations. However, Wilson (1971, 1973) never specified the kinds of reputations men could accrue. This analysis suggests at a minimum, men assort based on reputations for competency and altruism in Bwa Mawego.

Do these two reputations exhaust the kinds of reputations that exist? The answer is "no." It is possible other kinds of reputations exist. However, very little theory or empirical observations suggest the total suite of reputations that could exist or the psychological underpinnings dedicated to processing such information. Identifying the totality of reputations that could occur may be an area for future research. A post-hoc analysis of the relationship between reputations and ego network size (i.e., the total number of individual relationships extending from an ego to others) demonstrates both types of reputations increase a man's ego network (Model R^2=0.45; N=53; p<0.0001; Hard Working Reputation: β=0.25; t=2.18; p=0.03; Altruistic Reputation: β=0.5; t=4.2; p<0.001), suggesting men value other men who are competent or altruistic. Although men become friends with other men who have similar reputations, men with better reputations have more friends overall.

The social network analysis also confirms both Wilson's (1969, 1971) and Dirks' (1972) observations that male social affiliations are based, in part, on living proximity. Men who live in the same hamlet have a greater likelihood of being peer reported to assist one another in a time of need. Additionally, men who live in the same hamlet are more likely to reciprocate labor. That living proximity predicts friendships and labor exchange is consistent with models of contingent reciprocity that show living proximity to be a naturally occurring assortment mechanism. However, this analysis does not answer the question of why such men live in the same hamlet. At least two possibilities exist: 1) men who have a pre-existing friendship may move to the same hamlet to be in closer proximity to one another so as to guarantee assistance when it is needed; or 2) men who happen to live in the same hamlet become friends because they are in closer proximity to one another and thus, in a better

position to determine each others qualities and behavioral propensities. Thus a future area of research may be to identify the motivations behind residential location.

This analysis confirms Wilson's (1971, 1973) and Dirks' (1972) observations that men's social relationships are adaptively flexible behavioral responses to economic insecurity and stochastic work opportunities. Men are statistically more likely to be peer reported to assist one other in a time of need if they have greater discrepancies in land access. That is, men who have greater access to land for bay oil manufacture are more likely to be friends with other men who have less land at their disposal. This suggests the presence of an incipient patron-client type relationship within the community (Dirks 1971), where men who have less access to wealth (because they have less access to land with which to manufacture bay oil) seek men who have greater access to wealth. Men who have greater access to land to distill bay oil have the largest ego networks (R^2=0.16; β=0.4; t=4.2; $p<0.001$; N=56). Men with greater access to wealth exist in a more favorable position to negotiate asymmetric rewards from the relationships that ensue (something predicted by Dirks 1971 and BMT – Noe and Hammerstein 1994). This analysis dovetails with respect to the interpretation that bay oil manufacture is an arena where males compete for high quality social relationships and social relationships are sensitive to relative bargaining power. Foreshadowing the sensitivity of male social affiliation to relative bargaining power, Dirks (1971: 575) states:

> The advantage accruing to the man who controls a scarce resource manifests itself in two ways. Such men are able to build very large and extensive personal networks. In addition, the person in control of scarce resources is in a position that is elevated and fortified by his material advantage. He is the dominant partner in his relationships with most other men in the community. Those who comprise his close group are his subordinates. His ties with others are clearly vertical, corresponding closely to the patron-client model of inter-personal relations…. The ranked dyads found in Rum Bay differ from the patron-client relationships of Latin American cultures in their lack of formality and pronounced deference.

Dirks (1971) pioneering functional analysis of Caribbean male same-sex social affiliation was prescient indeed of its relationship to BMT and competitive altruism.

Age matching does not predict friendships in Bwa Mawego, contrary to Horowitz (1967), Wilson (1969, 1971, 1973), and Dirks (1972). Horowtiz (1967: 32) suggested age matching as a likely mechanism for male affiliation because it is improper in some communities to give orders to individuals who are much older than the self. The fact that age does not predict social affiliation is interesting because it is a naturally occurring assortment mechanism. However, unlike living proximity, age matching has no saliency in this population. Although it is possible age matching is an important assortment mechanism in other Caribbean populations, this particular dataset cannot speak to these scenarios.

STUDY LIMIATIONS

There are several limitations to this project. First it is possible that the amount of contingent reciprocity occurring in this community is not accurately reflected by this particular dataset. This is a reasonable critique as any research using "snaphots" of daily life (albeit, this project's exposure time is ten months) are bound to miss contingent relationships that straddle the tail ends of the data collection time frame. Additionally, an underlying assumption of the data collection protocol is contingent reciprocity in labor exchange occurs "in-kind." It is the case that men in Bwa Mawego exchange labor for other services. Some examples of such contingent reciprocity that occurs not in-kind includes, using one's chain saw to cut wood in lieu of exchanging labor in a factory, or exchanging labor in bay farm fields for labor in factories. This begs the question: "If such data were obtained, would it change the results and

overall conclusions of the study?" This seems unlikely. Although such data would increase the likelihood of detecting within community contingent reciprocity, the weight of evidence supporting labor exchange as a form of competitive altruism is overwhelming. Furthermore, that competitive altruism operates in this community does not restrict contingent reciprocity's presence, as competitive altruism causes contingent reciprocity to occur (so does living proximity).

A second limitation concerns the data collection. In 2007, social network data was collected. Between 2007 and 2008 labor exchange data was collected. In 2008, hard-working reputations were collected. In 2009, altruistic reputations were collected. The results presented suggest reputations affect both the exchange of labor and male social networks. However, a more precise interpretation would be: reputations for altruism in 2009 predicted labor exchange between 2007 and 2008, and reputations for both hard working in 2008 and altruism in 2009 predicted the same-sex male social network in 2007. Neither theory nor evidence exists concerning how within-individual reputations change over the life-course. Based on the data presented here, age is not a predictor of either reputation; however this does not mean, reputations do not change over an individual's lifetime. A more appropriate data-collection strategy would involve collecting data on both reputation types in the same year. However, time constraints and opportunity costs did not all this for this project.

A third limitation of the study is it relied on peer-reviewed social networks. Although peer-reviewed social networks are considered valid techniques for estimating social relationships (Bernard 2002; Hanneman and Riddle 2005) one may rightly question how ego-estimated social networks might differently capture the relationship between social relationships and labor exchange. Collecting ego derived social networks was beyond the time

and monetary scope of this dissertation project. A valuable extension of this research project would examine ego-generated social networks in conjunction with peer-reviewed social networks.

Lastly, although this dissertation project demonstrates labor exchange in Bwa Mawego is a form of competitive altruism, it cannot definitively show that all labor exchange is competitive altruism. However this project does suggest anytime: 1) individuals in a population vary in cooperative abilities; 2) reputations for altruism can accrue; 3) people have the ability to choose others based on their abilities or their reputation for altruism; and 4) partner choice in labor or non-labor social relationships has reproductive consequences, then competitive altruism is bound to operate. Thus, when these conditions hold competitive altruism predicts labor exchange. When these conditions do not hold competitive altruism will not explain labor exchange.

PRACTICAL IMPLICATIONS

The community of Bwa Mawego is economically impoverished and is susceptible to a variety of economic and natural shocks that could adversely impact the community. Bwa Mawego relies on a single cash crop whose pricing is at the whim of global market forces beyond the community's control. One possible solution to reducing economic vulnerability is articulating bay oil manufacture with the incipient agro-tourism industry of Dominica. Several Dominican communities that rely on a single cash crop (e.g. coffee and cocoa) have generated revenue by articulating traditional agricultural practices with tourism. In these communities, local histories are captured through exhibits, hiking trails permit visitor access and improve labor routes for residents, and visitors can witness and purchase commodities created through traditional

agricultural practices. It may be possible to reduce economic vulnerability and increase income by tapping into this incipient mono-crop agricultural tourism industry. According the Ministry of Agriculture (personal communications, James Henry - Agricultural Officer, July 2008 and Dave Williams – Forestry Division, June 26th 2007) no community in Dominican that relies on bay oil manufacture has pursued such a possibility. However, a variety of issues need be considered before such a plan of action is pursued (e.g. community's desire for such an industry, how many visitors can a community endure without negative impacts, ability for visitors to access the site, and the preparedness of the community to develop and maintain the site as an attraction).

Bwa Mawego also is susceptible to a variety of natural disasters. Hurricanes, landslides, and the over-harvest of tropical rainforests are real threats in this community. Communities such as Bwa Mawego who rely on hillside agriculture and the clear-cutting of native tropical rainforest species for food or commodity production exist in a precarious position because soil stability on slopes becomes weakened. Rain, tropical storms, and hurricanes exacerbate the weakening of soil stability on slopes. As soil stability on slopes becomes weakened, landslides are more likely to occur. The occurrence of landslides is something village residents have witnessed in the past and fear in the future. Furthermore, village residents suggest the practice of forest clear cutting has increased the distance one must travel to secure wood to distill bay oil. Residents state many poor physical health outcomes are related to the distance one must travel while carrying heavy loads. A possible solution to both issues is generating funds to replace forest trees in areas that have been cleared.

Finally, the relationship between labor exchange and intra-community social dynamics should be monitored. Research suggests when communities transition from cooperative labor to

wage labor markets, within-community social dynamics can be adversely affected. When labor is situated outside the community, social interactions occur amongst people who are not part of village corporate group. As such, labor, the traditional mechanism for navigating social relationships, is no longer present. People increasingly withdraw from maintaining a dense network of individuals from within their community. When natural or economic disasters strike individuals have a reduced social support system they can rely on in times of crisis. The analysis presented here demonstrates within community labor is intricately tied to non-labor social dynamics; however, the overall effect size of labor and social relationships is small. This small effect may be indicative of community wide vulnerability to economic and natural shocks.

CHAPTER SUMMARY

There is a biologic market for male relationships in the community of Bwa Mawego. The contextual backdrop for this market is bay oil manufacture. Men signal men for same-sex, social relationships through the medium of labor exchange. Males also signal their competency to females by acting as a chief-for-a-day. Men who provide the most labor to others accrue the best reputations for altruism. Men with better altruistic reputations form larger groups. The more helpers in a group, the more men compete to be seen by the CFAD. Individuals displaying greater intent to a CFAD have a statistical likelihood to achieve a reciprocal partnership with the CFAD. Living in the same hamlet facilitates this process. Furthermore, the greater number of days a male acts as a CFAD, the better his reputation for competency. The better his reputation for competency, the greater his chances he is associated with a conjugal partner. Thus, altruists attain more same-sex social relationships, while competent

men are more likely to achieve a conjugal partner. The biologic market for male relationships is signaled through separate reputational systems that differently affect within-sex and between-sex social dynamics.

If two men were rated as likely to assist one another in a time of need, they also were more likely to assist one another in labor exchange. Thus labor and social relationships converge in this market. Men who were rated as having the largest ego networks were also rated to be the most altruistic, suggesting a preference for altruists. People who were rated to help each other in a time of need also were more likely to have similar reputations for altruism and competency. Discrepancies in land access caused men to have greater within-sex social affiliation, suggesting the presence of proto-patron-client type relationship.

Portions of this research suggest labor exchange is a fundamental organizing principle to social behavior in Bwa Mawego, while other sections foreshadow disaster because an inefficient transition to wage labor weakens the link between labor and social dynamics - a paradoxical situation to say the least. Reluctantly, this author concludes by reminding the audience that such is the situation of labor exchange even 55 years after Erasmus' (1955, 1956) pioneering work. Cooperative labor is forever weakening in the face of wage labor markets; however, it remains resilient because cooperative labor ties people to one another and to their shared cultural and economic history. Public policy and audience participation will dictate the pace and sensitivity of such change to external economic forces.

CHAPTER FIVE

CONCLUSION

The International Monetary Fund estimates about one-fifth of the world's population exists in a state of poverty (Khan 2000). More than half of this population (~63%) lives in rural areas and the majority of this group is smallholder cultivators (Khan 2000). To have any chance of effectively helping this segment of the rural poor, policies must be designed with regard to their specific economic contexts and social problems. A single policy is unlikely to act as a panacea, as the rural poor are multidimensional (Rosenberry 1989). However, a sustained effort to gather information regarding the particular problems communities face is an important starting point for tailoring economic and social programs (Khan 2000).

Many smallholder cultivators in the developing world rely on cooperative labor as an economic strategy to generate income (Moore 1975; Ponte 2000; Gilligan 2004). Labor exchange has remained the most common form of cooperative labor within this population over the past 60 years (Erasmus 1955, 1956; Moore 1975; Geschiere 1995; Ponte 2000). It exists despite the presence of wage labor markets, suggesting individuals prefer labor exchange to wage labor under certain conditions. Previously, researchers suggested cooperative labor strategies persisted in these populations because smallholder farmers were unresponsive to changing economic conditions (e.g., Rogers 1969; Hoffman 1996). Today, many transaction-cost economists and economic anthropologists agree that labor exchange remains viable because the rarity of cash and a lack of credit has caused transaction costs to outweigh the benefit associated with a transition to wage labor (Guillet 1980; Chibnik and de Jong 1989; Gilligan 2004). In addition to lack of cash and credit, the analysis presented here suggests

people continue to engage in labor exchange because within-community incentives, such as same- and between-sex social relationships, outweigh the benefits to extra-community wage labor opportunities. Individuals may rationally pursue labor exchange if it results in a safety net of within-community social relationships one can rely on in a time of crisis or if it impacts reproductive opportunities.

Smallholder cultivators in the developing world maintain within community exchange networks because they function to mitigate risk associated with natural disasters or economic shocks (Khan 2000). When communities transition to wage labor markets, social bonds, normally maintained by within community labor relationships, become weak or ineffective (Ponte 2000). When social bonds are weakened, rural communities have a reduced ability to absorb natural disasters or economic shocks (Khan 2000; Ponte 2000). If disasters or shocks occur and rural communities cannot absorb them, poverty can deepen and vulnerability becomes exacerbated (Khan 2000). Social networks created and maintained through labor exchange may play an important role for smallholder cultivators because they help mitigate risk. This is in agreement with ethnographic research demonstrating economic behavior of smallholder agriculturalists in the developing world tends to be risk averse (e.g., Kuznar 2001; Netting 1993).

Despite variation in ecology, culture, economic history, and regional politics, contingent reciprocity is assumed to be the mechanism that underlies labor exchange, and therefore is a fundamental principle of social affiliation in smallholder agricultural societies (Erasmus 1955, 1956; Horowitz 1967; Moore 1975). The implication is social relationships formed through labor exchange are motivated by a "tit-for-tat-like" dynamic. However, only a single paper (Hames 1989) imperfectly shows contingent reciprocity belies labor exchange. A lack of

statistical controls, and recent theoretical and modeling advances on the evolution of cooperation demanded a re-analysis of labor exchange. Knowledge of the motivational frameworks for behavior is important, as policy designed without regard to people's values and preferences are bound to fail (Tucker and Taylor 2007).

The Dominican community of Bwa Mawego is typical of many Afro-Caribbean populations: they are impoverished, practice hillside agriculture, have a matrifocal orientation, and many males exist in a state of economic and social marginality (Quinlan 2004; Quinlan 2006; Quinlan and Flinn 2003). Like most smallholder agricultural communities in the developing world, people in Bwa Mawego rely on labor exchange to generate an agricultural labor force.

Analysis of ten months of labor exchange data in Bwa Mawego's primary cash generating enterprise - bay oil distillation – does not support the argument that contingent reciprocity is operating. However, labor relations are embedded within the community's non-labor social dynamics, as bay oil distillation affects male-male friendships and male-female conjugal relationships.

In particular, I find *labor exchange* affects male, same-sex social relationships. This occurs through the mechanism of competitive altruism, not contingent reciprocity. Men compete through altruistic displays, attempt to be regarded as more altruistic than other men, and people use this competitive context to inform decisions related to reciprocal partnership formation. Labor exchange in bay oil manufacture is reciprocal to the extent that people desire reciprocal partnerships; however, only a subset of dyads actually form contingently reciprocal relationships (~28%). Whenever people vary in ability, ability affects reputations, and

reputations or ability are used as a choice criterion for partnership formation, competitive altruism is bound to operate.

The process of bay oil manufacture is energetically taxing and time consuming. Male residents of Bwa Mawego vary in their ability to assist others in this enterprise, which causes altruistic reputations to vary across individuals. Variation in altruistic reputations explains why group sizes vary between men. Men with the best reputations form the largest groups. There is greater competition in larger groups, which causes individuals to "outbid" one another to curry the favor of the chief-for-a-day (CFAD). Men who offer the best price (greater days of service) are more likely to be chosen by the CFAD for a reciprocal partnership. This signal cannot be faked, which ensures cheaters are excluded from invading this population and allows high quality individuals to assort with one another. Men desire reciprocal partnerships with altruists because partnering with an altruist leads to public and private benefits (Gintis et al. 2001). Private benefits are reaped through non-labor social relationships.

Reciprocal labor relationships affect non-labor social dynamics, as men who labor together are more likely to assist one another in a time of need. Men with better altruistic reputations form larger non-labor social networks; that is, altruists can rely on a greater number of individuals to assist them in a time of need. This is the first empirical evidence I am aware, that has calculated the effect size of the relationship between labor dynamics and male same-sex, social dynamics within a single community.

Labor is not the only criterion for male, same-sex social relationships. Men who have similar reputations for altruism and competency, who live in the same hamlet, and who have greater discrepancies in land access are more likely to be peer rated as friends. Men with greater access to land (and therefore wealth) are more likely to be friends with men who have

less access to land. This suggests the presence of a proto-patron-client type relationship in the community, a situation noticed in other rural Afro-Caribbean communities (Dirks 1972). Disproportionate resource holding power is known to affect social affiliation in a variety of taxa (e.g. Barrett et al. 1999). It is not surprising it also affects male, same-sex friendships in Dominica.

Laboring as a CFAD affects between-sex social dynamics. Male hard-working reputations affect conjugal partner outcomes. This further supports the notion bay oil manufacture is a biologic market for male relationships and tied to the social fabric of village life. Men with better hard working reputations are more than twice as likely to be associated with a conjugal partner. Additionally, when men work with a female in bay oil distillation (who is often a conjugal partner), the number of men who offer assistance declines. This may be indicative of a man leaving the market for same-sex social relationships and attempting to maximize household economic and reproductive outcomes. If this is the case, it provides an alternative perspective to Caribbean male gendered behavior and identity. Men who invest the majority of their time, energy, and income into same-sex social affiliation operate orthogonally to females, but not necessarily to long-term household economic functioning as the exchange relationship obtained through labor creates a safety net in times of crisis. Men whose preferences align with a conjugal partner may be more sensitive to household social functioning and economic decision-making; however if disaster strikes, a large social network may not exist. Thus, males have options for navigating risk and achieving reproductive outcomes in this community. Future research will hopefully reveal the conditions that cause men to take one strategy and not another.

SUMMARY

1) Competitive Altruism predicts labor exchange in communities when:

Theoretical Level

a. Individuals vary in ability

b. Individuals accrue reputations based on ability

c. People have choice over potential partners

d. Choice is based on "reputations" or "ability"

Data Analytic Level

e. A concave-up quadratic relationship exists between labor given and labor received

d. "Ability" predicts why dyads form reciprocal relationships, and

f. "Reputations" do not predict why dyads do not form reciprocal partnerships

2) Labor exchange in Bwa Mawego is a form of competitive altruism, not contingent reciprocity.

3) Competitive altruism acts as a filter and allows contingently reciprocal relationships to emerge for a subset of all dyads in Bwa Mawego.

4) Living proximity is another assortment mechanism that facilitates contingently reciprocal relationships in Bwa Mawego.

5) Labor exchange, living proximity, and reputations for altruism and hard-working facilitate male non-labor, same-sex social relationships in Bwa Mawego.

6) Discrepancies in land access also facilitate male non-labor, same-sex social relationships in Bwa Mawego.

7) Females prefer males who have reputations for competency in bay oil manufacture in Bwa Mawego.

8) When men work with a female (who is often a conjugal partner), the number of males who are willing to assist declines.

9) Labor exchange and the social networks that develop are an important strategy for smallholder agriculturalists in the developing world to mitigate risk in the face of economic shocks and natural disasters

10) This benefit may offset the cost of not obtaining wages.

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APPENDIX

A: *Sample Bay Oil Distillation Event*

5:55 AM

DJ, RM, and I arrive at Factory #2. Another, JL, is preparing to finish his third distillation event in three days. As JL bottles the oil from his third batch, DJ puts a plaster paste onto holes located on the still. I cut wood and place it in front of the kiln so it is ready to be placed into the fire.

6:10 AM

DJ and myself load the still with bay leaves. JL is assisting by placing firewood into the fire.

6:25 AM

JL and myself load the still with bay leaves. We notice the rim of the still is damaged and attempt to bend it back into place. JL is washing dishes we used to cook and eat food. I weigh several parcels of bay leaves.

6:40 AM

We wait for several minutes for the fire to attain a sufficient heat so the bay leaves can be compressed easier.

6:55 AM

JL offloads spent bay leaves into the ravine. DJ assists using a bamboo pole. RM makes a long wood pole for pushing wood into the fire.

7:10 AM

JL and I move spent bay leaves into the ravine. DJ and RM load bay leaves into the still (DJ hands, RM rams).

7:25 AM

JL finished cleaning the offloading area. All four of us takes turn loading the still.

7:50 AM

We finished ramming the bay leaves into the still, placed the lid onto the still and provided water to generate steam. I went back to the house for food supplies.

8:40 AM

We eat breakfast at the factory. JL and DJ patch holes in the still with plaster paste. JL gives water to the still because too much hot water vapor escaped from the holes in the still. We all rest for 10 minutes.

9:15 AM

DJ continues to patch holes in the still.

9:55 AM

JL's wife visits. Both leave. JL made three batches, but only filled one jerry can for of oil. DJ cuts wood. RM carries bwaden parcels. I carry wood.

10:35 AM

I weigh wood for one hour.

11:35 AM-12:05 PM

Everyone rests.

12:05-12:10 PM

I give water to the still.

1:20 PM

RM and I put wood into the fire and flour paste onto holes in can. We rested until 3:00 PM.

4:45 PM

I put water into the still for 5 minutes. Put wood to burn on the fire.

5:45 PM

We put water into the still. I then left for BW's shop for supplies: picked up alcohol, juice, flour, and cigarettes. Got caught in rain and waited at shop.

8:20 PM

Gave water to the still.

9:10 – 9:30 PM

DJ took turn to sleep. Pole holding still-door fell (still-door = access door allowing one to remove spent bay from still). We fixed the pole and door, then patched still with flour paste.

9:30 – 11:00 PM

Chopped wood and fed wood to fire with RM.

1:00 PM

AD arrived at factory to assist. DJ woke up and gave water to the still. RM and I took turns sleeping while AD and DJ worked.

5:00 AM

Awoke. Gave wood to fire. We cooked a pot of coffee. RM left.

6:00 AM

Off loading began. DJ, AD, and myself took turns offloading.

6:45 AM

AD left.

8:00 AM

Collected Oil. DJ and I left factory for home.