Social capital in rural Bangladesh: a critique from the gender perspective

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Contents

Abstract

This thesis analyses the effect of social capital networks on family planning decisions in the Matlab region of Bangladesh. Social capital literature has ignored important aspects of networks such as the role of power and gender subordination. Using social network analysis, we reveal the disparities in family planning networks. The results show that both men and women are likely to receive useful information on family planning through their networks; however, by comparison with the female networks, male networks are better equipped to provide information from diverse sources and are less likely to be constraining. The reasons behind these structural differences in male and female networks are explored using subgraph analysis at the dyadic and triadic level. The results suggest that ties between actors are governed by the prevailing gender norms and are likely to further reinforce the existing inequalities in these social networks. The limitations of social capital in the patriarchal society of Bangladesh are further emphasised by analysing the role of social capital networks on women's contraceptive decisions. Consistent with the social capital literature, the results show that women are more likely to use contraceptives if they are in contact with other users. Nevertheless, one of the main factors determining women's contraceptive use is not social capital but the cultural preference for a male child; furthermore, female networks are likely to encourage behavioural conformity in the choice of contraceptive method rather than provide support for individual decision making. Incorporating gender into the analysis thus reveals the limited and contradictory nature of social capital, and this exhaustive analysis cautions against investing in social capital in gender blind terms.

Statement from candidate

This work has been conducted to meet the requirements of the PhD program at Macquarie University. This study has not been previously submitted to any other institution or University to attain a degree. Any material that belongs to other individuals or institutions has been acknowledged in the text. A reference list containing the material cited is also provided. Ethics approval for this work was attained on 15th Jan 2007, reference: HE24NOV26-D04940.

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Bhanu Bhatia

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1. Introduction

Social capital has emerged as one of the most popular concepts in the social sciences in the last two decades and promises to explain everything from children's health (Carter and Maluccio 2003) to national growth (Putnam, Leonardi and Nanetti 1993). Its magical appeal is such that it manages to penetrate disciplinary boundaries. It is also extremely popular with development organisations such as the World Bank. Some of its proponents claim that social capital has powerful 'positive social effects' (Putnam 2000, p. 23), is a 'glue that holds societies together' (Serageldin and Grootaert 2000, p.44) and can 'confront poverty and vulnerability' (Woolcock and Narayan 2000, p. 226). These bold claims are, however, made without any consensus on what exactly is meant by social capital. The search for the meaning of social capital results not in one clear idea but a list of concepts such as norms, trust, networks, civic community, institutions, and solidarity, which are all linked to social capital in one way or another.

Its most admired proponent argues that social capital comprises 'features of social organization, such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions' (Putnam, Leonardi and Nanetti 1993, p. 167). In Putnam's (1993) work, social networks form the bedrock of social capital. He proposes that dense networks of association promote trust and norms of reciprocity which lead to mutually beneficial action. Moreover, the benefits deriving from dense networks are not limited to interacting parties but spill over to practically everyone through the generation of social trust. Even though Putnam's (1993, 2000) work forms the basis of many contemporary social capital studies, it raises more questions than it answers. Putnam (1993, 2000) fails to clarify how we should measure trust and norms. How is interpersonal trust related to the trust in community, nation, and other nations? How do norms and trust interact with society and institutions? Even the most tractable component of social capital, social networks, has been confused with terms such as 'solidarity

groups' (Rankin 2002) and associated with beneficial outcomes. Obvious problems of exclusion, peer pressure, power, conflict, exploitation, inequality, and discrimination in networks have been conveniently ignored (Fine 2001, 2003).

Even more perplexing is the fact that women continue to be absent in the studies of social capital, as if gender plays no role in the formation of ties and the distribution of resources deriving from social networks. Previous research on this issue shows that women are more likely to be excluded from powerful male networks (Norris and Inglehart 2006; Lin 2000). Even when women do gain entry into men's networks, they participate on discriminatory and unequal terms (Katungi, Edmeades and Smale 2008; McGuire 2002; Lin 2000; Caiazza and Gault 2006). Furthermore, networks between women, which are often embedded in discriminatory social space, are likely to reinforce gender ideologies that disadvantage women rather than provide resources to challenge discriminatory practices (Silvey and Elmhirst 2003; Mayoux 2001). Thus 'what may be positive social capital for men…can be experienced as social constraint or a burden by women' (Silvey and Elmhirst 2003, p. 876). While providing resources to women to 'confront poverty and vulnerability' (Woolcock and Narayan 2000, p. 226), networks may be instrumental in holding women to the very position of vulnerability. Social capital theory provides little recourse in dealing with these contradictions.

This thesis builds on the gender critiques of social capital (Silvey and Elmhirst 2003; Mayoux 2001; Molyneux 2002; Rankin 2002) and shows that the one-dimensional notion of social capital is essentially flawed by undertaking a case study of men's and women's family planning networks in Bangladesh. Bangladesh forms part of what has been described 'a belt of classic patriarchy' (Kabeer 1988, p. 95). Common to all patriarchal systems are norms of female subordination (Kabeer 1988). Solidifying the patriarchal system further are the norms of 'purdah', which are strictly adhered to by most women in Bangladesh. Although 'purdah' refers to women wearing

concealing clothing, in practice 'purdah' acts as an institution that restrains women's mobility outside of the domicile and keeps them economically dependent on men (Kabeer 2000). The practice of purdah and associated seclusionary practices start as early as the age of eleven for most rural women in Bangladesh and are reinforced by family and kin throughout their lives (Aziz 1994). In this context, social capital is often recommended as a resource for women's empowerment (Larance 1998; Dowla 2006). This thesis does not deny the importance of social networks in a context where women's mobility is restricted, but rejects the solely positive view attached to networks in the social capital literature. Unlike previous gender critiques of social capital in developing countries (Rankin 2002; Silvey and Elmhirst 2003; Mayoux 2001), which mainly provide qualitative evidence of the gendered patterning of networks, we adopt a quantitative approach.

This study uses family planning discussion networks to demonstrate issues of power, conflict and inequalities in networks using tools of social network analysis. A study of family planning networks is chosen, as fertility issues are central to the lives of most women in Bangladesh (Bhatia 1981). Women's wellbeing is not only dependent on meeting the desired fertility, they are also the main carrier of the burden of fertility regulation. Family planning is also an important policy area from the perspective of the government of Bangladesh and high population growth is recognised as one of the biggest problems facing national development in Bangladesh (Ministry of Health and Family Welfare n.d). In response to the population concerns, the Bangladeshi government and many international donors have put in decades of effort into lowering fertility rates across the country. Despite all efforts, Bangladesh's fertility rates have been slow to change in recent years (NIPORT et al. 2009). Although the total fertility rate (TFR) fell from 6.3 in 1975 to 2.7 in 2007 (NIPORT et al. 2009), Bangladesh is still far from achieving its earlier goal of replacement fertility by the year 2010 (Ministry of Health and Family Welfare n.d). Our study of

male and female family planning networks contributes to the family planning literature in Bangladesh while calling into question the treatment of networks in the social capital literature.

We begin by outlining the conceptual and measurement difficulties associated with social capital literature in Chapter 2 and discuss the gender omissions of social capital in detail. While this discussion points to the inadequacies of social capital as a concept, it also shows the importance of incorporating networks in studies of behaviour in developing countries. However, we argue that social capital is an inadequate tool for analysing the complexities of the social world because it ignores the negative effects of social networks. Instead, we call for the employment of the tools of network analysis to tease out the complexities of networks. Evidence is also presented on demographic studies that back the usefulness of network analysis techniques in studying family planning choices in developing countries.

The discussion of the literature is followed by an introduction in Chapter 3 to the context of the Matlab region of Bangladesh, where the data for this study was collected. Matlab region was selected because of a unique and long standing health intervention that mainly targets women in one half of the area, commonly referred to as the 'treatment area'. The other half of the Matlab region is served by the conventional government program operating in most regions of Bangladesh and is referred to as the 'non-treatment area'. Incorporating villages from both 'treatment' and 'non-treatment' areas allows us to study any possible changes in social capital resulting from the intervention. Chapter 3 also describes the data for this research, which was collected using structured surveys that provide information on demographic and socio-economic characteristics, as well as information on men's and women's family planning networks in Matlab.

Using the tools of social network analysis, we undertake a structural analysis of men's and women's family planning networks in Chapter 4. The structural analysis reveals that both men and women are likely to derive social capital from networks by receiving informational benefits through networks. The make-up of male and female ties is fundamentally different. Women are

embedded in dense and disconnected substructures, whereas men are embedded in sparse structures and are connected to nearly everyone in the network through bridging ties. This implies that information flow is likely to be less inhibited in men's networks than in women's networks. Furthermore, since women are embedded in denser networks, they are likely to face greater pressures in these networks compared to men. The issue of the unequal distribution of power is also found to be more acute in women's networks. Decades of health interventions which have introduced women to many outside influences in the treatment area have had little effect on the underlying structure of ties in the studied communities. The results show that women face fewer opportunities and greater constraints in networks as compared to men and therefore a gender blind view of social capital is unjustified. But the analysis fails to identify how these differing network structures emerge.

We investigate the processes of networking that lead to the observed network structures in Chapter 5, using the concepts of transitivity, homophily and the role of 'purdah' norms. Transitivity argues that people will try to achieve balance in their relationships such that if i sends a tie to j, j sends a tie to k, then there will also be a tie from i to k (Valente 2010). Transitivity is analysed to test the structural properties of balance in the formation of ties. Homophily, on the other hand, looks at the content of social relationships. According to the homophily principle, ties are more likely to be formed between people of similar attributes (McPherson, Smith-Lovin and Cook 2001). We investigate the role of gender norms in tie formation by studying the spatial arrangements of connections. The results show that although transitive and homophily are important aspects of female tie formation; their explanatory power is limited to the boundary of the household. The spatial arrangements show that most relationships between women are formed within the norms of 'purdah' which discourages women's mobility outside of the domicile. Men's networks, on the other hand, are not restricted to the household or the village. Like the women's networks, transitivity is found to be important in the men's networks, but

homophily could not be tested due to the lack of data on male attributes. Nevertheless, the results show that ties between actors are governed by the dominant gender norms of 'purdah' that continue to disadvantage women by restricting their mobility. These networks are, therefore, likely to further reinforce the existing inequalities rather than provide capital to alter discriminatory gender ideologies.

Finally in Chapter 6, we test the effect of social capital on the contraceptive choices of women. The analysis shows that women in the treatment area adopt modern methods of contraception at a greater rate than women in the non-treatment area. This difference is not explained by different stocks of social capital but rather by differences in the quality of services in the two areas. In the absence of adequate services in the non-treatment area, women turn to their social networks for advice on family planning, but the network effects on family planning adoption are limited. The analysis also reveals that women in the non-treatment area are less likely to use modern methods if they do not have a son, whereas these effects are negligible in the treatment area. The strong cultural preference for male children in Bangladesh has been previously noted in the literature (Chowdhury and Bairagi 1990; Pitt et al. 1999), and the analysis suggests that in the absence of motivation from family planning program workers, women are more likely to be concerned with cultural norms. This is not to suggest that in the treatment area women are not concerned with meeting the desired fertility rate, but the higher contraceptive prevalence rate suggests that they are more willing to use modern methods to control the timing and pace of births. Possession of social capital simply does not translate into greater choices for women and needs to be supplemented with social and economic change. An analysis of contraceptive method choice further shows the limits of the concept of social capital. The results show that contraceptive method choices in the non-treatment area are strongly associated with the network partners' choices but only weakly correlated in the treatment area. Despite high stocks of 'solidarity networks' women in the non-treatment area imitate their network partners' choices rather than

use social capital to obtain information on the methods most suitable for their individual needs. This again shows the limitations of the social capital concept and suggests that networks are more constraining than liberating for women in this context.

Using the evidence presented in this research, this thesis cautions against the gender blind treatment of social capital. Through this research we also contribute to the demographic literature in multiple ways. This research is the first ever in Bangladesh to provide a view of men's family planning networks and a study of networks under differing programmatic settings. As far as we are aware, this research is the first attempt to apply the tools of social network analysis to a study of contraceptive method choice in Bangladesh.

2. Social Capital, Networks and Family Planning

Recent work in development economics recognises that under conditions of extreme poverty, a lack of real social security and an under-developed market system, many people in developing countries depend on their social relationships for basic services such as access to information, credit and insurance (Conley and Udry 2001; Morduch 1999; Fafchamps and Lund 1997). In the economic literature, these social relationships have been characterised as 'social capital', a concept that has been justly criticised for its vagueness, theoretical difficulties (Fine 2003) and exclusion of important social attributes such as power, particularly gender inequality (Molyneux 2002). Nevertheless, development economists are encouraged to use the term and aid agencies, notably the World Bank, have begun to use it extensively (Molyneux 2002). The aim in this chapter is to canvass some of the limitations of 'social capital' as a theoretical and empirical construct, especially from the point of view of gender. The review shows that that 'social capital' is an inadequate analytical tool which fails to capture the complexities of the social world. Instead, the research proposes the use of social network analysis to measure and analyse the role of social relationships.

In a society such as Bangladesh in which women's mobility is limited and major health decisions are taken in accordance with traditional practices, the advantages of information obtained through networks can be invaluable. Given women's limited independence in the patriarchal society of Bangladesh, however, social approval by husband, family and kin-based networks can also be major hindrances. Social network analysis helps to bring out these contradictory effects which are simply ignored by social capital theorists. To demonstrate the importance of the approach taken in this research, this chapter introduces the existing literature on family planning which employs the tools of social network analysis to study network effects on fertility.

Theoretical and empirical issues of the social capital concept

What is this thing called social capital?[1]

The concept of social capital derives its current popularity from the publication of the book *Making Democracy Work*[2] (Putnam, Leonardi and Nanetti 1993), which has been identified as being one of the most cited contributions of the 1990s in the social science literature (Fine 2001). In this work, social capital is used as one of the variables to explain regional differences in economic performance in Italy. The work concludes that social capital is not only important in explaining institutional performance and regional growth in Italy but is an essential ingredient of a well-functioning democracy. Since the publication of this book, hundreds of journal articles and many books on the topic of social capital have appeared. Social capital has also become popular in development policy (Cleaver 2005) and has found its way into project designs of the World Bank. The World Bank website states:

> Increasing evidence shows that social capital is critical for societies to prosper economically and for development to be sustainable. Social capital, when enhanced in a positive manner, can improve project effectiveness and sustainability by building the community's capacity to work together to address their common needs, fostering greater inclusion and cohesion, and increasing transparency and accountability (World Bank n.d).

Despite all the attention, however, the very definition of social capital, its name and the way it is used has been a matter for debate. Researchers continue to propose and adopt different definitions of social capital to the extent that it has evolved to mean different things to different people. This section reviews the work of some prominent scholars of social capital and

[1]The term 'social capital' has a quite different history deriving from the institutionalism of Veblen, but we confine our discussion here to the modern, essentially neo-classical version.

[2] This work has been published in the name of three authors, Robert D. Putnam; Robert Leonardi and Raffaella Y. Nanetti. However, Robert D. Putnam clarifies in the preface of this work that the arguments developed in this book are mainly his and the other authors do not bear responsibility for the material. Consequently, the names of all three authors are acknowledged while referring to the book. But only Putnam is credited with the arguments and analysis appearing in this work. This is indicated as Putnam (1993).

demonstrates this definitional chaos.[3] The conceptual shortcomings of these definitions are also identified, and they raise serious doubts about the usefulness of social capital as an analytical concept.

Putnam, Leonardi and Nanetti (1993) define social capital as 'features of social organization, such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions' (p. 167). Social capital is seen as productive, like other forms of capital, since it facilitates spontaneous cooperative action amongst individuals allowing them to meet certain objectives. To provide an example of this, Putnam (1993) argues that informal savings institutions called 'rotating credit associations' found in various parts of the world are able to successfully undertake savings and lending activities only by drawing heavily on social capital. The rotating credit associations operate on the principle that all members contribute on a regular basis to a fund which is provided to each member in rotation. Members are expected to continue contributions until everyone has had the chance to receive funds. These associations function on the understanding that all members meet their obligations and do not drop out after they have received the funds. Members are therefore carefully chosen on the basis of their reputation for honesty and reliability, information on which is often acquired through networks. The risk of non-payment is further eased by strong social norms against default. These norms have been found to be so powerful that members who are unable to meet their obligations 'are reported to have sold daughters into prostitution or committed suicide' (Putnam, Leonardi and Nanetti 1993, p. 168). Thus social networks and norms enhance cooperation by providing useful information about individuals, increasing the flow of information and reducing opportunistic behaviour.[4] Putnam (1993) further links social networks to mutual trust. In the case of rotating credit

[3] Since social capital means different things to different people, it is necessary to look at the concept from the perspective of individual researchers.

[4] Putnam (1993) argues that networks foster a variety of norms that enhance cooperation without providing a comprehensive list; however, norms of reciprocity are of primary importance in his work.

associations, new members may join an existing group by borrowing trust through social networks – 'I trust you, because I trust her and she assures me that she trusts you' (Putnam, Leonardi and Nanetti 1993, p. 169).

Trust is further identified as an essential component of the concept of social capital since it increases the likelihood of cooperation and is needed for all economic transactions where explicit contracting is either impossible or extremely costly. Trust is seen to be created by norms of reciprocity and networks. Horizontal networks amongst peers are expected to generate information about trustworthiness and thus reinforce such behaviour by providing incentives to be trustworthy. Frequent interactions amongst people in horizontal networks are also likely to develop norms of acceptable behaviour such as norms of generalised reciprocity which are reinforced in these relationships. This generalised reciprocity refers to a belief that 'a benefit granted now should be repaid in the future' (Putnam, Leonardi and Nanetti 1993, p. 172). Communities with a strong norm of generalised reciprocity, it is argued, effectively deal with problems of collective action and restrain opportunism, hence generating 'social trust'. These ideas are summarised by Putnam (1993) as follows:

> Voluntary cooperation (like rotating credit associations) depends on social capital. Norms of generalized reciprocity and networks of civic engagement encourage social trust and cooperation because they reduce incentives to defect, reduce uncertainty, and provide models for future cooperation. Trust itself is an emergent property of the social system, as much as a personal attribute. Individuals are able to be trusting (and not merely gullible) because of social norms and networks within which their actions are embedded (Putnam, Leonardi and Nanetti 1993, p. 177).

Dense horizontal networks are emphasised as being most effective in promoting these norms of generalised reciprocity and social trust, since such networks can be easily regulated. Furthermore, the above conceptualisation of social capital is not restricted to specific interacting individuals but

is extended to communities; thus, social capital emerges as a public good with positive externalities. In a later work, Putnam (2000) clarifies these ideas further. He asserts that:

> social capital also can have "externalities" that affect the wider community, so that not all the costs and benefits of social connections accrue to the person making contact…a well-connected individual in a poorly connected society is not as productive as a well-connected individual in a well-connected society. And even a poorly connected individual may derive of the spillover benefits from living in a well-connected community[5] (Putnam 2000, p. 20).

Putnam (1993, 2000) observes that social capital has powerful 'positive social effects' (Putnam 2000, p. 23) and is both a 'private' and 'public' good (Putnam 2000, p. 20). The role of generalised reciprocity is central to translating interpersonal networks into a public good. According to Putnam (2000), dense networks encourage norms of generalised reciprocity not just between interacting individuals but also in the broader community, forming the basis of social trust.

In summary, the idea emerges from Putnam's definition that social capital is related to networks, norms and social trust that assist in promoting mutually beneficial action. Networks, norms and trust, however, are different concepts (Dasgupta 2005) with definition and measurement-related problems of their own. For example, a network is 'an interconnected group of people who usually have an attribute in common' (Productivity Commission 2003, p. 10). On the other hand social norms are 'shared understandings, informal rules and conventions that prescribe or modulate certain behaviours in various circumstances' (Productivity Commission 2003, p. 9). Such a broad definition of social capital essentially embraces too many concepts under one heading and

> encourages us to amalgamate strikingly different objects…beliefs, behavioural rules and such forms of capital assets as interpersonal links (or 'networks'),

[5] Reduced crime rate due to cooperation amongst neighbours is offered as one of the examples of such positive externalities. Everyone benefits from such cooperative efforts, even if certain individuals do not contribute.

> without offering reasons as to why such an inclusive definition would prove useful for our understanding of the social world (Dasgupta 2005, S.2-S.3).

Moreover, if we are willing to include norms, trust and networks, then why should we exclude other social attributes that contribute to mutually beneficial action? Putnam (1993) also argues that social capital generates positive externalities. This is evident from the very definition of social capital which only constitutes those 'networks, norms and trust that can improve the efficiency of society' (Putnam, Leonardi and Nanetti 1993, p. 167). However, this leads to a circular argument since social capital is identified by its effect (Portes 1998; Sobel 2002); for example, 'a successful group succeeded because it has social capital, but the evidence that it has social capital is its success' (Sobel 2002, p. 146). One can overlook this problem by assuming that networks, norms and trust will always lead to good outcomes, thus the issue of circular logic does not arise. Nevertheless, networks, norms and trust may lead to undesirable outcomes for the society and/or for individual members. Inefficiencies created by colluding firms for the purposes of price fixing are mostly possible by establishing trust in networks. Although such activities clearly benefit the firms involved, they have negative effects on the society as a whole. From the definition of social capital, 'it is not clear what is different between rent seeking and social capital, except you downplay the one you do not favour' (Fine 2003, p. 595). A network is also likely to be exclusionary, such that 'some people will be connected while others will not' (DeFilippis 2001, p. 792). Further, the benefits of networking in exclusionary groups may not only be restricted to insiders but might come at the cost of individuals outside the group (Sobel 2002).

In his later work, Putnam (2000) recognises the negative aspects of social capital and as a remedy offers the notion of bonding and bridging social capital. He classifies dense networks between homogenous groups as bonding social capital, and ties amongst diverse individuals of differing social standing as bridging social capital. Bonding social capital is thus linked to exclusive

networks and bridging social capital to inclusive networks. Bonding networks are identified as being essential for creating social support and harnessing reciprocity. On the other hand, bridging networks are identified as being more useful for accessing assets. Stocks of bonding and bridging social capital may be distributed unequally between rich and poor and Putnam (2000) admits this, but instead of addressing social and economic inequalities in networks, Putnam (2000) states that 'under many circumstances both bonding and bridging social capital can have powerfully positive social effects' (p. 23).

Participation in certain dense and homogenous groups may also encourage risky and harmful behaviour by their own members. Drug addiction and group crime are examples of such behaviour whereby individuals are persuaded into destructive behaviour by group members (Quibria 2003), yet the harmful effects of peer pressures in groups have been conveniently ignored by Putnam (1993) in favour of well-functioning and harmonious groups. This overly-simplistic notion has nothing to say about power struggle and conflict amongst the group members.

Participation in group networks may also create norms that encourage conformity and restrict individual freedom (Portes 1998). Another extreme case of the negative effect of norms can be identified from Putnam's (1993) treatment of social capital. He describes how rotating credit association norms against defection can lead to suicide or the sale of daughters into prostitution by members who are unable to meet their obligations, which is clearly not a desirable outcome for the individual or society if prostitution is considered to be a problem (Putnam, Leonardi and Nanetti 1993). Despite this, Putnam (1993) continues to treat norms against defection as a social good.

An even more puzzling definition of social capital is offered by rational choice sociologist Coleman (1988) who states that:

> Social capital is defined by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structure, and they facilitate certain actions of actors – whether person or corporate actors – within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible. Like physical capital and human capital, social capital is not completely fungible but may be specific to certain activities. A given form of social capital that is valuable in facilitating certain actions may be useless or even harmful for others (S98).

Following this rather vague definition, Coleman (1988) identifies various forms of social capital. These include trustworthiness of the social environment, information flow in networks, norms and effective sanctions and obligations.[6] This list of different forms of social capital can be endlessly extended given Coleman's definition of social capital, which can include anything as long as it facilitates action amongst actors. Further identifying social capital by its function leads to similar issues of circular reasoning identified in Putnam's (1993) work. An example by Portes (1998) helps to clarify this point:

> Saying, for example, that student A has social capital because he obtained access to a large tuition loan from his kin and that student B does not because she failed to do so neglects the possibility that B's kin network is equally or more motivated to come to her aid but simply lacks the means to do. Defining social capital as equivalent with the resources thus obtained is tantamount to saying that the successful succeed (p. 5).

Following this vague and faulty conceptualisation of social capital by Coleman (1988), social capital could be anything and even include both its causes and effects (Portes 1998, 2000). Further, like Putnam (1993), Coleman (1988) stresses the positive effects of social capital. As an example, he cites the wholesale diamond market in New York which is predominantly controlled by the Jewish community. In this market, traders readily exchange stones with one another for

[6] Obligations are thought of as outstanding credit slips which are gained through doing favours, so an individual who has high levels of obligations outstanding has more social capital.

the purposes of inspection at private leisure without any system of formal insurance. This allows for quick and smooth functioning of the market without the baggage of costly systems of insurance. For Coleman (1988), such efficient trade in this market is possible because of close and dense connections which enhance trustworthiness between traders (primarily due to sanctions) or because of high social capital, but Coleman (1988) fails to question the basis of these solidarity networks. As Fine (2001) points out, such a treatment ignores the fact that the diamond market in New York is linked to the longest standing cartel organised by de Beers to control prices. It is unlikely that traders would continue to operate in the same trusting manner if the cartel was broken (Fine 2001); thus, the main basis of solidarity in the New York diamond industry could be in the profits from price fixing rather than close connection. Such negative features of social capital are mostly ignored in Coleman's (1988) analysis. To be fair, Coleman (1988) mentions the negative aspects in the definition and in some parts of the text; however, the main aim of his article is to draw attention to the benefits of social capital, especially as a resource for persons. This position is also evident in a later work in which he worries about the loss of social capital and argues that both sociologists and society have failed to recognise this 'problem' (Coleman 1993).

Fukuyama (2001), another proponent of social capital, argues that:

> Social capital is an instantiated informal norm that promotes cooperation between two or more individuals. The norms that constitute social capital can range from norms of reciprocity between two friends, all the way up to complex and elaborately articulated doctrines like Christianity and Confucianism. They must be instantiated in an actual human relationship: the norm of reciprocity exists in potentia in my dealings with all people, but it is actualized only in my dealings with friends (p. 1).

The central idea in this definition is that instantiated informal norms are social capital as long as they promote cooperation. Fukuyama (2001) lists norms related to honesty, reliability and reciprocity as examples of norms that generate social capital. He argues that whether or not a

certain cooperative norm constitutes social capital depends on the social group in question, and norms of trust towards family members and distrust towards outsiders cannot form the basis of social capital outside the family. Fukayama's (2001) treatment thus recognises that certain cooperative norms between individual groups may generate negative externalities, and it is therefore argued that to capture the effect of social capital at an aggregate level, its true utility should be measured net of its externalities. Given this definition, however, it would be impossible to measure social capital at any level. Norms are hard enough to quantify (Durlauf and Fafchamps 2004) without introducing the notion of their utility, which is a matter of subjective judgment. Fukayama (2001) himself recognises this problem but does not address the issue in detail. Instead, in a subsequent article, Fukayama (2002) argues that societies have different stocks of social capital and this affects their growth potential. This claim is made without providing much empirical evidence that convincingly captures Fukayama's (2002) notion of social capital.

A more radical, but less recognised, treatment of social capital is provided by Bourdieu (1986) who defines it as:

> the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition—or in other words, to membership in a group—which provides each of its members with the backing of the collectively-owned capital…The volume of the social capital possessed by a given agent thus depends on the size of the network of connections he can effectively mobilise and on the volume of capital (economic, cultural or symbolic) possessed in his own right by each of those to whom he is connected (pp. 248-249).

Social capital is thus a resource arising from group membership (such as family groups, select clubs and voluntary associations). For Bourdieu (1986), it also has an individual component. The amount of social capital possessed by an individual depends on the number of connections (formed through membership of a group) that the individual can mobilise. Also included in the individual's social capital is the amount of resources held by the connections which an individual

can access because of an established relationship. For Bourdieu (1986), these relationships in the group are not a natural given and are established by investment in economic and cultural resources that are undertaken individually and/or collectively to produce lasting relationships for future benefits. These benefits arising from membership of a group are seen as the basis of group 'solidarity which makes them possible' (Bourdieu 1986, p. 249). The definition thus clearly separates social capital from its effects (Portes 2000). Social capital arises from resources embedded in social relationships and should be actively mobilised in order to acquire material and informational benefits (Portes 2000). Bourdieu's analysis also includes dense networks of association as social capital but links it to the resources possessed by the members of the group. Consequently, solidarity networks without any resources do not constitute social capital (DeFilippis 2001).

Unlike Putnam (2000) and Coleman (1993), Bourdieu (1986) is not concerned about the decline of social capital. He sees social capital as a function of social class, because its acquisition is dependent on class-determined economic and cultural capitals.[7] This is assured by the exclusionary tendencies of groups. Bourdieu (1986) argues that membership of a group is restricted to ensure the preservation of group identity. Groups aim to bring together 'individuals as homogenous as possible in all pertinent respects in terms of existence and persistence of the group' (Bourdieu 1986, p. 250). In his work, social capital is directly linked to exclusion which provides the basis for reproducing social inequalities.

The focus on exclusion, homogeneity of group members, group solidarity and durable relationships leaves little room for weak ties, such as acquaintances, in social capital (Lin 1999). This is especially limiting because extensive evidence shows that individuals acquire useful information through weak ties (Granovetter 1973; Lin, Ensel, and Vaughan 1981; Rogers and

[7] Cultural capital includes cultural goods as well as immaterial forms such as mental disposition.

Kincaid 1981). A study by Granovetter (1973) on labour markets helps to clarify this point by discovering that a significant proportion of people find their new job through a contact who they rarely meet. Although important in job searching, these contacts were found to be marginally included in the job changer's current network and were often maintained through chance meetings or through friends. Extensive evidence collected by Burt (1992) also shows that greater returns are derived by actors playing brokering roles between networks rather than through membership in dense groups. According to Bourdieu's (1986) definition, such weak ties and brokering connections would not qualify as social capital since these relationships may not be durable and between homogenous groups of people. Despite these omissions, Bourdieu's (1986) work on social capital is theoretically most refined (Portes 1998) and clearly accounts for social inequalities, yet it remains largely ignored by research on social capital.[8]

The definitions discussed so far provide a variety of different meanings for the term 'social capital', making it difficult to understand social capital in any consistent fashion. Linking social capital to any one definition is made more complex by the fact that none of its treatments comprehensively addresses all the theoretical issues underpinning the concept. Despite the shortcomings of these definitions, scholars have continued to adopt any one of them, or have proposed a definition of their own and called it 'social capital'. This has caused definitional mayhem in the field and different concepts such as networks, norms and trust have all come to be called 'social capital'.

Norms and trust are not only difficult to measure, but their generation or obliteration is influenced by growth, law, government, historical context, and so on (Dasgupta 2005). None of these issues are handled in the theoretical literature in any detail, which leads to measurement

[8] Although Bordieu is recognized in critiques of social capital (Fine 2001, Fine 2003, Portes 1998, Quibria 2003, Cleaver 2005), his work is rarely referred in numerous empirical applications of social capital.

problems. The only element of social capital that is comparatively more tractable (Dasgupta 2005) and is studied by all scholars is social networks, but here, too, the social capital literature (except for Bourdieu's work) has ignored the negative consequences of networks and associated them with positive win-win situations. This has resulted in the measurement of positive group effects of social capital, leading to conclusions that social capital is good. Not only is this reasoning tautological (Portes 1998; Durlauf and Fafchamps 2004), it also conceals the problematic issues of power, conflict, exclusion and gender in networks. Networks can simultaneously act both as a resource and a constraint; for example, women in developing countries may receive useful information from their networks, but at the same time these networks may reinforce gendered patterns of behaviour that disadvantage women (Silvey and Elmhirst 2003). These issues are not handled in either the theoretical or empirical literature on social capital. The next section seeks to draw out the difficulties associated with the empirical literature on social capital before turning to the little studied problems of social capital in relation to gender.

Measurement issues related to social capital

Just as there is no consensus about what social capital is, so there is also no consensus about how to measure it. The scholars' measures of social capital are based on their individual understandings of the concept. The only common theme in this literature is that it tries to estimate at least one of the commonly identified aspects of social capital – networks, norms or trust. Various proxies are used to capture these aspects of social capital, which are measured separately or together, and these measures of social capital are then used to explain a variety of different outcomes ranging from household expenditure to the growth rates of nations. According to Putnam, social capital research provides evidence that 'where trust and social

networks flourish, individuals, firms, neighbourhoods and even nations prosper' (Putnam 2000, p. 319).

The claims about the explanatory power of social capital, however, should be approached cautiously. By undertaking a review of the empirical literature on social capital, this section shows that the quantitative measures of social capital are employed in an 'elastic' fashion (DeFilippis 2001), without any analytical rigour. The flexible nature with which the concept of social capital is employed, both in measurement and the choice of outcomes it seeks to explain, makes it very difficult to understand and employ social capital measures in any consistent fashion. This section seeks to establish these points using prominent empirical studies in social capital research. This is by no means an exhaustive review of the empirics of social capital because the literature is far too broad and excellent studies on this subject have been previously conducted (for more details, see Fine, 2001; Durlauf and Fafchamps, 2004; Durlauf, 2002). More importantly, the main findings can be established without going into extensive detail.

The most influential empirical work on social capital was published in the book *Making Democracy Work* (Putnam, Leonardi and Nanetti 1993). In this work social capital, defined as networks, norms and trust, is argued to be a key variable in explaining regional differences in economic growth in Italy. The regional variations between the more prosperous northern Italy and the less wealthy southern Italy during the period 1970 to 1990 are studied. The research found that, during this period, the northern regions in Italy had more vibrant networks and norms of civic engagement which facilitated cooperative action and generated trust, while southern regions suffered from vertical relations organised around authority and dependency, were less able to solve problems through collective action, and had lower levels of trust. In other words, the northern region enjoyed high social capital whereas the southern region suffered from social

capital deficits. The greater endowment of social capital amongst the northerners is argued to have enabled them to ensure good governance leading to a higher growth rate. To provide an empirical basis for the argument, Putnam (1993) measured social capital in the two regions using a variety of measures including newspaper readership, availability of sports and cultural associations, turnout in referenda and prevalence of preference voting. Other measures such as timeliness of budgets, legislative innovation, and bureaucratic responsiveness were used to capture institutional performance or good governance. Information was also collected through surveys on the level of satisfaction with regional government from residents in the two regions. The authors found that the relatively rich northerners not only had higher levels of social capital but rated better in the institutional performance indicators and also reported being more satisfied with their local government. Thus, the research concluded that social capital leads to better institutional performance which leads to greater levels of satisfaction with regional government and hence better economic outcomes (Putnam, Leonardi and Nanetti 1993).

The results on Italian social capital were extended further in a subsequent effort by Helliwell and Putnam (1995) published in the Eastern Economic Journal. Using the same data and similar variables of social capital as Putnam, Leonardi and Nanetti (1993), the research conducted time series analysis to demonstrate the effect of social capital on per capita GDP in different regions of Italy. The results showed that during the 1960s and 1970s, the economically less developed regions in Italy were able to catch up and achieve similar GDP per capita as the more developed regions (as predicted by the convergence theory). Having more social capital was found to further accelerate the convergence process, but in the 1980s this trend was reversed, which coincided with regional government reforms in Italy. During the 1980s, the richer regions in the north were found to grow at a much faster rate and the same flattening income gaps between richer and poorer regions was not observed. The authors argued that the reasons for this could again be

attributed to varying levels of social capital. Regions with higher social capital in the north were better able to utilise the benefits of regional reforms and thus grew at a faster rate, while others with lower levels of social capital in the south lagged behind. Indirect evidence from surveys on citizen satisfaction with regional governments was found to support the hypothesis that the regional reforms were more successful in the northern regions with higher social capital. Evidence showed that after the reforms, people in the north with higher social capital had an increased level of satisfaction with regional governments compared to people in the south. However, the analysis conducted by Helliwell and Putnam (1995) and Putnam (1993) can at best be suggestive due to unaccounted factors that may affect growth and social capital simultaneously and hence bias the results (Portes 1998); for example, economic prosperity or even expectations of future growth may lead to a more active and participatory community. Furthermore, people in regions with better governance are likely to be more optimistic and hence take a keen interest in politics and communal life. Since not all these factors are controlled in these studies, the results can easily be spurious. Despite these shortcomings, Putnam maintains that social capital is the 'key to making democracy work' (Putnam, Leonardi and Nanetti 1993, p. 185).

The enthusiasm over linking social capital with important macro outcomes is not limited to Italy, but the approach has been extended to make cross country comparisons by Knack and Keefer (1997). This study argues that the two components of social capital, trust and civic cooperation, are significant determinants of growth. These effects can operate through a variety of channels. Trusting societies help to reduce transaction costs amongst trading parties, free time for innovation for employers by reducing the time spent on constant monitoring activities of employees, suppliers, etc., and reduce the dependency on formal institutions to enforce agreements. Trusting societies are also more likely to attract greater investments due to greater trust in government officials and policy pronouncements. Norms of civic cooperation are argued

to affect economic growth by reducing collective action problems in societies, as these norms can reduce self interested behaviour by encouraging cooperative behaviour and placing sanctions on defecting individuals.

To provide empirical evidence of trust and cooperative norms on growth, Knack and Keefer (1997) analysed survey data on 29 countries from World Values Surveys (WVS). To capture trust, they used answers to the question 'generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?' It is, however, unclear which aspects of trust this variable captures and how this question was interpreted by respondents in countries with different cultures (Sabatini 2005). The implications of using responses to such a general question on trust across national borders were not explored in extensive detail and this variable was asserted to be a semi-reliable measure of social trust in the society. Further cooperative norms in societies were measured using responses to a set of five questions that ask whether certain behaviours such as 'avoiding fare on public transport' can be justified. The results show that 'trust' and 'civic cooperation' were significant variables in explaining growth in income and investment-GDP ratio during the period 1980-1992, where both 'trust' and 'civic cooperation' were tested together as well as separately. Knack and Keefer (1997) also found that the effects of trust were stronger in poorer countries, but even if the measurement difficulties associated with capturing 'trust' and 'civic cooperation' are ignored, these results are far from satisfactory. As was the case in studies by Putnam (1993) and Helliwell and Putnam (1995), the role of other factors such as policy reform, institutional performance, effective leadership and crime rate cannot be ruled out in this study. Although these effects are difficult to quantify and control, they are likely to affect growth, trust and civic cooperation simultaneously and thereby bias the results.

Knack and Keefer (1997) extended the cross country analysis further to include the effects of associational activity, another component of social capital, on economic growth. The authors argue that membership in groups can help encourage cooperative behaviour and solve collective action problems. However, if the interests of members of different groups' conflict with each other, the overall group effects on economic performance could be negative. The groups can also try to secure benefits for themselves at the cost of the society by lobbying activities. These positive and negative effects can counteract each other or the overall effect can be negative or positive. Using WVS data, the study investigated which of these effects dominated. To capture associational activity, they used the average number of groups per respondent per country. They found no evidence of a significant relationship between membership in groups and economic growth or investment. In fact certain groups had a negative effect on investment. What's more, they found no evidence between membership in groups and greater levels of trust as suggested by Putnam (1993).

Newton (2001) provides further evidence to dispute the findings of both Putnam (1993) and Knack and Keefer (1997). These latter studies argue that social capital positively affects political outcomes by enhancing government performance. In addition, Knack and Keefer (1997) state that social trust can lead to increased trust in governments and policy pronouncements made by governments. Using data from World Values Surveys, and using a similar variable of trust as Knack and Keefer (1997), Newton (2001) shows that there are no tight linkages between this generalised level of social trust and trust in political institutions in either developed or developing countries.

Despite the contradictions and methodological difficulties, social capital concepts are applied in many micro level studies in which Putnam's work is often used to provide theoretical and

empirical guidance. These micro level studies are also heavily influenced by an earlier attempt of Coleman's (1988) in which he argued that social capital facilitates the creation of human capital of the next generation. In this study, children's intellectual development is argued to be heavily influenced by social capital inside the family as well as in the community. This idea is illustrated using a data set of 4000 students from public schools. The social capital of the family is argued to be represented by the relationship between children and their parents and other members of the family. Single parent households were perceived as being structurally deficient in social capital and this variable was used to measure a lack of social capital in the family. Even if both the parents were present, the child might still suffer from social capital deficits if the child-parents relationship was not strong. To capture the strength of relationship, the number of siblings present in the household and the mother's expectation of a child going to college were used as proxies of social capital. Numbers of siblings were used to capture the lack of attention per child and hence lower levels of social capital. Community level measures of social capital were captured using the number of times the family had moved and the type of school the child attended (families sending children to religiously-based private schools were assumed to be part of a community organised along religious lines and therefore to have more social capital). All of these variables were then used to explain the differences in high school dropout rates.

Coleman's results showed that, after controlling for other family resources, the percentage of students dropping out was higher for single parent households and those with four siblings (compared to households with one sibling), and lower if the mother expected the child to go to college and if the family had high levels of community social capital. Although Coleman defined the relationship between the children, parents and other members of the family as social capital available to the child in the family, no explanation is offered as to why the relationship between siblings is not part of the stock of child's family social capital. Further, a mother's expectation

about her child's schooling is unlikely to capture the independent social effects of a child's upbringing on schooling and may be endogenous in this model, since parents are likely to motivate their children for higher education if they believe that such efforts will pay off in the future (Dasgupta 2005). The results also show that frequently talking with parents about personal experience, another proxy of social capital in the family, has no relation to dropping out. Coleman recognises that the results do not provide an adequate test of the effect of social capital but blames this on data difficulties, without providing any clues as to what would be suitable indicators for measuring social capital. He simply adds, 'taken all together, the data do indicate that social capital in the family is a resource for education of the family's children, just as is financial and human capital' (Coleman 1988, S113).

Coleman's (1988) ideas about family social capital are further challenged by Bianchi and Robinson (1997) using data on the daily activities of children under the age of 11 years in California. The study analysed the amount of time children spent doing homework, reading activities and watching T.V. The study assumed that if children spent more time on reading activities, they would perform better in academic environments. On the other hand, too much time spent watching TV is assumed to have a negative effect on children's development. The results show that the most significant predictor of time spent on reading activities and studying by children is high educational attainment by the parents. Part-time work by mothers is found to reduce the amount of time children spend watching TV compared with children whose mothers are at home full-time. Single parent families, presumed to be structurally deficient in social capital by Coleman (1988), were not found to have a significant effect on any of these outcomes. The number of children, again a measure of lower social capital in Coleman's (1988) work in the household, was in fact found to have a positive effect on children's reading and studying time.

The lack of consistent and well-defined measures of social capital by Coleman (1988) in his micro-level analyses, coupled with questionable analysis employed by Putnam (1993) at a macro-level, leaves the door open for many more vague constructions of the concept. These efforts have found their way into innumerable micro level analyses in developing countries, further increasing the confusion over social capital measures and its effects. Some key studies are described below to indicate the general findings.

Social capital is employed by Narayan and Pritchett (1999) to explain household income in 87 Tanzanian villages. To measure social capital, this study constructed an index of village level associational life which included several dimensions of group participation. The index was constructed by combining responses on the frequency of group membership and group characteristics – kin heterogeneity of membership, income heterogeneity of membership, group functioning, group decision making, and voluntary membership. Their results showed that expenditure per person for each household (their proxy for income) in the village was positively related to social capital. The study found that a 'one-standard-deviation increase in village social capital…is associated with at least 20% higher expenditures per person in each household in the village' (Narayan and Pritchett 1999, p. 890). It is important, however, to note that the measures of social capital were constructed using some very strong assumptions; for example, the authors assumed certain groups to be more social than others, as illustrated below:

> we assumed that being a member of each group made a greater contribution to social capital if the group was more heterogeneous across kinship groups, more inclusive and horizontal, and *better functioning*. Hence the contribution of each group to social capital is an equally weighted subindex of these three characteristics (p. 877, emphasis added).

According to these assumptions, if associational life leads to well-functioning groups then it is social capital. On the other hand if groups are functioning poorly then it is not social capital. The

approach selects positive aspects of associational life to generate positive effects without critically engaging with the negative aspects of associational life. Even if we accept this approach, how do we select good groups from bad ones in future research? Do we run a test on groups and assume that if the results are positive then it must be social capital? Or do we make certain assumptions about the usefulness of groups to the society? Surely this cannot provide us with a test to prove that social capital largely leads to beneficial outcomes.

The work of Narayan and Pritchett (1999) is further expanded by Grootaert (1999) in his study on social capital and household welfare in Indonesia. He argues that different aspects of association will determine the effectiveness of social capital in the form of local association. Six measures were employed to capture different dimensions of social capital: density of association, internal heterogeneity index of the organizations, frequency of meeting attendance, members' participation in decision making, payment of dues and the community orientation of organizations. This work constructed a similar index to that of Narayan and Pritchett (1999) in order to measure social capital using responses to frequency of membership and six different dimensions of group participation, and tested its effect on household income. The effect of different dimensions of social capital was also tested separately. The results show that social capital is a significant and positive determinant of household income levels, and that the density of association, the internal heterogeneity of the associations and the degree of active participation in decision making are the most important aspects of participation. Although this provides an empirical basis from which to choose certain dimensions of participation over others, it expands the never-ending list of different measures of social capital.

More indicators of social capital are provided by Krishna (2002) in his study on development in India. This study found that in villages in Madhya Pradesh and Rajasthan in India, people generally did not participate in any formal organizations but some nevertheless had high levels of

social capital as measured by membership of labour sharing groups, faith in government organization, solidarity and reciprocity. The study included a variety of measures on individual agency capabilities, including strength of political parties, caste associations, village *panchayat* (council), new development-oriented village leaders, traditional village council and patron-client links. Development was captured by aggregating variables for livelihood stabilization, poverty reduction, employment provision, and quality of basic services. Krishna (2002) found that even though people in some villages trusted each other, met on a regular basis and helped each other, their social capital alone did not lead to economic development. High social capital also needed high agency variable for economic development to be possible (Krishna 2002). This conclusion concurs with Fine's (2003) observation that 'for social capital to be effective, some further factor X must be present' (p. 591).

The brief review of empirical literature undertaken above demonstrates the broad range of proxies used to measure social capital and the many outcomes social capital seeks to explain. The proxies of social capital include the availability of sports and cultural associations, trust in people, feelings about avoiding fares on public transport, faith in government organization, number of siblings, group characteristics, solidarity and reciprocity, and more. Numerous proxies of social capital are then employed to explain a plethora of outcomes like economic growth in rich and poor nations, generation of human capital, household welfare and development of villages. Nevertheless, the central question of how to measure social capital remains unanswered; nor do we know much about employing social capital from one context to the other.

Most of the empirical work ignores the potentially negative side of social capital; for example, why do group activities not lead to price fixing and collusion? (Fine 2001) Rather, the studies conclude that social capital has positive effects, although the results should be treated with

caution. Much existing evidence, such as Newton (2001) and Bianchi and Robinson (1997), challenges these findings, and contradictory evidence on the effect of similar measures of social capital is found in different studies. Putnam (1993), for example, found group activities to be vital to economic growth, whereas Knack and Keefer (1997) found this aspect of social capital to be insignificant.

Numerous reasons might be behind these contradictory results. One of the most common shortcomings in a majority of social capital studies is the treatment of social capital as a causal variable. Although correlation may not be the issue of debate, causal direction cannot be established from the social capital literature (Dasgupta 2005). For example, studies attempting to measure the effect of trust and norms (establishing credible measures of these variables is in itself an extremely difficult task) on growth may be dealing with two variables that simultaneously influence each other. Trust is enhanced where norms of civic cooperation already prevail. Rich associational life is developed with the backdrop of material development (Molyneux 2002). The study by Miguel, Gertler and Levine (2003) demonstrates precisely this point. Using information from household, firm, village level and national level surveys in Indonesia, the authors examined the effect of industrial development on social capital between 1985 and 1997. The level of industrial development was captured by the proportion of manufacturing employment in each district and social capital was captured by participation in local organizations, the proportion of household spending on festivals and ceremonies, and the opinion of village leaders about mutual cooperation in the community. Other measures were used to capture intra-familial social capital. The results showed an association between industrialization and the growth of credit cooperatives and other community groups, as well as a positive effect on the proportion of household expenditure on festivals and ceremonies.

Trust in the social capital studies is further measured through individual surveys as a 'micro' and 'cognitive' concept (Sabatini 2005, p. 6). These measures are related to individuals' view of their social environment and their position in the social structure. Aggregations techniques are then used on answers derived from individual surveys to capture trust at a community or national level, which inevitably breaks the connection with the historical and social context in which the concept should be established (Sabatini 2005). The level of trust is further dependent on the respondent's self evaluation, which makes comparison across individuals a difficult task (Haddad and Maluccio 2000). Therefore serious measurement errors cannot be ruled out in social capital studies.

The studies that use local associations as a proxy for social capital might be misleading. Aggregate measures of participation in group organisations may be capturing the changes in the form of associational life, for example from informal to formal networks, rather than lower or higher levels of social capital. In addition, social capital might be present in cultural settings in which formal local organizations are altogether absent. Membership of formal associations is generally much higher in developed than developing countries (Krishna 2002). The study by Conley and Udry (2001) has shown that the exchange of information amongst farmers in Ghana was not dependent on participation in a formal organization, nor was the availability of social insurance in the rural Philippines dependent on being a member of a structured social group (Fafchamps and Lund 1997). Restricting the focus to formal local organizations might thus prove to be an unfruitful exercise, at least in the context of developing countries. The studies using group participation as a proxy of social capital in developing countries at least manage to successfully demonstrate the practice, in social capital research, of disregarding context (Fine 2003).

To summarise, we have seen that social capital looked at as 'trust' and 'norms' provides both theoretical and empirical pitfalls and is therefore ignored in this research. The commonly

identified and more tractable component of social capital, social network is confused with participation in formal groups which runs the risk of ignoring informal ties. Also the empirical or theoretical literature of social capital pays little attention to the negative aspects of networks, which, as discussed in the next section, are central to the study of female social capital in developing countries. In this thesis we ignore formal associations and focus on informal social networks. Social network analysis, which provides tools for including interpersonal networks outside of formal associations and organisations, is employed for the research. By providing tools which highlight both the structural constraints and opportunities present in networks, social network analysis give a more holistic view of networks than social capital.

The forgotten gender dimension of social capital

Despite the numerous shortcomings, influential contemporary proponents of social capital such as Coleman (1988) and Putnam (1993) have regarded social capital as a trouble-free concept (Arniel 2006), in which social networks are assumed to be 'benign and harmonious' (Rankin 2002, p. 7). It is argued that beneficial outcomes such as higher growth rates (Putnam 1993), greater schooling attainment (Coleman 1998) and higher household income (Narayan and Pritchett 1999) are linked to social capital in one way or another. Social capitalism opportunities are further viewed to be free to all for investment in the hope of future returns (Arniel 2006). In view of this ideology, it is not surprising that little emphasis has been placed on addressing structural inequalities in social capital; nor have the issues of gender, race, caste and religion been taken into account. This neglect occurs despite the existence of strong theoretical and empirical evidence that points towards the negative and discriminatory forces of social capital in relation to certain members of society (Bourdieu 1986; Cleaver 2005; Molyneux 2002; Arniel 2006).

This section aims to draw attention to the negative effects and limitations of social capital mainly by introducing gender into the analysis. A gender analysis reveals the socially constructed norms surrounding male and female identities; examples of gendered norms include the designation of traditional caring roles to women and the association of men with responsibilities outside of the household. These gender norms are essential in shaping the set of opportunities available to men and women and power relations at all levels of the society (Reeves and Baden 2000; Pandolfelli, Meinzen-Dick and Dohrn 2007). By incorporating gender our analysis illustrates that women often engage in networks on unequal and discriminatory terms. Women are likely to participate in informal networks and are often excluded from more powerful male networks. Even when they are included in male networks, they are likely to face discrimination, have limited access to resources and exercise little power in these networks. Moreover, power dynamics in networks may ensure that women face increased pressure to conform to gender subordination rather than challenge discriminatory practices. Instead of addressing these gender issues, social capital has so far either focused on male networks or has seen women as essentially 'social' and therefore the most competent 'social capitalists' (Molyneux 2002) without accounting for gender inequalities.

Gender analysis of social capital can benefit from Bourdieu's (1986) treatment of social capital. Although he does not discuss gender, Bourdieu (1986) sees social capital as a means of inclusion and exclusion. He argues that social capital is a collective resource possessed by the members of a network of 'more or less institutionalised relationships' or a group (Bourdieu 1986, p. 248). The identity and boundaries of the group can be preserved by avoiding the injection of new members that are different from the group. The group may therefore make momentous efforts to ensure homogeneity in any new alliances formed by its existing members, thus ensuring its future existence.

> Exchange transforms the things exchanged into signs of recognition and, through the mutual recognition and the recognition of group membership which it implies, re-produces the group. By the same token, it reaffirms the limits of the

> group, i.e., the limits beyond which the constitutive exchange – trade, commensality, or marriage – cannot take place (Bourdieu 1986, p. 250).

Sex-based segmentation of group organisations points to these exclusionary tendencies of social capital. Studies in management show that even though social networks are essential to organisational success, women continue to lag behind in forming strategic partnerships (Eagly and Carli 2007; Timberlake 2005). Norris and Inglehart (2006) show that in many developed and developing countries men continue to dominate powerful professional and political associations, whereas women are found to dominate associations related to the traditional women's role of caring. Discrimination on the basis of gender and race in social networks is also found by McGuire (2002) in an investigation of a large United States-based financial services corporation having 20,000 employees. The results of a survey conducted among employees of the organization showed that women, particularly black women, were less likely to hold jobs that provided an opportunity to form resourceful networks, and as a consequence they had fewer resourceful network partners within the organization than men. Women were also found to be less likely to receive help from their network members in the organization even after controlling for job characteristics and education. The results provide strong evidence that 'women, regardless of their race, received less instrumental help from their network members than men did simply because of their gender' (McGuire 2002, p. 315).

Lin (2000) explicitly recognises the inequalities in social capital and argues that certain groups may suffer from capital deficits and/or return deficits. These deficits may be suffered by people belonging to certain disadvantaged groups based on race, gender, caste or other characteristics. Capital deficits can be caused by differences in opportunities and investments; for example, male children may be encouraged to form extensive networks and be provided with the resources to do so, unlike female children (Lin 2000). Women may also suffer from constraints in developing diverse networks due to greater care responsibilities for children and the elderly than men. These

constraints are reflected in the network composition of men and women. Using data from a nationally representative sample of American adults, Moore (1990) found that women have a larger proportion of kin-based ties as compared to men. These gender differences persist even after controlling for age, income, educational qualifications, marital status and number of children.

Inequalities in the amount of social capital possessed by different groups on the basis of gender, race or social status may also be caused by networking habits. Extensive evidence shows that people network with others occupying similar social positions (homophily). The patterns of selecting similar others on the basis of race and ethnicity are found to be so strong that they influence not only marriage, work-related networks and school friendships, but also limit discussions about certain topics (McPherson, Smith-Lovin, and Cook 2001). Such a process of networking would ensure that people in disadvantaged positions exercised lesser influence through social networks and had access to information of inferior quality compared to resource rich networks (Lin 2000).

Even if capital deficits are overcome by acquiring equal amounts of social capital, return deficits may still persist for certain groups. This may occur if women themselves are reluctant to mobilise social capital for achieving certain outcomes, for example, or if the members of the group are reluctant to invest on the behalf of women (Lin 2000).[9] Burt (1998) also points out that women may encounter a legitimacy problem, as they are considered as outsiders in organisations, due to which they may not derive the same benefits from social capital as men. In organisational research, Burt (1998) discovers that successful women are sponsored by actors in positions of authority whereas women who accumulate social capital in their own right fall behind. On the other hand men do not require sponsorship and are able to derive returns on basis of their own

[9] Lin (2000) is one of the few social capital theorists to provide a detailed discussion of gender.

social capital. In the case of traditional religious institutions in the United States, women were found to be more religiously active in congregations than men but were less likely to be invited to take on leadership positions. Instead, the women's role was confined to providing support rather than holding the authority to lead (Caiazza and Gault 2006). Women, thus, bore responsibility for investing in social capital from which they themselves did not benefit (Arneil 2006). In a study on information exchange in rural Uganda, female-headed households were found to be less likely to receive information on agricultural technologies than male-headed households (Katungi, Edmeades and Smale 2008).

Fixation on group participation adds to the problem of gender omissions in the social capital debate. Compared to men, women are found to prefer less bureaucratic, loose and informal networks (Stolle and Micheletti 2006), and to give more importance to neighbours (Caiazza and Gault 2006) and kin-based networks (Marsden 1987; Moore 1990). Only limited effort has been made, however, to measure the effects of these informal and kinship networks, in which women are more likely to participate, as part of social capital.

Counting groups as a measure of social capital also disregards the normative nature of ties. A historical analysis of men's groups in America shows that male networks were actively involved in discriminating against women and cultural minorities. On the other hand women's associations were formed as a response to the discriminatory practices and their primary role was to challenge existing power relation, not to enhance solidarity between women. These women's groups were instrumental in the fight for women's right to vote, which undermined the strength of families and communities. This shows that social capital is embedded in divisive politics rather than social trust (Arneil 2006). Instead of addressing the interplay between social capital and social inequalities, women's entry into the labour force is blamed for the decline in family and kinship networks leading to a fall in social capital (Putnam 2000). Family is also hailed by the World Bank

as the main centre of social capital to be worked with and strengthened. 'Family' in this instance is treated as a unit without the gendered division of labour and power (Molyneux 2002). This omission by the World Bank is extremely surprising, since it is well-established in the social sciences literature that women in many parts of developing countries are continuously disadvantaged in their access to food, education and health care, of which the World Bank can hardly be unaware. Women are also found to relate to their networks differently to men. In Thailand, women were equally likely to migrate as men, but women were found to be more likely to remit wages to parents (Curran 1995). This raises the issue of differing sets of expectations facing men and women in networks.

Gender analysis of social capital by Silvey and Elmhirst (2003) and Mayoux (2001) provide useful illustrations of gender omissions of social capital in relation to developing countries. Silvey and Elmhirst (2003) argue that including gender in the analysis reveals the 'struggle, contest and negotiation' in social networks (p. 866). Silvey and Elmhirst (2003) use two case studies on female migrants from the rural to urban areas of Indonesia to demonstrate these complexities in social relationships. The first case study was conducted on women from the village of Tiuh Indah in North Lampung, southern Sumatra, who worked in factories in Tangerang, West Java. The second case study was on women from Sulawesi and Central Java regions who worked in factories in Ujung Pandang, South Sulawesi. Information for the study was obtained from surveys and interviews conducted in 1994-1998 with female migrants in these regions.

The research found that women from both regions benefited from social capital embedded in networks of kin in their respective villages and city-based networks of peers. The village networks provided the migrant workers with practical support through the subsidised supply of agricultural products. In the case of women from South Sulawesi, women were also able to return to their respective villages due to economic hardships during the Indonesian economic crisis in 1998. The

peer networks in the city provided women with additional support, although the networks were organised rather differently in the two regions. In the case of women in Tangerang, the rural-urban kin networks were formalised through an organization called Ikatan, which was responsible for young women migrant workers. The organization held regular meetings which helped maintain direct contact between migrants. In the case of South Sulawesi, women were largely organised on the basis of rural agricultural communities. Despite the differences in network structure, women in both regions were able to gain from their networks by sharing rooms to spread the cost of rent, providing food for each other, helping each other to find jobs, providing information about wage levels and employment rights and helping each other to make contacts with factory managers. The Ikatan also maintained links between the migrants and their village-based families which helped to reduce the fears of parents in the villages about the 'moral and material well-being' of their daughters working in the cities (Silvey and Elmhirst 2003, p. 870). Women in Tangerang thus gained by being subjected to reduced pressures of quitting factory employment due to participation in the Ikatan networks.

Consistent with the social capital literature, social networks gave considerable support to young factory workers, but this came at a major cost. In South Sulawesi, women faced pressures to return to their rural homes due to norms of 'appropriate female behaviour'; and when they returned due to social pressures or due to economic hardships were expected to take up excessive household work. Although women in Tangerang did not face pressures to return to the village, they had to send most of their earnings home and faced difficulties in covering their own costs. These pressures intensified in 1998 during the Indonesian economic crisis, and presence of Ikatan made it more difficult for women to under-report their earnings to manage the financial demands of their parents. There was, however, little expectation placed upon male factory workers to provide labour or money during the crisis. Parents also continued to exercise strict

control on women's behaviour in the cities through the social networks. The leader of Ikatan stated:

> Parents are happy to know that there is someone they trust, a relative [i.e. someone from the same blood line], who can look after their daughters. When these girls come to the city, they are very young, very inexperienced. It is important that they are taken care of, to ensure they do not make mistakes or find themselves in trouble (Silvey and Elmhirst 2003, p. 873).

The close connections between Ikatan, peer networks and kin in the village also meant that information about transgressions could easily spread, and this acted as an additional barrier to women exercising their own preferences. Participation in the peer networks also constrained women from joining other more powerful networks, such as the labour activists' group. In some cases, such participation was discouraged by network members, and for Tangerang women meant suspension from Ikatan (Silvey and Elmhirst 2003). These costs paid by women in return for social capital benefits can by no means be deemed insignificant. Peer and family networks provided women with social capital while they established their careers in factory employment outside their villages, but in return, these social capital networks were successful in restricting women's freedom and in increasing their burden of providing financial or practical support to their families. The networks were also successful in excluding women from more powerful occupational networks. Families and peer networks were able to exercise power over women primarily by appealing to the existing gender norms. It is important to note here that no such pressures were imposed on men. This suggests 'that what may be positive social capital for men (e.g., a household safety net), can be experienced as social constraint or a burden by women in the same network' (Silvey and Elmhirst 2003, p. 876).

The limited benefits of women's social capital networks due to norms of gender subordination are also demonstrated by Mayoux (2001) in the case of Cameroon. Mayoux (2001) points out the important links between social capital and gender inequality in analyzing female borrowers of

seven microfinance institutions (MFIs) in Cameroon. The microfinance programs, now widespread in many countries, function on the principle of group-based delivery of loans. The group members take joint liability as collateral for the loan and the whole group is held responsible for default whether the loan is extended to individuals or used for group activities. The social capital embedded in networks and norms of association amongst group members is used as substitute for the traditional financial collateral usually needed for borrowing purposes. The MFIs in this region extended loans to the respondents mainly for undertaking economic activities to achieve long run poverty alleviation for women, and MFIs in Cameroon assumed that the networks formed amongst borrowers would help women to build on social capital. This coupled with credit was supposed to enhance their economic capabilities, abilities to negotiate change in the society and hence lead to an improvement in their status.

In most cases, women participating in MFIs employed their loans to gain economic independence by investing their loan amounts in activities such as farming, tailoring and retail trading. Women also used network ties to members in the group and markets, as well as more informal networks with male and female kin and neighbours for their business development, which they reported to be essential to their survival. The network arrangements employed by women provided a range of benefits such as child care, labour on the farm, marketing and help in repayment of loans. Nevertheless, despite participation in MFIs, high levels of social capital and mammoth individual efforts by women themselves, most were found to have very low incomes and faced difficulties in expanding their businesses. The reasons behind this can be partially explained by the constraints placed on the women by hierarchical relations in the household and kin groups. Women in all ethnic groups were seen as dependants of men and had no rights to property or children, and these laws were reinforced by local chiefs and leaders. Women were also found to get little support from their husbands and often had to hire labour while cultivating

their crops, which led to reduced profits. Despite the lack of cooperation from their husbands, women were obligated to provide free labour for the cultivation of their husband's crops. Participation in microfinance also extended women's responsibilities to providing cash for the family, but women's access to loans provided husbands with an excuse to not contribute towards household expenditure. Increased expenditures associated with ill health and education of children was also borne by women, who saw this as their responsibility. In some cases, powerful women in the community supported norms of gender subordination, which shows that 'although households and families may be important sources of social capital there is also a need to address the norms which regulate relations within them' (Mayoux 2001, p. 439). Without this, the benefits of social capital for women may be limited.

The exclusionary forces of men's social capital and the macro-level institutions were also found to be major hindrances for women trying to achieve economic independence. Women in Cameroon were without any permanent access to land[10] and were forbidden from planting permanent trees on kinship or rented land. This meant that they could not grow profitable plants like coffee and cocoa. Furthermore, most urban markets of lucrative goods such as cash crops and manufactured goods were male-dominated, making it difficult for women to gain access. Even travelling to the markets was by no means an easy task for female traders. They often faced violence and extortion on the main roads from government officials, transport drivers and armed police who often colluded with each other to exploit women. Women were also found to be exploited in some village-based mixed-sex credit organisations. In these programs, women were found to be the biggest contributors to savings but were disadvantaged in getting loans and were also under-represented in decision-making positions, implying that most of the women's money was being redirected to male borrowers at low interest rates (Mayoux 2001).

[10] The land in Cameroon usually belongs to the males in the family and women are not free to plant trees and cash crops on this land.

Analysis of gender suggests that high levels of social capital at the community level or participation in groups by women will simply not lead to better outcomes for the society or for women themselves. Networks between women have a limited effect if groups and family members continue to reinforce dominant gender norms (Silvey and Elmhirst 2003; Mayoux 2001; Molyneux 2002) and can operate to disadvantage women. Powerful women in the community who gain their positions in the face of existing gender inequalities may also be supportive of gender subordination (Mayoux 2001). Thus women's social capital may exercise limited influence in challenging existing inequalities and may even reinforce them.

Male social capital can be systematically organised to exclude women from more powerful networks (Mayoux 2001). Even if women gain entry into male networks and gain as much social capital as men, they may still derive lower returns (McGuire 2002; Caiazza and Gault 2006; Lin 2000) and face exploitation by men in the group (Mayoux 2001). The poorest women may be the most disadvantaged and may face exclusion and discrimination, not only in male-dominated networks but also in female groups. Some worrying evidence of this was found by Mayoux (2001) in the case of Cameroon microfinance programs; thus, incorporating gender into the analysis reveals the 'conflictual and contradictory' nature of social capital (Rankin 2002, p. 7). Some of the problems of social capital are summarised by Fine (2003) as follows:

> However, and however much, social capital incorporates social relations and processes, it is thereby embedded, to use the vernacular, in matters of exclusion and inclusion, power, conflict, exploitation, oppression, hierarchy and conflict (p. 595).

Social capital theorists have continued to ignore these rather unpleasant consequences of social relationships and continued to celebrate networks and norms of association. The most influential proponent of social capital, Putnam (n.d.) argues that 'the central idea of social capital, in my view, is that networks and the associated norms of reciprocity have value' (p. 1). He further

elaborates that the benefits of social capital are not limited to the participating members, but that they also have positive externalities. Such claims have serious consequences and lead to misguided policy prescriptions. This is evident in the case of the World Bank, which endorses family as the main centre of social capital to be worked with and strengthened (Molyneux 2002) without paying attention to gender inequalities in households and communities.

This study aims to provide further evidence of gendered inequalities of social capital in the context of the Matlab region in Bangladesh, where norms of purdah and female seclusion and subordination are widespread. Even though the very concept of social capital remains elusive, the effort here is not to redefine social capital. The study will be limited to gender analysis of social capital using easily available measures of ties in social networks. The gender issues are revealed by studying male and female family planning networks in Bangladesh using tools of social network analysis. In order to successfully define and measure family planning networks, we turn next to the diffusion studies on fertility which employ network analysis techniques. The review also demonstrates the importance of using network analysis techniques in studying fertility related behaviour in developing countries.

Family planning and social networks

A growing strand of literature in social networks, separate from the social capital literature, studies the network effects on the decision to use family planning. Fertility in this context is considered not just an individual attribute but as socially determined, especially in developing countries where conformity with local norms may be more prevalent than individualistic behaviour (Gayen and Raeside 2005). Family planning is seen as an innovation which may spread through a variety of channels such as interpersonal or central sources like the media (Valente et al. 1997). Once contraceptive behaviour is adopted by some within a community then social

interaction can be a powerful mechanism that determines the speed at which the whole community adopts it (Bongaarts and Watkins 1996).

The literature further identifies social learning and social influence as two important and separate components through which these effects may operate. Social learning occurs by providing new information and aiding the evaluation of the information in social networks (Behrman, Kohler and Watkins 2002). Peers may exchange ideas regarding a new method, or the advantages and disadvantages of a small family, and adopt the method in their own lives if suitable. Heterogeneous and diffuse networks are more likely to be conducive to social learning by increasing access to diverse information (Madhavan, Adams and Simon 2001). Social influence arises when social networks reinforce or alter norms of behaviour (Behrman, Kohler and Watkins 2002). Social conformity, due to the desire to avoid conflict or due to the active exercise of power by others to conform, is one of the several forms of social influence (Montgomery and Casterline 1996). Dense and homogenous networks are likely to lead to social pressures to conform to local norms (Madhavan, Adams and Simon 2001). Social approval of family members or peers may be sought by women in developing countries before the adoption of family planning (Valente et al. 1997). Kincaid (2000) further argues that 'individuals who are highly interconnected and centrally located within local social networks are more likely to hear about innovations earlier and to have more opportunity for social comparison and influence' (p. 218).

Evidence of social interaction on fertility is found in a variety of settings (Valente et al. 1997; Behrman, Kohler and Watkins 2002; Kincaid 2000; Montgomery and Casterline 1993). A qualitative study in rural Kenya showed that family planning is a topic frequently discussed with peers. These conversations were found to take place amongst homogenous groups which women saw as 'like themselves'. Women in Kenya were found to be largely hesitant about new sources of contraception, and side effects were commonly discussed amongst peers. Sometimes these

discussions were found to still women's anxieties about side effects but in some cases they also inculcated fears of side effects not linked in any known way to contraceptives. Such fears arose despite the easy access to family planning clinics in rural Kenya. The research showed that social distance between the staff at clinics and respondents often generated mistrust. In addition, the family planning workers were perceived as being trained in western medicine by the respondents and unable to provide information suitable to respondents' 'bodies' and circumstances. The women therefore relied on peers whose bodies and circumstances were 'like themselves' for information as well as advice (Rutenberg and Watkins 1997).

Community-based programs have, however, had more success in convincing people to use contraception. These programs recruit local residents for the dissemination of family planning services and knowledge. In previous research in Bangladesh, health workers have been shown to be both a source of social learning and social influence (Simmons et al. 1988; Simmons 1996). In the Bangladeshi society where norms of female seclusion continue to dominate, female health workers have been used to provide supplies to women in their homes and motivate couples to practise family planning. Evidence from the Matlab region suggests that health workers have been instrumental in exposing women to new ideas about the advantages of smaller families, while providing method-specific information. The significance of contact with the health worker is described by a respondent as follows:

> She gave us the idea about many things. She said that '…this is good and that is bad. You should act accordingly.' You see if a dirty pot is rubbed with ash every day, it will become clean. So like this she also came from time to time and explained everything. Thus, [she] helped to remove the black dirt from our mind [and] it turned white. Gradually we came to like her. She helps us a lot (Simmons 1996, p. 263)

In the above passage the respondent is clearly referring to a transformation in ideology as a result of social interactions with the health worker (Simmons 1996); however, the presence of health workers does not eliminate the importance of peer interactions. Marten (2002) showed that

women in Bangladesh reported talking to health workers regarding contraceptives, but they were apprehensive about trying a method unless they knew of someone who had personal experience with that method. The networks were a source of information but were more commonly observed to exercise social influence regarding family size and contraceptive use. A respondent reported 'She [indicating her brother's wife] forced me to come with her to get a copper-T [IUD]. Me, my brother's wife and this woman [indicating a neighbour], we got copper-T's together' (Marten 2002, p. 105).

Even if women are willing to trust information from formal sources, cultural constraints can discourage women from accessing clinics, leaving peers as the only source of information. In Jamaica, practising birth control is seen as interfering with natural processes of procreation, which is of positive value to the individual and society. Having many children is considered to help in ensuring support in the future and providing extra hands for work. Reproduction is also an opportunity for an individual to return 'the gift of "life blood" his or her parents gave' (Sobo 1993, p. 55); thus in this setting, any individual practising birth control is seen as selfish and unintelligent. As a result young women in Jamaica cowered from seeking advice from medical practitioners to avoid drawing attention to their lifestyle. These women would instead resort to learning about contraceptives by watching their friends (Sobo 1993).

Empirical evidence has also uncovered pervasive effects of networks on contraceptive use. One of the earliest studies to apply the tools of social network analysis to family planning networks in developing countries was conducted in Korean villages.[11] The Korean data showed that the villages with better connected communication structures had a higher contraceptive prevalence rate (CPR). Individuals were also more likely to adopt family planning as the proportion of their

[11] An even earlier empirical assessment of network effects on family planning adoption was conducted in Taiwan (Palmore and Freedman 1969).

network connections who were using contraceptives increased (Rogers and Kincaid 1981). Since then, many studies have been conducted that focus on measuring network effects. Kincaid (2000), in his work on Bangladesh, compared women participating in family planning discussion groups that were initiated by health workers with women who were dependent on home visits by health workers, or women who were participating in neither approach. He found that women were five times more likely to use contraception if they engaged in family planning discussions at a group level. This was primarily caused by higher continuation rates among women participating in the social network approach and hence suggests that peer support plays an important role in regular contraceptive use. The results suggest that women participating in the social network approach were more likely to continue or switch methods than drop them altogether due to better knowledge or encouragement received from peers (Kincaid 2000).

Direct evidence of the effect of network partners' encouragement to use contraceptives on an individual's likelihood of adoption is provided by Valente et al. (1997), who studied interactions amongst members of voluntary associations in Cameroon. They restricted their attention to interaction between group members. The groups studied were organised along the lines of ethnicity. Women reported as network partners people they had known for a few years and with whom they had frequent conversations. Women's perceptions about their network partners' use, whether or not correct, and encouragement to use contraception by network members were found to matter the most in explaining whether or not the respondent ever used contraceptives. The results showed that the 'respondents whose networks were entirely composed of those who encouraged use were 11 times more likely to have used contraception than those whose networks were entirely composed of those who did not encourage use' (Valente et al. 1997, p. 683). Other socio-economic characteristics like age and education were not significant in explaining 'ever use' after controlling for the network variables; but wealth was found to be important. The results also showed that women were likely to use similar methods to their network partners (Valente et

al. 1997). This suggests that when deciding on contraceptive use, women do not only seek information from network partners but also seek support for their choices. Unfortunately the results emerging from group participation cannot be generalised to the whole population due to selectivity issues. Women participating in groups are unlikely to be a random subset of women. The groups in Cameroon were composed of migrants, who were not likely to be like the people who chose to remain in the province. Furthermore, people choosing to join groups in Cameroon might have certain different characteristics that make them more likely to use contraceptives (Valente et al. 1997).

In a more general study conducted on married women of reproductive age in six districts of Bangladesh it was found that women with more kinship ties were more likely to use contraceptives. Most of the reported network partners were found to be family relations; 76% of network partners were the husband's brother's wife, largely due to the limitations imposed on women's mobility in the patriarchal society of Bangladesh. Social learning was explored by people's centrality position in the network. People who receive or sent many ties to others were considered central in the network, and the attitude of network partners about contraceptive use was used to capture social influence. Although the number of ties sent to other actors was significant in explaining contraceptive use, the approval of contraceptive use by network members was the most important determinant. The logistic regressions showed a strong association of the health worker's influence, husband's approval and interpersonal communication with increased contraceptive practice over and above mass media and economic factors (Gayen and Raeside 2005, p. 14). The networks in this case were likely to be fairly dense as most of the respondents were related to each other. This last aspect of network structure was not explored in this research but is demonstrated to be important by Kohler, Behrman and Watkins (2001).

Kohler, Behrman and Watkins (2001) argue that social learning is maximised in sparse networks, which increases the sources of new information from networks. On the other hand, dense networks in which all the network partners know each other exert greater influence. In their study of family planning networks in Kenya, Kohler, Behrman and Watkins (2001) state that 'if social learning dominates, we expect to find that both dense and sparse networks containing family planning users increase the probability that a woman will adopt a method of contraception' (p. 46). Sparse networks may be more effective in providing new information than dense networks. So if social learning is the main process through which network effects operate, the effect of density (if it exists at all) is expected to be negative. In sparse networks, an increase in the number of family planning users is expected to exert only small effects on a woman's probability of using family planning. By contrast, if social influence dominates, changes in the proportion of family planning users in dense networks should be associated quite strongly with a woman's contraceptive use. Kohler, Behrman and Watkins (2001) tested the effects of density and the proportion of network partners using contraceptives on the adoption of contraception in rural South Nyanza district, Kenya. Egocentric data, in which the respondent provided information about the network partners, was used for the purpose of their research. Density was calculated by the number of ties in evidence divided by the total number of possible ties. The information used was based on respondents reporting whether network partners knew each other. The results demonstrated that in regions with low market activity, dense networks with many contraceptive users greatly increased the chance of adoption of contraception by the respondent. Density alone, however, had a negative effect on contraceptive use. A different picture emerged for regions with high market activity; in this case, one of the most important factors in contraceptive use was the number of users in the network. The interaction between density and the percentage of network partners using contraceptives was negative but not significant.

The results showed strikingly dissimilar patterns in different regions and suggest that networks provide information as well as impose constraints on individual behaviour depending on the context (Kohler, Behrman and Watkins 2001). The regional differences in this work were attributed to market activities and the authors concluded that market participants may care less about social acceptance (Kohler, Behrman and Watkins 2001); however, these disparities can also be caused by differences in social structures. Kohler, Behrman and Watkins (2001) collected information about network partners from the respondents and effort was not made to contact the network partners about their ties; thus a view of the complete network structure is not available in this study. It is possible that the regions with high market activity have a better connected overall network structure, which increases the information flow about contraceptive methods; but the data used in the study does not allow a full investigation into 'the interdependence of social interaction and market activities' (Kohler, Behrman and Watkins 2001, p. 56). Although the study shows that context determines which of the two factors – social learning or social influence – will dominate; the reasons behind this cannot be conclusively established unless more information is available on the pattern of ties in the regions.

As context matters, so does gender, as is successfully proven by Behrman, Kohler and Watkins (2002). Using longitudinal data from rural Kenya, this study was also able to control for biases that may be present due to unobserved characteristics of the respondents. More specifically, a respondent may prefer to talk to people similar to themselves (homophily). This implies that the behaviour of the network partners and respondent would be correlated rather than there being an independent influence by network partners on the respondent or vice versa. Respondents who want to use contraceptives may select network partners who are using contraceptives. Using fixed effects estimates, Behrman, Kohler and Watkins (2002) showed that the odds 'of a woman currently using contraceptives increase by a factor of more than 2…if she has at least one contraceptive user among her network partners' (p. 728). Having additional network partners

who were users did not significantly affect contraceptive decision, which implies that network effects operate through social learning rather than social influence in this data set. The results also showed that the odds of contraceptive use if there are additional users in the networks are biased upwards by 300% if selectivity is not controlled. The study is also unusual in incorporating male networks in the study of contraceptive choice. So far, the demographic literature has ignored the role of men, which may 'reflect the perception that women are more engaged in such networks or are more central in contraceptive choices than are men' (Behrman, Kohler and Watkins 2002, p. 732). However, in the context of rural Kenya, men reported talking about family planning as much as women. Men were also more likely to have known their network partners much longer than women had. In Kenya, women marry and leave their community to live in their husband's house; men, on the other hand, rarely leave their village of birth. The results showed that men were more likely to use contraceptives if at least one network partner was a user. The probability of men using contraceptives was also positively related to the proportion of networks partners using contraceptives: the variable 'number of remaining family planning users in the network' has a positive and significant effect on contraceptive use by men (Behrman, Kohler and Watkins 2002, p. 733). Substantial selectivity biases were not found in the case of men. The results indicated that women mostly sought information in their networks, but men were more likely to be influenced by their network partners. This outcome could be due to the culture, in which men do not leave their village of birth and have probably known their network partners since childhood (Behrman, Kohler and Watkins 2002).

Information on male involvement in family planning networks is also provided by Stoebenau and Valente (2003) in their study of community-based family planning programs in a village in Madagascar. The workers from the community-based program use local communication channels to disseminate information and act as role models in the community. The workers were found to be central to both male and female networks. Two types of network information were collected

to ascertain this. Respondents were asked to name the network partners from whom they seek advice on all important matters. Information was also collected on the networks partners consulted on issues related to family planning. The community-based workers were found to be central in both advice and family planning networks, but a greater proportion of women were connected to the community-based workers compared to men. Respondents in either network with links to the community-based workers were found to be better informed about family planning. In the family planning networks, respondents were also found to have a more positive attitude towards using birth control methods if they were indirectly connected to the community-based workers (i.e. they were connected through other network partners). Direct links with the worker and having family planning discussion partners in the village increased the likelihood of using modern contraceptives, and having family planning discussion partners outside the village had a positive and significant effect on contraceptive use.

The effects of networks are not limited to the adoption of contraception but are also found to influence contraceptive method choice. Paul (1990) studied the intention to use the contraceptive pill in Bangladesh. He found that women's intention to use the pill was strongly determined by their attitudes towards contraceptives, the approval of husband and friends to use contraceptives, religion, and method specific attitudes of the respondent. Other important variables like distance to the health centre or personal motivation regarding fertility regulation (including individual reproductive goals and the cost of fertility regulation) were not found to influence the intention to use the pill.

Longitudinal data from a remote community in Nang Rong in Thailand showed a variety of patterns in the choice of contraceptive method across villages, but one popular method was

found within each village.[12] Using focus group interviews, Entwisle et al. (1996, p. 9) found that 'family planning is an everyday topic of discussion amongst women'. These discussions were limited to women in the same village, despite numerous opportunities for women to interact outside the village geographic boundaries, and the interactions were also found to take place amongst women of a similar background and life stage. The participants in these conversations readily named the most popular method in the village and couples reported a preference for methods that were widely used by others. The authors hypothesise that 'the more widely a technology is adopted, the more attractive it becomes to others' (Entwisle et al. 1996, p. 10). The limited interaction between people from different villages further inhibits change in the historically popular method choice of contraception within villages (Entwisle et al. 1996). Quantitative evidence from the same community in Thailand showed that household level kinship ties inside and outside the village have a positive effect on injectable contraceptive use. The injectable contraceptives were the newest form of contraception in the district, and it seems that kinship ties may have encouraged their use through the flow of new information. Contraceptive pill use was affected by kinship ties outside the village. The pill was found to be historically more popular but required a consistent cash flow which could be provided by kinship ties outside the village. No evidence was found of kinship ties encouraging the adoption of another historically popular method, the IUD. Village level kinship ties outside the village also affected both pill and contraceptive use. Although these results support the hypothesis that household kinship ties have an effect on modern contraceptives, it is hard to ascertain whether social learning or influence were dominant in the studied community (Godley 2001). The association between social networks and the type of method adopted is also supported in the research by Valente et al. (1997) on voluntary associations in Cameroon.

[12]Rogers and Kincaid (1981) also found the Korean villages had a popular method of contraception; for example, in some villages the majority adopted the pill, while in some the majority adopted IUDs.

The research on social interactions and family planning helps to establish a number of facts. Both men and women frequently talk about family planning. The literature demonstrates that the effects of women's social interaction cannot be simplified into having or not having networks. The networks can affect individual action quite differently depending on content, structure and context; gendered patterns of network effects are also evident, and network effects can be positive or negative. Social networks can enhance learning and encourage the adoption of contraception, but if social influence dominates, networks can hinder the spread of adoption if network members are against family planning (Kohler, Behrman and Watkins 2001). The literature also builds a strong case for extending the rational individual model to include social interaction. Although Behrman, Kohler and Watkins (2002) argue that some of the results may suffer from biases due to issues of strategic selectivity and homophily, it is highly doubtful that the results are entirely driven by this. Women in Cameroon are not likely to form groups based on contraceptive use (Valente et al. 1997), nor are kinship networks in Bangladesh and Thailand going to be established in order to seek information on contraception. Also Behrman, Kohler and Watkins (2002) found that the selectivity issue was not important for men and family planning decisions therefore should be explored on the basis of context. In spite of these many findings, social network literature still leaves many questions unanswered due to data limitations.

With some exceptions discussed above, limited efforts have been made so far to collect information from network partners directly.[13] Second-hand reports about network partners may be unreliable and shed no light on the overall structure of the network. Although Gayen and Raeside (2005) made efforts to sample the complete communication structure in Bangladesh, they omitted some potentially important network partners, such as married women above the age

[13]Amongst exceptions are Gayen and Raeside (2005), Valente et al. (1997), Rogers and Kincaid (1981), Stoebenau and Valente (2003) and Kincaid (2000).

of 45, who may exercise considerable social influence in networks. These members were omitted despite the fact that respondents mentioned talking to elderly women.[14]

Further insufficient evidence exists on the interactions between network structure and context. As evidenced in the above studies, network effects vary according to context and, as demonstrated by Kohler, Behrman and Watkins (2001), social learning can be the main factor in regions with high market activity, whereas social influence may be stronger in regions with low market activity. Even in the study by Kohler, Behrman and Watkins (2001), it was impossible to convincingly establish the reasons behind the relative importance of social learning in regions with high market activity in Kenya.

Besides, only a handful of studies seek to quantify the effect of social networks on contraceptive method (Valente et al. 1997; Godley 2001; Rogers and Kincaid 1981). Some of these studies are based on kinship networks or select groups of women, such as voluntary associations in Cameroon, and therefore cannot be easily generalised. On the basis of their qualitative study, for example, Entwisle et al. (1996) concluded that people in the Nang Rong community of Thailand tend to adopt the contraceptive methods widely used by others, yet quantitative evidence from the same community shows no relationship between kinship ties in the village and use of the pill, which is one of the historically popular methods (Godley 2001). Since the data is based only on kinship ties, it is impossible to ascertain whether or not other social relationships within the village have an effect on pill use.

Not even a single study exists that employs the tools of social network analysis to study contraceptive method choice in Bangladesh. Previous research shows that networks are of

[14] The research by Kincaid (2000) in Bangladesh focussed on network structure of centrally located women rather than the entire village or community.

paramount importance in method selection by women in Bangladesh (Paul 1990; Marten 2002; Bhatia et al. 1980). Furthermore, effective method selection is of great importance in achieving lower fertility rates in Bangladesh. Examination of the *Bangladesh Demographic and Health Surveys* (2007) reveals that knowledge of contraceptives is nearly universal in Bangladesh, a country that has also seen a dramatic increase in the contraceptive prevalence rate (CPR) and a decline in fertility in recent decades. Contraceptive use by married women between the ages 15-49 has gone up from 8% in 1975 to 56% in 2007. The total fertility rate (TFR) has fallen from 6.3 to 2.7 over the same period.[15] Although there has been a steady increase in CPR during this period, the TFR has changed slowly since the 1990s, stalling at 3.3 for a decade and then dropping again to 3.0 in 2004. In addition, the changes in TFR have in no way been uniform across Bangladesh and some regions have reached a TFR of 2.0, whereas some still have TFR above the 1990s level of 3.7 children per woman (NIPORT et al. 2009).

Bairagi, Islam and Barua (2000) argue that prevalence of contraceptive use is not the only indicator of program success. Fertility depends not only on acceptance but also on use effectiveness and on continuity of use. High contraceptive use can be offset by discontinuation and contraceptive failure rates. In one of the rare studies on contraceptive failure rates resulting in accidental pregnancies in the Matlab region of Bangladesh, Bairagi, Islam and Barua (2000) found that condoms, traditional methods and pills had the highest failure rates. For the period 1990-1994 'the all-method failure rates are 11·6% for pills, 3·7% for IUDs, 0·6% for injectables, 19·2% for condoms and 13·5% for "other" methods' (Bairagi, Islam and Barua 2000, p. 113). The 'other' methods included traditional methods like withdrawal and abstinence, and less popular methods like foam, jelly and sampoon. One of the most important determinants explaining these failure rates was found to be the quality of health workers operating in the area (Bairagi, Islam and Barua 2000).

[15] The TFR figures are based on birth histories of ever married women in the age range of 15-49 (BDHS 2007).

Among the women who reported using contraceptives in the *Bangladesh Demographic and Health Surveys* (2004), a quarter reported having problems with the method. Such problems may lead to misuse of the method or even termination, and discontinuation rates remain high. Nearly half of all contraceptive users in Bangladesh stopped using their method within twelve months of starting, and the presence of side effects was the most commonly reported reason for this. Among non-users, 73% reported wanting to use contraception in the future, and only 25% women among non-users reported that they did not intend to use contraceptives in the future (NIPORT et al. 2005).

The figures show that the future of Bangladesh fertility decline is not only dependent on encouraging non-users to adopt family planning but on the acceptance of long term and effective methods and correct use. As suggested by Paul (1990), network studies on contraceptive method choice can be useful in highlighting the factors associated with method choice in Bangladesh.

Until now, no work has been reported on Bangladesh in relation to male family planning networks. Many studies have found that in Bangladesh, the husband's approval of family planning is one of the significant variables in the decision to adopt contraceptives (Kamal 2000; Khan and Rahman 1997; Marten 2002). Marten (2002) reported that husbands' influence was one of the most important factors in explaining contraceptive use in Matlab, Bangladesh. Women sought not just permission but also support from husbands before they decided to use contraceptives. Cases in which women did not receive this support resulted in non-use. This suggests that free availability of contraceptives in Bangladesh has not been sufficient to encourage women to exercise their own preferences. Conversely, in cases where women were opposed to their husband's wishes to adopt a contraceptive method, men were successful in convincing their wives to adopt a particular method, or even to abort.

A respondent who underwent an abortion gave the following account:

> When I went to get my MR [abortion] and the doctor was ready to do it, then I jumped up from the table and said I couldn't do it, I was scared, it was a great sin, it is not good…The doctor told me that your husband was telling you again and again to get a MR outside this room, he doesn't want the child. So my husband forced me to do MR (Marten 2002, p. 102).

Kincaid (2000) found that women are twice as likely to practise family planning if the husband approves of contraceptives. Kamal (2000) found that odds of use increase by 5.2 for pills, by 5.4 for IUD and injectables, and by 4.3 for sterilization if husband approves of the method. Khan and Rahman (1997) show that the husband's approval is the most significant variable in explaining the adoption of permanent methods of contraceptives by women in Bangladesh, even after controlling for the respondent's attitude. Research conducted on the adoption of sterilization procedures in rural Bangladesh show that the main difference between sterilised and non-sterilised women is that the latter are more worried about the reaction of others and usually faces their husband's objection to the procedure (Bhatia, Faraque and Chakraborty 1980). Even though it is known that men are central in contraceptive decisions in Bangladesh, the communication structures of men are a mystery.

This research addresses some of the above issues by including both male and family planning networks in the analysis, using data from the Matlab region of Bangladesh. We further analyze the role of social networks on contraceptive method choice. As demonstrated by Bairagi, Islam and Barua (2000), the type of method adopted can have far-reaching implications for achieving lower fertility in Bangladesh. Following Gayen and Raeside (2005), we include the nominated network partners in the sample and therefore do not rely on second-hand reports. In addition, network partners are not omitted from the sample on the basis of age or sex, which allows us to capture the entire communication structure. This study provides the first-ever evidence of

communication structures under an intense family planning program undertaken in the Matlab area by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B).[16]

Conclusion

'Social capital' has come to mean so many things that it is nearly impossible to associate the term with one distinct meaning. Despite this vagueness, it is claimed to have the power to explain everything from children's schooling to economic growth; it is both a private and a public good; it is universal in nature and freely roams from one country to the other without any regard for the context. However the above review cautions against the magical appeal of social capital. The review shows that the most common identifiers of social capital are networks, norms and trust. But much remains desired in theoretical and empirical clarity of these variables. The task of measuring norms and trust is particularly difficult, and the social capital literature provides few satisfactory options in this regard. Furthermore, it is not clear what types of trust and norms we are looking for, nor how these variables interact with institutions, governments and society.

Even the most tractable measure of social capital – social networks – has been confused with positive win-win situations without dealing with problems of exclusion, peer pressures, power, exploitation, and discrimination in networks. Bringing gender into the analysis reveals some of these difficulties. As the review of the literature on network effects and contraceptive decisions shows, networks are an integral part of family planning choices, but social capital provides

[16] An earlier work by Munshi and Myaux (2006) provides evidence of social interactions effects on contraceptive use in the intervention area of the Matlab region. Using data from 1983-1993, they show that individuals are more likely to adopt family planning as the proportion of adopters in their own religious group increases. A significant association in adoption rates is also found amongst women living in the same *bari* (a group of households usually clustered together). The study, however, does not provide evidence of the communication structure in the studied villages. Furthermore, the work was conducted in a period when contraceptive prevalence was comparatively lower in the Matlab intervention area and the population was still in the early phases of intervention. Much has changed since 1993, as the population in the area has gotten used to the ICDDR,B services. The findings by Munshi and Myaux (2006) and this research are, therefore, not directly comparable.

inadequate apparatus to deal with the complexities of the social world. Our study derives theoretical and empirical guidance from previous studies in demography and contributes to both the social capital literature and network studies on family planning.

This research aims to show that social capital takes a simplistic view of the role of networks by treating the networks of men and women alike. This ignores important aspects such as the role of power, gender subordination and the unequal distribution of resources. Our use of social network analysis demonstrates how these aspects contribute to fundamental differences between men's and women's family planning networks in the context of Matlab, Bangladesh. We investigate the networks of both men and women and their effects on family planning choices—contraceptive adoption as well as the type of method adopted for birth control. In so doing, we provide a complete map of the overall network. This allows us not only to compare male and female networks but also to investigate the differences between each woman's respective social position within the network and its implication for family planning decisions. This work helps in preventing misguided policies that blindly invest in social capital and also has important implications for the Bangladesh Family Planning Program.[17] Primary data are collected in the Matlab area of Bangladesh to aid the analysis. The data and context will be discussed in Chapter three.

[17] High population growth is recognised as one of the biggest problems facing national development in Bangladesh (Ministry of Health and Family Welfare n.d)

3. Data and Context

The data for this study was collected by conducting structured surveys in the Matlab region of Bangladesh during the months of January to July in the year 2007. The questionnaire was designed to suit the socioeconomic and cultural characteristics of Bangladesh, specifically, of the Matlab area. The study design takes advantage of long-standing health interventions unique to the region which allows us to observe whether certain types of intervention lead to alterations in the network structure. The study context and health interventions in the region will be elaborated first in this chapter before moving on to a discussion of the data.

Matlab Region

Matlab region is located in the Chandpur district of Bangladesh and is about 55 kilometres south east of the country's capital, Dhaka. The core economic activity in the Matlab area is agriculture (Aziz 1994). The region consists of a predominantly Muslim population and has long been a target of scientific experiments. One half of the region has had an intensive family planning and health program run by ICDDR,B (International Centre for Diarrhoeal Disease Research, Bangladesh) since 1979 and is widely known as the 'treatment area'. The treatment area has two hospitals, ten additional health centres run by the government and four health centres run by ICDDR,B. The other half of the region has a less intensive health and family planning program which is run by the government and is known as the comparison, government area (Bhatia et al. 1980) or 'non-treatment area'.

Household structure

Households are usually clustered in a *bari*, or group of households with a common courtyard (Aziz 1994, p. 19). In Matlab, a man is allowed to have multiple wives, though the practice is rare. Young brides leave their parental home and settle in the husband's family home after marriage, but after a few years of marriage, the married couple usually forms an independent household, generally due to domestic quarrels. Such a unit is usually known as a 'nuclear family'. If the family does not separate, it is known as the 'joint family'. The head of the household is the eldest male, although in some cases he may be a nominal head while actual authority is delegated to his son/sons. The wife of the head of the household is in charge of domestic responsibilities (Aziz 1994, pp. 21-22).

Gender norms

The practice of purdah is strictly adhered to by women in Matlab, as in the rest of Bangladesh. The term 'purdah' (literally, 'curtain' or 'veil') is commonly used to refer to the practice of wearing concealing clothing by women outside of their house. It also symbolises a barrier between the outside world of the man and the domestic sphere of women (Kabeer 2000, pp. 34-35). In reality:

> purdah is a complex institution that entails much more than restrictions on women's physical mobility and dress. It denies women access to many opportunities and aspects of everyday life and at the same time confers upon them social status as a protected group (Cain et al. 1979, cited in Kabeer 2000, p. 41).

In other words, purdah has severe implications for women's economic independence and decision-making ability, since it restricts the search for gainful employment outside the household, access to information, and access to their own and their children's health care.

The seclusionary practice of purdah typically starts as early as the age of eleven or twelve in Matlab, after which girls are expected to stay within the *bari*. Even within the household, girls are

expected to stay in female company. After marriage, the bride is allowed limited communication with her husband, especially in the presence of others. Her interactions with her husband increase when she becomes a mother, and she is sometimes also assigned duties outside the *bari*.[18] Nonetheless, one of the main roles of the wife is to obey her husband (Aziz 1994).

These gender norms mean that Bangladeshi women bear a major burden of the state's 'modernisation' project. While the government promotes development of the garment industry, for example, a study of female garment workers in Dhaka (Kabeer 2000) demonstrated the difficulties faced by women in taking employment outside the household. They were met by resistance from fathers, their husband's extended family, religious leaders, community members and even the media over their work choices and were frequently subjected to violence. A similar conflict occurs over the bodies of women in the area of family planning and women's health. Although the government promotes family planning, women trying to achieve better outcomes for themselves and their children often believe that contraception is 'against religion' and face limitations imposed by family networks. Introducing gender to the analysis reveals the 'struggle, contest and negotiation' (Silvey and Elmhirst 2003, p. 866) that constitute the 'dark side' (Fine 2003) of social capital.

Health Intervention

i) Government program

During the period 1978 to 1980, the government of Bangladesh recruited thousands of full-time local field workers, or Family Welfare Assistants (FWAs) to motivate couples to adopt family planning and to distribute contraceptives at the community level in all regions of Bangladesh

[18] In recent years, the interactions between husband and wife have become less restrained.

(Phillips, Hossain and Arends-Kuenning 1996). The FWAs[19] (field workers) are responsible for supplying oral pills and condoms at clients' homes, and field visits are required to take place once every two months. In general, each field worker is responsible for 700-800 women. The field workers are overseen by approximately 6000 supervisors (Routh et al. 2001). Family welfare centres (FWCs) were established in the 1980s and these centres have been provided with trained paramedics called family welfare visitors (FWVs) for maternal and child health (MCH) and family planning services (Saha 1994). There is one FWC for every 25,000 people. Depo-medroxy-progesterone acetate (DMPA) injections and intrauterine devices (IUDs) are provided at Family Welfare Centres (Khan and Rahman 1997). Sterilisation procedures – tubectomies and vasectomies – are mainly performed at the sub-district level or at *upazila* health complexes which are generally within two hours' travelling distance for most people in rural areas and serve a population of fewer than 200,000 people (Cleland and Mauldin 1991).

A social marketing program to promote the sale of birth control pills and condoms was also initiated in the mid-1970s. Another characteristic of the population program is the involvement of more than 200 nongovernmental organisations (NIPORT et al. 2005). The method of doorstep delivery was briefly abandoned by the government but has been reinstated since 2003 (Directorate General of Family Planning, Ministry of Health & Family Welfare n.d.).

ii) International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B)

The Matlab region in Bangladesh has been long been the focus of scientific experiments. It was initially targeted for a field trial of cholera vaccine, conducted between 1963 and 1968, by the Cholera Research Laboratory. Along with this vaccine trial, effective and prompt treatment was provided to people suffering from the disease. A surveillance system recording vital events such

[19] Family Welfare Assistants (FWAs) are also referred to as government field workers and government health workers in this research.

as birth and deaths in each household for most of the Matlab region was also introduced (Fauveau 1994).

The family planning program in the Matlab region was first started in 1975 by the Cholera Research Laboratory (now the ICCDR,B). Initially, the program provided home delivery of contraceptives in 150 villages with a population of 125,000, while another 84 villages with a population of 135,000 were used as a comparison group. An immediate result of this was observed with reduced fertility and increased contraceptive use. In 1977 some of the program features were modified and a much more intensive program called the Family Planning Health Services Project (FPHSP) was launched. The study area was divided into a treatment area of 70 villages with a population size of 80,000 and comparison area of 79 villages and a population size of 89,000. Intensive family planning services were provided only by the ICDDR,B in the treatment area and the comparison area was served by the government program. ICDDR,B established a central facility in Matlab *bazaar*[20] (market), staffed by a physician, two female family planning visitors, a record keeper and two clinic attendants. This centre provided family planning supplies and clinical methods of family planning, and conducted treatment of side effects and complications arising due to contraceptive use and abortions (Bhatia et al. 1980).

Four sub-centres were established, each covering a population of 20,000 and staffed by a resident 'lady family planning visitor' (LFPV). The sub-centres provided similar services to the main centre but had the added responsibility of training female village workers. A total of 80 female village workers (FVWs) were recruited, primarily to visit and provide services to married women in their homes. The recruitment criteria required that FVWs had some education, were residing in the same village, were married, had personal contraceptive experience and were from families

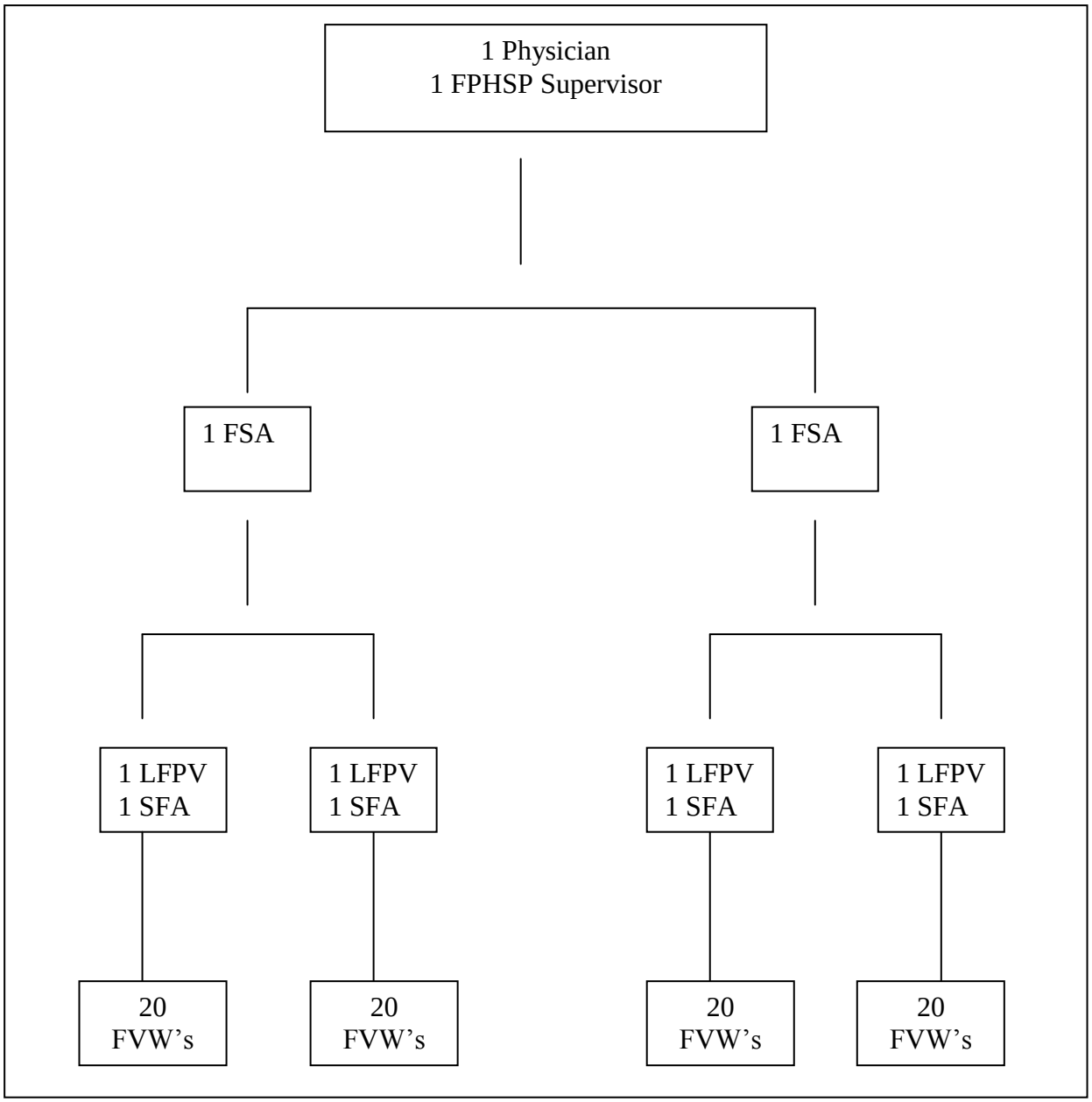
[20] Matlab *bazaar* is the main market in the area. Various other local marketplaces can also be found near most villages in Matlab.

that were respected in the community. The FVWs were responsible for providing services to twenty families per day (each family was visited once every fortnight) and were expected to undergo constant training.[21] Senior field assistants (SFAs) were also recruited and carried out the responsibility of providing support to the village workers, discussing program benefits with male members of the household and community leaders, and visiting families in which women were experiencing personal and medical difficulties. The senior field assistants and female village workers were supervised by a field surveillance assistant (FSA), and a physician was responsible for conducting the whole project. Table 3.1 details the structure of the program (Bhatia et al. 1980).

The services provided by the FVWs at clients' homes included giving information and supplying various non-clinical contraceptives, including oral pills, condoms and DMPA injections; information about proper nutrition and hygiene for the mother and child both during and after pregnancy. Information about better infant and child nutrition, tetanus toxoid immunisation, and iron and folic tablets for pregnant women was made available, and FVWs also provided counselling to women and kept a record of vital events in the households of both treatment and control villages. IUD insertions and removals were conducted at the sub-centres (Bhatia et al. 1980). The system of home delivery of non-clinical contraceptives and other supplies has been gradually phased out in the last ten years. During the time of this study, all the villages in the treatment area had fixed sites in place for obtaining contraceptive supplies, but sterilisation procedures are no longer provided by ICDDR,B and are only performed in the government facilities. All other features of the program are still in place.

[21] Female village workers (FVWs) is used interchangeably with the term ICDDR,B field workers and ICDDR,B health workers in this research.

Figure 3.1: Structure of the ICDDR,B program in Matlab(adapted from Bhatia et al. 1980)



Key: FSA- Field Surveillance Assistant; SFA- Senior Field Assistant; LFPV- Lady Family Planning Visitor; FVW- Female Village Worker

The cholera vaccination trial and the services provided helped to gain the trust of the community, as the number people suffering from the disease were reduced. During the introduction of the various components of different projects, however, the villagers sometimes became suspicious of the intentions of the field workers and other ICDDR,B workers. For instance, since vaccinations were provided using injectables (DMPA), villagers at first suspected that they were being given

family planning injections that would lead to an inability to conceive a child in the future. Minor side effects due to the vaccinations also caused a sense of panic. Certain field trials needed the collection of blood samples, which was not welcomed due to the local belief that the loss of single drop of blood could result in permanent loss of strength. Moreover, data collection and field trial questioning related to menstrual cycles, sexual behaviour, personal hygiene, stillbirths and induced abortions made the villagers extremely uncomfortable (Aziz and Mosley 1994).

Such difficulties have only been overcome by using village health workers who have been able to establish a rapport with community members. Because the village health workers reside in the same village and have personal experience with the health services, they have been able to establish credibility in the eyes of the villagers and individual women. In addition, the village workers established fictive kin[22] relationships with their clients to encourage them to freely discuss sensitive issues (Aziz and Mosley 1994).

Implications for social capital research

The issues discussed above highlight the fact that acceptance of health services is as much a social process as an individual one. The individual's acceptance of health services is not a simple demand-side decision; for example, the simple process of accepting vaccination can be received with suspicion and hostility unless other people's positive experiences with the vaccines have been established. The supply of a set of health services is not the only issue here: convincing the population of its advantages is also a major challenge.

In a society in which women's mobility is limited and major health decisions are taken in accordance with traditional practices, access to information through networks can be invaluable

[22] Fictive kin are unrelated by birth or other family ties but are given the kinship title and in many ways are treated as part of the family. For example in the context of Matlab the health workers were often referred to as elder sister (*apa*) by the clients, even though they had no biological connection to the client.

(Chapter 6). In Matlab, for example, an individual woman's acceptance of contraception can be partially explained by her interaction with health workers who are familiar with its usefulness and are therefore able to convince the woman of its advantages. A woman can thus be induced to adopt family planning services after observing positive effects of this in her immediate networks. The same holds for the women accepting work in garment factories. Kabeer (2000) reports that although the first wave of garment workers in Bangladesh were women who took up work in the factories for reasons such as economic hardship, or to pay for their children's education, the second wave was induced to take up employment as a result of interactions with other women already exposed to the industry.

On the other hand, in the case of Matlab and many parts of Bangladesh, women adhere to strict gender norms which are reinforced by close family members; thus, if most networks are kin and family-based, such networks might be more limiting than liberating. Bearing children is one of the most important expectations of a married woman in the Matlab region. Failure to produce offspring provides the husband with a legitimate excuse for divorce or additional marriage (Bhatia 1981). Furthermore, women are under enormous pressure to deliver male offspring (Balk 1997; Chowdhury and Bairagi 1990). In these circumstances, failure to meet the expected level of fertility could lead to pressure to not use contraceptives.

Data

The questionnaire

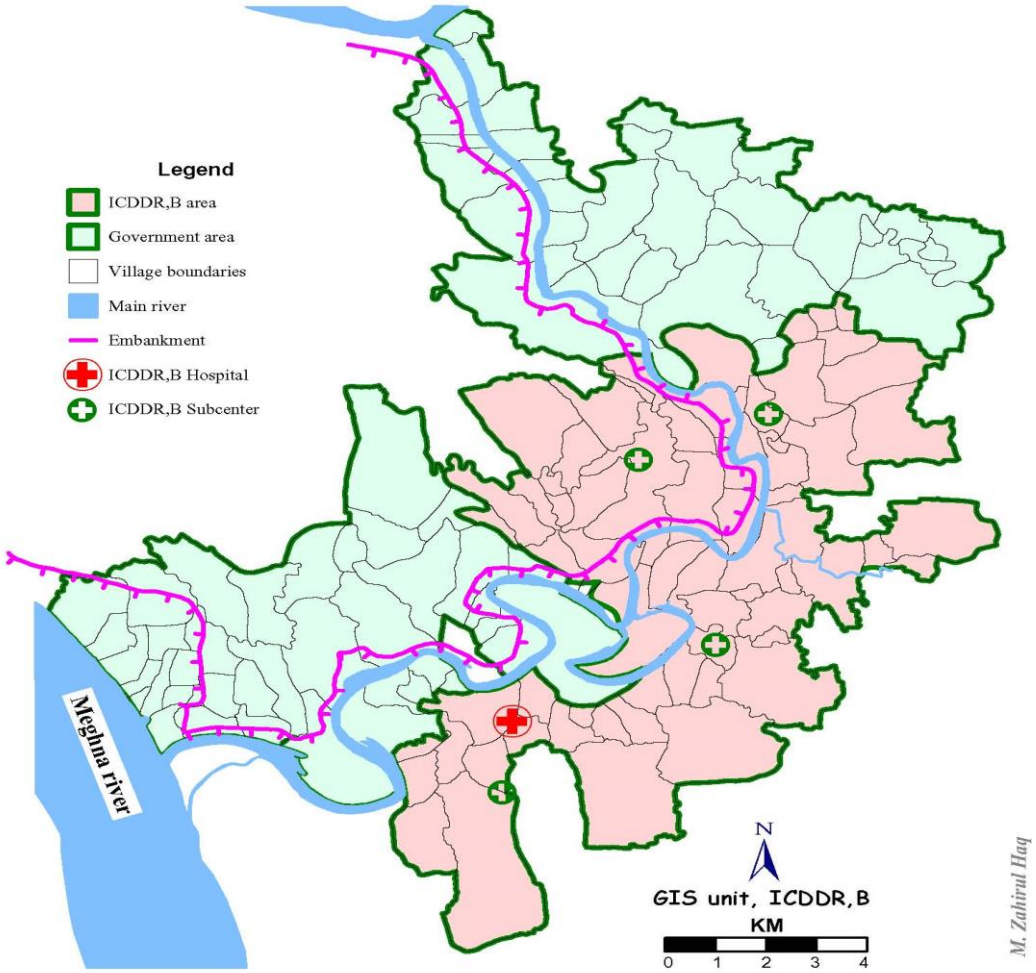
The questionnaire was designed to suit the context of Matlab, and the Matlab Health and Socioeconomic Survey (1996) and Bangladesh Demographic and Health Survey (2004) were closely consulted to ensure the design was culturally relevant. Individual interviews with women

included questions on age, education, household structure and assets, dwelling structure, occupation, marital history, pregnancy history, contraceptive use, reasons for not using any method, female autonomy, visits by health workers, and social networks. Male interviews were restricted to questions about contraceptive use and social networks. Both men and women were asked to 'name five people with whom they discuss fertility and family planning issues excluding their spouse'. Information was also collected from the respondents about their network members' location, frequency of contact with the network members, views of network members on family planning, whether the network members used or did not use contraceptives and which method network members used. Detailed information on whether or not the respondent was visited by health workers and the service provided in this visit was also collected.

Data collection

The study design took advantage of health intervention in the region by selecting villages from the treatment and comparison areas of Matlab. This allowed us to observe whether intensive health intervention causes alterations in the local network structure. Village selection was made on the basis of data derived from earlier surveys on the Contraceptive Prevalence Rate (CPR), wealth, education and population. Villages were also selected on the basis of their proximity to a health facility and the local market, to control for differences in contraceptive access.

Figure 3.2 Map of the Matlab Area



The Matlab area is divided into two regions by the river Meghna, which is a cause of regular flooding in the region. Villages were selected from the area on the right side of the river, as shown on the map. The left side enjoys the benefits of an embankment which protects it from regular flooding, which in turn leads to higher income in the region. Restricting the selection to the right side helps to control for large income disparities between villages which could cause variations in observable and unobservable health benefits. Unfortunately, no other controls for income were possible. The average education level in the area is 3.39 years (provided by

ICCDR,B for the year 2004) and the sample included villages that closely represented this average. The average contraceptive prevalence rate in the government area was found to be 48.1% and in the ICDDR,B area to be 70.1% (provided by ICCDR,B for the year 2004). Villages with both high and low contraceptive prevalence rates (CPRs) were included in the sample to examine whether network structures differed in villages with differing CPRs. Caution was exercised in interpreting the statistics on CPR as they did not always match the field experience. This may reflect the fact that the CPRs were based on information collected in 2004, while the data for this study were collected in 2007. Since figures on CPRs after 2004 were not available at the time, local personnel were consulted about the CPRs in villages to ensure that villages with varying levels of CPR were selected for the research. The study was restricted to villages with less than 2000 people, which allowed us to obtain samples of manageable sizes.

The villages included in the sample are listed in Table 3.1.

Table 3.1: Sampled Villages

Village Name	Education	CPR	Total Population	Male Interviews	Cluster
Pailpara	3.40	71.8	1507	Completed	Cluster B
Shahpur	3.29	69.0	932	Completed	Cluster C
Tatkhana	2.70	69.6	555	Not Completed	Cluster C
Sobahan	2.41	51.6	1081	Completed	Cluster D
Gangkanda	4.48	44.3	609	Not Completed	Cluster D
Bakchar	3.25	41.5	1094	Completed	Cluster E
Ketundi	3.40	40.1	1463	Not Completed	Cluster F

Some of the selected villages are adjacent to each other. These are treated as one cluster because they are identical in their socio-economic characteristics; for example, villages Shahpur and Tatkhana are treated as one cluster because they are adjacent to each other and the total population size in these villages is well under 2000.

The data were collected using the snowball method. We began with a random sample of 1% of the eligible couples in each of the selected villages (*round one*). The eligible couples included

currently married women between the ages of 15-49 and their husbands. The names and addresses of all the married women in the 15-49 age group in each of the selected villages was provided by ICDDR,B. The data on married women has been regularly updated by ICDDR,B through field visits in both the treatment and the government area since the inception of the family planning program in the Matlab area. Regular field visits by ICDDR,B workers ensures that the information is reliable as well as up to date. However the data on the residential status of the husband was not available to the researcher and was ascertained at first contact between the selected individuals and the interviewers. If the husband was not currently residing in the village, the couple was dropped from the random sample and replaced with someone who met the criteria. Each of the selected respondents was asked to 'name five people with whom they discuss fertility and family planning issues excluding their spouse'. Both husband and wife were asked the same question separately. All the network partners named were tracked down and asked for their five ties (*round two*), if they were not already included in the original list. The new contacts identified in round two were followed and asked for their five ties (*round three*). At this stage, the process was terminated because of time and resource constraints. All the network partners identified in the first and second round were tracked and interviewed. But any new contacts identified in round three were not followed.

Unlike comparable research on family planning networks in Bangladesh by Gayen and Raeside (2005), criteria of age, residential (except in the first round), marital or fertility status were not used to exclude network partners from this research. As a result, many respondents lived outside the cluster boundary, especially in the case of male network partners. Respondents residing outside the Matlab area were not followed. This problem was negligible in the case of female respondents but was more acute in the case of males, as men often named network partners who resided outside the Matlab area. Despite this, more than 85% of the male network partners and

95% of the female network partners were successfully interviewed for this research, although it was not possible to complete the male interviews for all the villages due to time constraints.

Since men spend most of their time outside of the household they were harder to track and required a greater allocation of resources than was available. For this reason, Cluster F and some of the smaller villages were excluded for the male interviews in the initial stages of random sampling, although the female interviews were successfully completed in all the villages. Social network data collected in this way is a probability sample and individual observations should not be treated as independent. Due to the selection of a random sample in the initial stage, we control for the possibility of overlooking members of the population who are not actively involved in the local networks. This approach makes it possible to collect information about the characteristics of the network partners by network partners themselves, and the sampling technique avoids the imposition of the researcher's subjective boundaries on the community. The importance of this was demonstrated when both men and women reported network partners in other villages, although this was more common for men.

Field experience

Every effort was made to conduct the research independently so that the data would be free of the influences of organisations working in the area of Matlab, such as the government and other NGOs like ICDDR,B. Despite our efforts, however, the villagers often associated the research team with ICDDR,B and because ICDDR,B has been working in the area for more than 30 years, it was difficult to convince the villagers otherwise. This may lead to underreporting or over reporting of certain events. For instance, in a conversation with a female respondent from the non-intervention area, it was found that she received her supply of pills from a relative within the intervention area. Since the methods in the treatment area are only available for personal use, it seems that the pill user in the intervention area took the pills for herself but did not use them.

But association of the research team with ICDDR,B would lead such a respondent to report that she was using the pills herself.

Some questions in the survey may be subject to misinterpretation. The question about the names of people with whom the respondent discussed fertility and family planning issues was at times misinterpreted by the male respondents. The male respondents occasionally believed that this question was related only to contraceptive use and did not report the names of the people with whom they discussed matters related to family size. This may lead to some underreporting by male respondents. The same problem is not likely to be present in the information provided by women about network partners. It was found that women discuss fertility as well as contraceptive use with the network partners. In most cases, the respondents could provide elaborate details about the network partners' family planning choices. Men, on the other hand, often reported not knowing about their network partners' method choice.

The questions on whether or not the respondent used a particular contraceptive method suffered from a few difficulties. Male respondents were often not aware of the method chosen by their wife; either their perceptions were incorrect or they gave incorrect information to mislead the team. For this reason, network effects on contraceptive use is not analysed in the case of male respondents (Chapter 6). Female respondents, however, were never found to report the method used incorrectly.

In more general discussions, pill users were found to have a high non-compliance rate, which is not reflected in answers to the question on whether or not the respondent is currently using a method. Pill users often reported irregular use, predominantly due to side effects, lack of knowledge, and their husband's absence from home for a few days leading to forgetfulness. This incorrect use generally resulted from the inability of the respondent to read the instructions

provided with the packet. Also, pills are sometimes bought in pharmacies by the respondent's husband without consulting the pharmacist on correct use, due to embarrassment.

Side effects were reported by the users of other methods as well, but less commonly led to incorrect use. Commonly reported side effects were nausea, headaches, obesity, and loss of strength, irregular menstruation and dizziness. Loss of strength was feared most strongly with sterilisation. This is likely to affect the adoption of this method but cannot cause discontinuation. Injection was found to be most strongly related to obesity, thought to be brought about by the halt in menstruation caused by the method. Since injection demands a visit to the clinic once in three months, women are not able to misuse once the dose is given. Nevertheless, women occasionally reported delaying the next visit or skipping an injection till after menstruation. Condoms were not reported by the respondents as causing side effects.

It was observed during the survey that respondents were often confused when answering questions about contact with health workers. The question was meant to collect information on contact with FWAs in the government area and FVWs in the ICDDR,B area. However, the respondents sometimes identified data collection workers for ICDDR,B in the non-intervention area as health workers and would seek advice from them. As a result, the information collected on whether or not the respondent was visited by the health worker or frequency of contact suffers from misinterpretation bias. Fortunately, the social network data helps to overcome this problem. Health workers and data collectors were often reported as network partners, and since they were also interviewed as part of the survey, we are able to distinguish between the two. It should be borne in mind that individual women may have been contacted by health workers but may not report them as network partners if they do not deem them as important influences in their lives. Even so, the method accurately determines whether a community is regularly contacted by health worker or not.

During the fieldwork we also came across some unexpected information on service providers. Although theoretically women are supposed to receive contraceptives free of charge from the government health centre, they often reported that they were charged for them. Injectable contraceptives were also reported to be available in some of the pharmacies although private medical practitioners are not permitted to market this product. Some providers were further observed to misbehave with the respondents. This information was not collected as part of the survey but is likely to have an effect on contraceptive choice.

The data is unlikely to suffer from any further biases. Random checks were carried out throughout the survey to check the accuracy of responses. In the case of female interviews, 70% of the respondents received a second visit for cross-checking. The checks for men were restricted to 30% to 40% of the respondents. In villages where male respondents were found to deliberately mislead the interviewers, all the interviews were conducted again by the researcher. Being a female team leader, the process of cross-checking the male answers was more difficult. Both men and women felt that it was inappropriate to hold discussions related to fertility with the opposite sex. The community had to be assured about the researcher's intentions before any checks were carried out in each of the villages, and since males were mostly unavailable for interview due to work commitments outside the house, the cross-checking had to be limited to fewer cases.

Summary statistics

The data for this research was collected for a total of five clusters, each cluster being composed of one or two villages.[23] Three clusters belong to the government area and two belong to the ICDDR,B area. The clusters in the treatment area are close to the ICDDR,B sub-centres which provide maternal and child health services. The clusters in the comparison area each have a

[23] The networks associated with a particular cluster can be composed of several villages because network partners were followed even if they lived outside the cluster boundary.

government run family welfare centre in close proximity. The clusters also have a local market and pharmacy nearby.[24]

Separate interviews were conducted with both men and women in each cluster. These interviews included questions about network partners, who were followed in subsequent rounds. In the majority of cases, neither men nor women identified members of the opposite sex as their network partners.[25] This resulted in two largely sex-segregated networks in each cluster with only a minimal degree of overlap; hence, these two sets are treated separately throughout this research and are referred to as the male and female network. The total number of respondents sampled in each of the clusters is listed in Table 3.2.

Table 3.2: Sample Size

	No. of respondents in the female network	No. of respondents in the male network
Cluster B	153	145
Cluster C	151	96
Cluster D	146	106
Cluster E	104	83
Cluster F	106	-
Total	660	430

As shown in the above table the male networks are consistently smaller than the female networks in each cluster. Unlike conventional sampling techniques, the size of the data set was not fixed at the outset and depended on the number of new network partners identified in each round. Men generally identified fewer network partners, which resulted in smaller networks for males compared to females. On average, women reported talking to 3.4 people about fertility and family planning issues whereas men reported talking to only 2.9 people.

[24] Except for Cluster E, all the selected Clusters also have access to the main road, connecting Matlab centre to Dhaka, within walking distance. However in the case of Cluster E access to the main road requires some form of transport.

[25] The problem of sex segregation is more acute in female networks. Only three male contacts were identified in the female networks, while 14% of the contact persons in the male networks were female. However a large proportion of female contacts in the male network were concentrated in Cluster B.

Compared to females, fewer males were selected for round one interview in Cluster C and Cluster D, and a greater number of male networks partners were lost because they resided outside the Matlab area. This results in smaller networks sizes for males and provides a partial view of the male networks. Nevertheless, this research is the first ever in Bangladesh to collect information on male and female networks using snowball techniques, without imposing subjective boundaries on the sampled communities.[26] For this reason the networks associated with each cluster do not necessarily follow the geographic boundaries of their respective clusters, especially in the case of male networks. A greater number of male network members were living outside the cluster boundary compared to females. As a result, many residents from the villages that were dropped in male round one interviews were automatically incorporated in networks of Cluster C and Cluster D in rounds two and three. 8.3% of the respondents in Cluster C and 6.1% of the respondents in Cluster D were living in villages that were dropped in round one. The number of respondents interviewed who resided outside the cluster boundaries is listed in Table 3.3 and Table 3.4.

Table 3.3: Female Network

	Total no. of actors	No. of actors living outside	% of actors living outside
Cluster B	153	28	18.30
Cluster C	151	17	11.26
Cluster D	146	15	10.27
Cluster E	104	9	8.65
Cluster F	106	11	10.38

Table 3.4: Male Network

	Total no. of actors	No. of actors living outside	% of actors living outside
Cluster B	145	39	26.90
Cluster C	96	29	30.21
Cluster D	106	43	40.57
Cluster E	83	25	30.12

[26] For an exception see Kincaid (2000). Although this study employs snowball sampling in studying family planning networks in Bangladesh, it starts from link persons and does not include any information on the male networks.

As evidenced from the above tables, a significant proportion of network members live outside the cluster boundary in both the male and female networks, but male contacts are more widely distributed. The lack of restriction on network partners' residential status is thus of paramount importance in identifying the network structure, especially in the case of men.

The socio-economic characteristics of the respondents are examined next. The discussion is limited to female networks as this information was not collected for male networks, but if a male contact was identified in the female network then relevant socio-economic information was collected. Moreover, it was deemed unnecessary to interview all female network partners for the full length of the survey because many identified respondents were not of childbearing age, or were not living with their husband, or were post-menopausal. Although these women are an integral part of the networks, their contraceptive status is not analysed (Chapter 6) and therefore detailed responses to all the questions was not regarded as essential to this research. Selected information is, however, available for every participant in the female network. Table 3.5 shows the basic characteristics of the respondents in female networks in each cluster. A total of three male contacts, who are part of the female network, are also included in this analysis.

As Table 3.5 shows, more than 90% of respondents in each cluster are currently married.[27] The remaining female respondents are widowed or separated. The mean age is 35, which suggests that respondents tend to be older women who have met their fertility goals, although the age range and standard deviation indicate that younger women are also part of the contraceptive networks. Although the legal age of marriage is 18 in Bangladesh, married women as young as 15 are identified in these networks; thus, discussions of family planning are not restricted by age or marital status in the female networks. No unmarried women were identified in the data.

[27] A handful of observations suffer from missing values and thus in some cases the number of observations listed in the following tables is less than the number of respondents surveyed in each cluster.

The data in Table 3.5 show that despite decades of intervention and exposure to ICCDR,B staff in Matlab, the lives of women continue to be organised according to the gender norms. Very few women head their own households and generally the husband is the household head. Female headship mainly occurs in the absence of a male member for reasons such as death or migration. In addition, female education levels are low. The education levels were measured in years of schooling ranging from zero to twelve. Any higher education beyond class twelve was classified as thirteen. The mean educations levels are under five years in all clusters and less than 10% of women are employed outside of the household. The lowest employment rate was found in Cluster E, where it was only 2.88%. During the fieldwork, Cluster E was found to be one of the wealthier villages and this suggests that female employment might be negatively correlated with wealth.

Table 3.5: Socio-economic characteristics (Female Networks)

Cluster B					
Variable	Obs	Mean/Percent	Std. Dev.	Min	Max
Age (years)	152	35.25	9.63	18	61
Education (years)	152	4.97	3.97	0	13
Currently Married	152	97.37%		0	1
Head of the household	152	9.21%		0	1
Currently Employed	152	7.24%		0	1
Religion Islam	152	100.00%		1	1
Cluster C					
Age (years)	151	36.05	10.74	18	64
Education (years)	151	3.68	3.69	0	12
Currently Married	151	96.69%		0	1
Head of the household	151	9.27%		0	1
Currently Employed	151	6.62%		0	1
Religion Islam	151	94.04%		0	1
Cluster D					
Age (years)	146	34.97	9.27	15	59
Education (years)	146	3.74	3.79	0	12
Currently Married	146	94.52%		0	1
Head of the household	146	11.64%		0	1
Currently Employed	146	7.53%		0	1
Religion Islam	146	86.99%		0	1
Cluster E					
Age (years)	104	35.19	9.84	17	57
Education (years)	104	4.19	3.55	0	12
Currently Married	104	96.15%		0	1
Head of the household	104	10.58%		0	1
Currently Employed	104	2.88%		0	1
Religion Islam	104	100.00%		1	1
Cluster F					
Age (years)	106	36.25	8.14	17	55
Education (years)	106	4.30	3.85	0	13
Currently Married	106	97.17%		0	1
Head of the household	106	12.26%		0	1
Currently Employed	106	9.43%		0	1
Religion Islam	106	100.00%		1	1

The husband's occupation in Table 3.6 is used to capture the economic standing of women, as very few women in the sample were engaged in work outside the household. Although the husband's occupation provides a suitable proxy for economic status, ideal measures would have been household income or expenditure (Bollen, Glanville and Stecklov 2002). Such data, however, is extremely costly to collect in developing countries because of a heavy reliance on subsistence farming, therefore the market value of income and expenditure has to be estimated,

preferably over time, to obtain an accurate measure (Bollen, Glanville and Stecklov 2002). This was beyond the means of this research.

Occupation of the husband is therefore used as a proxy to capture wealth. Occupation is coded using dummy variables. 'Farmer' is coded as one if the respondent's husband is working on his own or leased land. The category 'Wage labourer' includes people working as agricultural, unskilled or skilled labourers. Very few respondents reported their husband's occupation as 'skilled labourer'. 'Business' represents anyone who is self employed. 'Service' captures paid employment in government, private sector or with NGOs. If the husband was reported to be working overseas, this is represented in separate category and is labelled as 'Service_abroad'. The groupings 'Farmer', 'Business', 'Service' and 'Service_abroad' generally represent more affluent households which either have access to land or a regular income.[28] People in the 'Service_abroad' category were observed to be among the wealthiest households during the fieldwork. On the other hand households in the 'Wage labourer' category tend to be poorer households which provide labour to farms, shops and households on an ad hoc or casual basis. 'Unemployed' tend to be the poorest households. The category 'Other' includes fishermen, boatmen, people working as shoemakers and in factories. Each of these occupations is poorly remunerated, hence they are classified together. Approximately 3% of the households in each cluster do not fall under any of these categories because of the death of the husband, or because the respondent is male.[29]

Occupational categories in Table 3.6 show a greater degree of variation across clusters as distinct from the socio-economic characteristics listed in Table 3.5. Clusters B and C, which are in the ICDDR,B areas, have the lowest proportion of unemployed people. These clusters also have the

[28] Households in these categories were not usually observed to be impoverished during the fieldwork and also possessed more assets and tended to live in better quality housing.

[29] An alternative to 'husband's occupation' could be 'household head's occupation'. In many cases, however, the identified head was not the main income earner in the family, hence the 'husband's occupation' is considered to be a better proxy.

highest number of people employed in the service category. Furthermore, Cluster B has a significant number of people working in each category and Cluster C is predominantly business, followed by farming on own or leased land. It is likely that the presence of ICDDR,B in these areas has generated opportunities for non-farm employment; however, sufficient information is not available to ascertain this. It is also likely that since Cluster B is closest to the Matlab *bazaar*, more employment opportunities are available to this cluster than other clusters. In Clusters D, E and F, most people are working as farmers on their own or leased land, and as wage labourers. Cluster F has the greatest number of people working as 'farmers', and Cluster E has the greatest number of people working overseas.

Although the occupation of the husband is used to proxy wealth, the measure suffers from difficulties. For example, households deriving income from working on their own farms may not necessarily be better off than households deriving income from wage labour if the size of the land cultivated is small. Also, other members of the family may provide regular support if the husband's income is inadequate. For these reasons, additional controls such as dwelling structure, assets and income from overseas were included in this research.

Table 3.6: Husband's Occupation (Female Networks)

Cluster B				
Variable	Obs	Percent	Min	Max
Farmer	148	20.95	0	1
Wage labourer	148	27.70	0	1
Business	148	22.97	0	1
Service	148	10.81	0	1
Service_abroad	148	10.81	0	1
Other	148	1.35	0	1
Unemployed	148	2.70	0	1
Not Applicable	148	2.70	0	1
Cluster C				
Farmer	150	22.67	0	1
Wage labourer	150	14.67	0	1
Business	150	34.00	0	1
Service	150	10.67	0	1
Service_abroad	150	8.00	0	1
Other	150	2.00	0	1
Unemployed	150	4.67	0	1
Not Applicable	150	3.33	0	1
Cluster D				
Farmer	144	26.39	0	1
Wage labourer	144	20.83	0	1
Business	144	20.14	0	1
Service	144	6.94	0	1
Service_abroad	144	9.03	0	1
Other	144	5.56	0	1
Unemployed	144	6.25	0	1
Not Applicable	144	4.86	0	1
Cluster E				
Farmer	104	31.73	0	1
Wage labourer	104	19.23	0	1
Business	104	9.62	0	1
Service	104	5.77	0	1
Service_abroad	104	23.08	0	1
Other	104	0.00	0	0
Unemployed	104	6.73	0	1
Not Applicable	104	3.85	0	1
Cluster F				
Farmer	104	38.46	0	1
Wage labourer	104	12.50	0	1
Business	104	14.42	0	1
Service	104	5.77	0	1
Service_abroad	104	17.31	0	1
Other	104	1.92	0	1
Unemployed	104	6.73	0	1
Not Applicable	104	2.88	0	1

In each cluster, the majority of households have tin or cemented walls in the house. The poorer households use mud or bamboo. This is represented in Table 3.7 using a dummy variable coded

as one if the main wall type is cement or tin and zero otherwise. Households receiving money from overseas are classified separately since 'husband's occupation' does not capture this source of cash inflow if other members of the household are a source of regular remittances. Possession of television or radio is also used to capture wealth. As evidenced from Table 3.7, none of the clusters consistently score higher or lower on each of these variables. However Cluster E has the greatest proportion of households benefiting from remittances.

Table 3.7: Wealth (Female Networks)

Cluster B				
Variable	Obs	Percent	Min	Max
Main wall type is cement or tin	152	82.24	0	1
Received money from overseas in the last 12 months	152	26.32	0	1
Own TV or Radio	152	45.39	0	1
Cluster C				
Main wall type is cement or tin	146	80.82	0	1
Receive money from overseas in the last 12 months	148	27.03	0	1
Own TV or Radio	149	47.60	0	1
Cluster D				
Main wall type is cement or tin	143	74.13	0	1
Receive money from overseas in the last 12 months	144	26.39	0	1
Own TV or Radio	144	62.50	0	1
Cluster E				
Main wall type is cement or tin	104	75.96	0	1
Receive money from overseas in the last 12 months	104	43.27	0	1
Own TV or Radio	104	36.54	0	1
Cluster F				
Main wall type is cement or tin	104	82.69	0	1
Receive money from overseas in the last 12 months	104	41.35	0	1
Own TV or Radio	104	55.77	0	1

The contraceptive prevalence rate (CPR) is analysed next and is based on the 'current contraceptive use status of the respondent and her husband'. Not everyone in the sample has been included in the analysis of contraceptive decisions. Snowball methods led to the inclusion of many respondents who were post-menopausal or living separately from their spouse (mainly due

to the migration of their husband to the city or overseas). Their contraceptive status is therefore not analysed. Respondents who reported having no ability to conceive for biological reasons were also omitted from the analysis. Table 3.8 lists the proportion of respondents omitted while calculating CPRs.

Table 3.8: Percent Omitted from CPR calculations (Female Network)

Variable	Obs	Percent Omitted
Cluster B	152	15.13
Cluster C	151	20.53
Cluster D	146	24.66
Cluster E	104	30.77
Cluster F	106	22.64

Table 3.8 shows that each cluster has a substantial number of respondents involved in family planning networks who are not making fertility choices for themselves. Although the contraceptive decisions of these respondents is not analysed in this research, the figures imply that women of all ages and fertility profile are of utmost importance in the family planning networks.

Table 3.9 shows the CPRs in the sample. Higher use of modern contraceptives was found in the ICDDR,B area. 77% of respondents reported to be using a modern contraceptive method in the ICDDR,B area and 60% in the government area. Table 3.9 also shows CPRs in the year 2004 provided by ICDDR,B for each cluster.

Table 3.9: CPRs (Female Network)

	CPRs for the female networks (data collected in 2007)	CPRs provided by ICDDR,B (for the year 2004)
	Percent Currently Using	Percent Currently Using
Cluster B	76.74	71.8
Cluster C	77.5	69.3
Cluster D	68.18	47.95
Cluster E	51.39	41.5
Cluster F	57.32	40.1

The data show that CPRs in the sample are much higher than the ICDDRB,B figures. Furthermore in 2007, CPR in the treatment area was 56.6% and 43.6% in the comparison area (ICDDR,B 2010). CPRs obtained through ICDDR,B and the sample figures are not directly comparable for several reasons. The ICDDR,B figures are based on the use of any method by married women in the age of range 15-49. Unlike the usual practice, the sample was not restricted to women between the ages 15-49. If women above the age of 49 considered themselves fertile, they were included in the analysis. Women younger than 49 who reported having no ability to conceive for biological reasons were omitted from the analysis. Traditional methods (such as coitus interruptus, calendar method) are typically included in CPR figures but were ignored in this research because field observations suggested that these methods suffered from misuse. A large number of respondents were also not using any method because their husbands were overseas at the time of the survey; hence, these women were excluded, but they are usually included in the statistics obtained from official sources.

The data for this research were collected from villages that were accessible from the main centre by public transport and had a health centre in the vicinity. These villages can therefore be expected to have a higher CPR than other poorly-connected villages in Matlab. The data was collected in the first half of 2007, before the monsoon season in Bangladesh. During the monsoon, villages in Matlab are frequently submerged in water, making it difficult for women to

travel; thus a dip in CPR can be expected during this time. Since monthly data on individual villages is not available for the year 2007, comparisons between the CPR rates reported here and the published statistics are difficult.

Lastly, it is possible that women in the sample are a select group that are more motivated to practice family planning or are more experienced than the rest of the population, and have been nominated as contact persons for this reason. Thus precisely for this reason the contraceptive prevalence rate may be high in the sample. Such selection bias cannot be controlled nor ruled out in this research. The bias is partially rectified by starting with a random sample in each cluster so that people with differing motivations for birth control are incorporated in the data. The results in Table 3.8 also reveal that the female networks include a large proportion of women for whom family planning decisions were not relevant at the time of the survey. Furthermore, analysis undertaken in Chapter 5 shows that female networks are largely bound to the *bari* of residence. All this suggests that these networks are general discussion networks rather than selected networks formed on the basis of motivation or experience with family planning.

Conclusion

This chapter has explained the social context in which rural Bangladeshi men and women determine their use of family planning and choice of method. The selected study area is one in which ICDDR,B has a long established program through which it has successfully raised the use of family planning by comparison with the 'non-treatment' area that relies on the government programs applied not only in Matlab, but elsewhere in the country. This study has selected villages from both 'treatment' and 'non-treatment' areas in order to observe network structures under different models of health interventions. Furthermore, by careful research design, we have selected villages that have similar socio-economic conditions and access to facilities such as a

local market, pharmacies and health centres for each of the 'treatment' and 'non-treatment' areas. This makes it possible to control for confounding socio-economic influences while comparing network structures across clusters. By snowballing from a random sample in each cluster, we have also avoided excluding respondents who may not be actively involved in the local networks. Although such biases cannot be eliminated completely, the problem would have been more acute if we had started, for example, from key family planning personnel.

The practice of purdah and associated seclusionary practices start as early as the age of eleven for most rural women in Bangladesh. Gender norms, which are further reinforced by the family and kin-based networks, are severely limiting factors for women trying to achieve better outcomes for themselves or their children. In this context, it would be unrealistic to believe that women act as independent economic agents. It is therefore necessary to study the choices women make in relation to the networks in which they are embedded. As we shall see, social capital is an inappropriate analytical tool for studying the complex web of social relations. Analyzing selected social networks in a positive light provides a misleading and shallow view of the social world of women and ignores important aspects such as the role of power, gender subordination and unequal distribution of and control over resources. Using tools of social network analysis, the next chapter demonstrates how these aspects contribute to fundamental differences between men's and women's networks.

4. Structural Analysis of the Networks

Social capital remains a vague concept which is difficult to associate with any distinct definition, meaning or indicator. The only element common to most social capital studies is that of social networks, but here, too, social capital literature generally takes a simplistic view of the role of social networks and links it with beneficial outcomes without accounting for issues of gender, power, conflict, inclusion and exclusion.[30] Such a simplistic view of networks runs the risk of exacerbating existing inequalities through incorrect policy prescription. An example of this is found in the practices of the World Bank that endorses the use of social capital for implementing development projects without taking into account the existing power relations or gender inequalities in communities. Furthermore, social capital literature mainly focuses on men's networks or assumes women to be naturally social and therefore the most competent social capitalists (Molyneux 2002). As previously discussed, the problem with this approach is not that women do not have social networks but that they derive very little power and opportunity from these networks compared to men (Mayoux 2001; Silvey and Elmhirst 2003).

This chapter focuses on drawing further attention to gender differences in the context of the family planning networks of men and women in Bangladesh. Gender differences are identified using concepts of density, cohesive subgroups and centrality from social network analysis. These measures are used to ascertain the constraints and opportunities faced by men and women in their networks. Our comparative analysis reveals the inequalities in social networks. It also highlights that networks are embedded 'in matters of exclusion and inclusion, power,…and conflict' (Fine 2003, p. 595). Thus, unlike social capital literature, we provide a holistic view of networks which accounts for both the positive and negative effects. The implications of the

[30] As previously discussed, this holds for most of the contemporary social capital literature; however, some social capital theorists like Bourdieu (1986) discuss the issue of inequalities in networks.

identified network structure on contraceptive decisions will be empirically tested later[31] (Chapter 6).

Before demonstrating the gender differences in networks, some basic principles of social network analysis are reviewed. Social network analysis is a study of patterns of ties or relations between actors, organisations or countries. The ties/relations linking its different members form a social network.[32] The regular pattern of relationships between actors is referred to as the structure of the network (Wellman 1983). Social network theory teaches 'that the structure of social relations determines the content of those relations' (Mizruchi 1994, p. 330). The structural properties of a network are thus studied to explain the constraints and opportunities on individual action (Wellman 1983). Social networks are argued to influence action by affecting access to resources such as information, wealth and power (Wellman 1983). Therefore social capital literature and social network analysis both emphasise the role of networks. Network literature, however, does not ignore the constraining nature of these relationships. Wellman (1983) states that network theory:

> deemphasizes analyses of why people act and emphasizes the structural constraints on their actions. It shifts attention away from seeing the world as composed of egalitarian, voluntarily chosen, two person ties and concentrates instead on seeing it as composed of asymmetric ties bound up in hierarchical structures. This shift has important consequences at all analytical scales. In studying communities, for example, it abandons spatial determinism and does not assume automatically that all communities are bound up in local solidarities. (Wellman 1983, pp. 156-157)

Thus social network analysis views individuals as 'bound up in hierarchical structures' rather than in cooperative and harmonious networks providing social capital. As previously discussed, demography literature also recognises the effect of networks on fertility behaviour. In

[31] The analysis of network effects on contraceptive choices will be restricted to women's networks due to data difficulties.

[32] The list of ties studied under social network analysis can be extensive, but common to all studies is the basic principle that the ties should form a link between a set of actors (Wasserman and Faust 1994).

demographic research, fertility control within marriage can be seen as an innovation that diffuses through a variety of sources including interpersonal networks (Valente et al. 1997; Montgomery and Casterline 1996). The literature further provides empirical evidence of the effect of social networks on family planning decisions in developing countries (Valente et al. 1997; Behrman, Kohler and Watkins 2002; Kincaid 2000; Rutenberg and Watkins 1997; Gayen and Raeside 2005). However, past research has been restricted mainly to women (for an exception to this see the Behrman, Kohler and Watkins 2002 study on Kenyan family planning networks), so the structural differences between the networks of men and women have not been explored. Furthermore, the techniques of social network analysis are only beginning to be applied in diffusion studies of fertility and their full potential is yet to be exploited; lack of suitable relational data may be largely responsible for this.

Using a unique relational data set, this research also expands on the demographic literature by extending the application of tools of social network analysis to study the structure of men's and women's family planning networks. The two data types of relational data commonly used by network analysts are sociocentric and egocentric. Egocentric data consists of the respondent, also known as the ego or focal actor, and his/her links; additional information on the connections between the nominated links, known as alters, is essential for egocentric data (Klovdahl 1985). This method provides a straightforward mechanism of collecting social network data but gives limited information on the structure of the network. On the other hand, sociocentric data are links between all the people in a specified population (Klovdahl 1985). This is also commonly referred to as a whole network. Although the approach yields maximum information, it requires identification of the boundaries of each population under study (Hanneman and Riddle 2005). In practice, this task is often not clear cut and the identified boundaries are often 'permeable and/or ambiguous' (Marsden 2005, p. 8), added to which, the whole network approach is difficult to

execute in large populations due to the costs associated with collecting data on each member of the population.

Due to the limitations of the egocentric and sociocentric approaches, we use the method of snowball sampling. The snowball approach begins with a set of focal actors and identifies their network partners. The identified network partners are tracked and interviewed for their ties, if they were not already part of the original list. This process can be continued until no new names are identified or until the researcher decides to stop.[33] This method thus overcomes the problem of boundary specification as well as provides rich relational data, although it is not effective in identifying isolates and does not guarantee that all the connected actors in a given population are identified (Hanneman and Riddle 2005). To reduce these biases in this study, the focal individuals were identified at random.

The methods used to analyse relational data in social network analysis can be formalised in a number of ways. This chapter uses the commonly employed representations of graph theory which provides a mathematical system of representing 'a social network as a model of a social system' (Iacobucci 1994, p. 93). The theory uses distinct and specialised language for representing social network models, and some of these basic concepts will first be covered here to aid the ensuing discussion. These basic concepts of graph theory provide the building blocks for the discussion of family planning networks undertaken in this chapter.

[33] The snowball method in this research was carried out for a total of three rounds (Chapter 3).

Structural Measures

Graph Theory[34]

In graph theory, points (referred to as nodes) are used to represent actors, and lines (also called edges) are used to represent relationships. A simple graph consists of an undirected dichotomous relationship, which is either present or absent, between each pair of actors. Examples of relationships represented using graphs include work, marriage, friendship and biological connections (Wasserman and Faust 1994).

A simple graph G consists of a set of g nodes/points, $P = \{p_1, p_2, ..., p_g\}$, and a set of lines/edges, $L = \{l_1, l_2, ...l_l\}$. A line in a graph is an unordered pair of distinct nodes, $l_k = (p_i, p_j)$. The line between nodes p_i and p_j is identical to the line between nodes p_j and p_i. The line between any two nodes is only included once in the set of lines and lines between nodes and itself are excluded. Thus a simple graph can be denoted as $G(P, L)$ (Iacobucci 1994). A simple graph can also be represented as a diagram as in Figure 4.1.

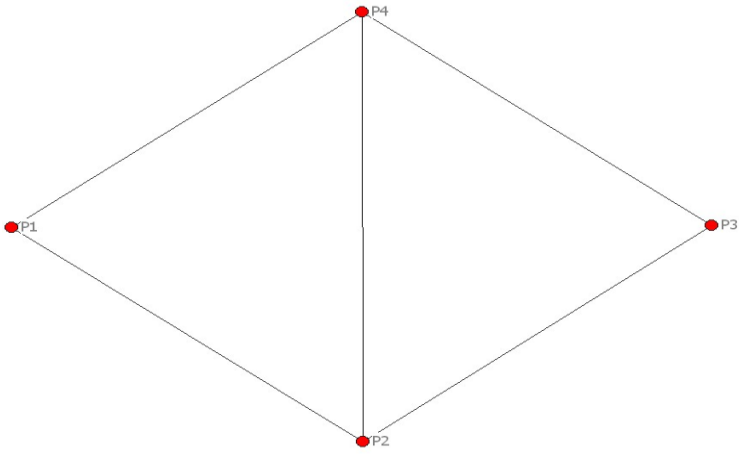


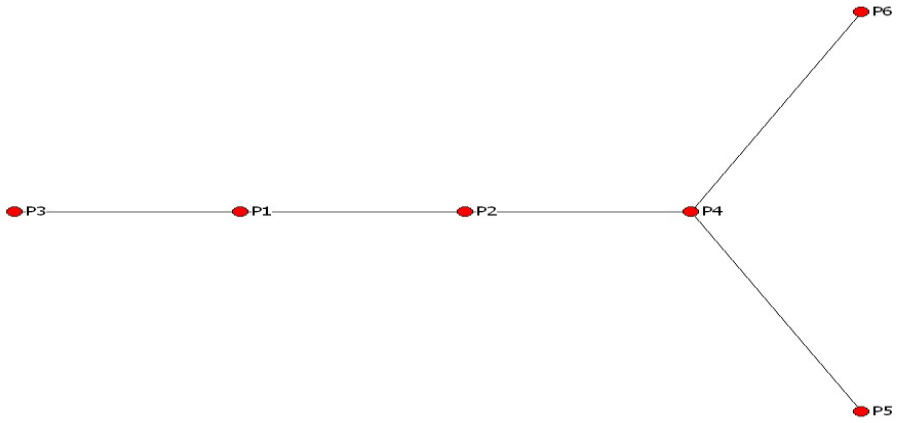
Figure 4.1: Graph or sociogram

[34] The formulas and notations in this chapter are largely derived from Wasserman and Faust (1994)

The points in Figure 4.1 represent actors and the lines represent relationships. Two points connected by a line have a direct relationship with each other and are considered to be adjacent (e.g. P1,P2). The number of points that a particular node is directly connected to are considered to be in its neighbourhood (Scott 2000). The total size of a particular node's neighbourhood or the number of nodes adjacent to it is its degree (in Figure 4.1, P1 has a degree of two).[35] However, a node may not be adjacent to other nodes but may still be connected through its neighbours. The idea can be explored using the notions of walks, paths and distances. A walk 'is a sequence of nodes and lines, starting and ending with nodes' (Iacobucci 1994, p. 105). A closed walk begins and ends with the same node. The length of a walk is determined by the number of relations or lines contained in it. In Figure 4.1 there are two walks of length 2 from actor P1 to P3 (P1,P2,P3 and P1,P4,P3) and two walks of length 3 (P1,P2,P4,P3 and P1,P4,P2,P3). Every walk that has distinct lines and nodes is a path. From nodes P1 to P3, walk P1,P2,P3 is a path, but walk P1,P2,P4,P1,P2,P3 does not qualify as a path. The shortest path between two nodes is known as a 'geodesic'. The length of the geodesic between two nodes is the geodesic distance or simply the distance between them (Wasserman and Faust 1994). In Figure 4.1, nodes P1 and P3 are not adjacent but they are still connected at a distance of two.[36] If there is no path between two actors then they are at an infinite distance from each other, hence they cannot reach each other, and the graph is disconnected.

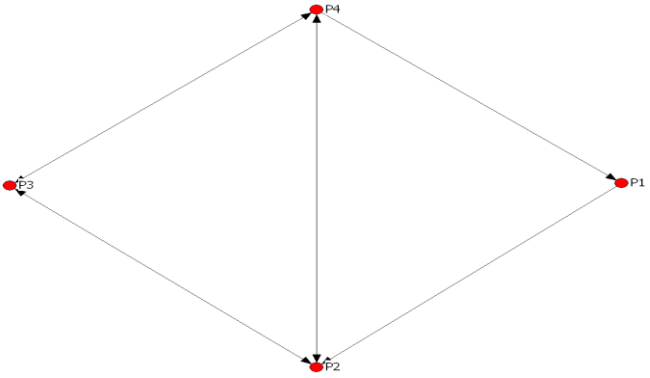
[35] Degree and number of ties are used interchangeably in this research.
[36] Adjacent actors are at a distance of one from each other.

Figure 4.2: Tree



Walks and paths can be further explored to define special kind of graphs called trees. A tree is a connected graph without cycles, which is a closed walk containing three or more distinct nodes except for the beginning and ending node (Wasserman and Faust 1994). Alternatively, a tree can be thought of as a graph with a unique path between every pair of points. In Figure 4.2, nodes P3 and P4 can communicate through only one path P3, P1, P2, P4.

Figure 4.3: Directed Graph



The methods of simple graphs can be extended to include ties that are directed from one actor to the other (called directed graphs or digraphs). A common example of directed ties includes friendship ties where one actor chooses the other but this choice may not be reciprocated. In directed graphs, the lines account for the direction of the relationship and are called arcs (Wasserman and Faust 1994). Although the data used in this research provides information on direction, the following discussion ignores the direction of ties, for a number of reasons. Firstly,

not all measures in graph theory can be used for directed ties. Secondly, in most cases it is easier to grasp the concepts for undirected ties. Thirdly, the data are based on discussion networks and therefore direction does not convey any particular meaning beyond the point that actors differ in their ratings of discussion partners.[37]

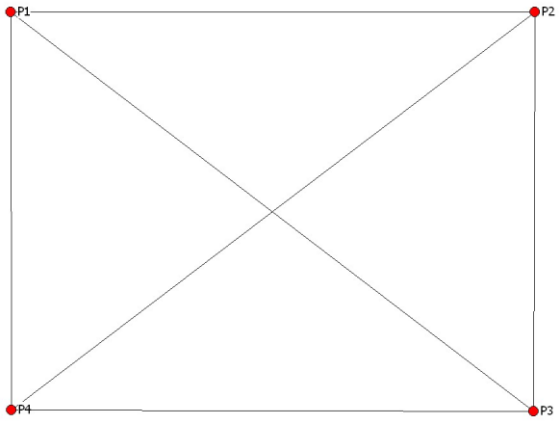
The basic graph theory concepts discussed in this section are used to explore the relational data in this research. These concepts are also used to describe the measures of density, sub group and centrality, used for analysing the structure of male and female family planning networks in this chapter.

Density

Network analysts frequently use density to capture the level of interconnectedness between actors or network cohesion, which is recognised as an important property of social systems in network studies (Krohn 1986; Marsden 1987). Density is not only popular but also the simplest measure of cohesion and can be analysed from the perspective of ego/personal networks or for the entire network. For the entire network, network density is the number of lines divided by the possible number of lines in a graph (thus both direct and indirect relationships are included in this measure). On the other hand, personal or ego network density consists only of an individual actor's direct relationship with others. While calculating personal network density, the individual actor and his/her direct contacts are ignored, and only ties between the contacts are included. The measures of density can vary from zero to one and a network reaches its maximum density of one when all actors have a direct relationship with each other (Scott 2000). A complete graph with a density of one is represented in Figure 4.4.

[37] It can be assumed that in our case there is a two-way information flow amongst all the actors that are connected through a direct tie, whether or not the tie is reciprocal.

Figure 4.4: A network with density of one



Although few graphs are fully connected (e.g. Figure 4.4) or fully disconnected, measures of density provide a ready index of the level of connectivity between a set of actors. Systems in which most actors know each other form a high density network in which actors are 'potentially subject to the reactions of all network members' (Krohn 1986, S84). In such networks, the strength of normative influences towards conformity is likely to be greater as network members can jointly influence a particular actor (Marsden 1987). Thus, greater density networks are potentially more constraining compared to low density networks in which network members do not know each other.

High density also implies that individuals have access to less diverse information. Individuals in dense networks are likely to have a higher frequency of information exchange with each other since information can be dispersed from a variety of channels and each member is likely to possess the same information. A closely interacting set of actors are also likely to be similar to each other due to the principle of homophily. Homophily is the degree of similarity between interacting pairs defined on the basis of factors such as beliefs, values and socioeconomic status. Prior research shows that individuals are most likely to interact with homophilous others and dense networks are more likely to be composed of homophilous individuals who are exposed to similar information and have similar beliefs, leading to the exchange of redundant information.

On the other hand, individuals in sparse or low density networks receive richer information through independent sources (Ibarra 1993; Rogers and Kincaid 1981).

Sparse networks are also likely to comprise a greater number of weak ties compared to dense networks. Ties with acquaintances can be considered as weak ties, whereas ties with close friends are strong ties. Weak ties are argued to be most effective in connecting socially distant individuals who are not similar to each other because they expose individuals to ideas, influences and information not available in the strong circle of friends. An individual's strong ties are highly likely to know each other resulting in a 'densely knit clump of social structure' (Granovetter 1983, p. 202). On the other hand, few acquaintances or weak ties of an individual, or 'ego' are likely to know each other, although these weak ties would be embedded in their respective 'densely knit clump of social structures' that are different to those of the ego. Weak ties form bridges that connect different social structures, and in the absence of such weak ties, the ego will not be exposed to ideas from socially distant individuals (Granovetter 1983, 1973).

Dense and weak ties have also been recognised in the social capital literature. Dense networks between homogenous individuals are classified as bonding social capital by Putnam (2000) and bonding networks are argued to be an essential ingredient in harnessing solidarity and reciprocity. Ties between individuals from differing social standing, by contrast, are classified as bridging social capital. Bridging social capital is argued to play a crucial role in accessing assets (Putnam 2000); however, what is less well recognised in the social capital literature but satisfactorily articulated in social network analysis are the negative effects of dense networks. Social network analysis acknowledges the potential of deriving social support in dense networks (Ibarra 1993), but at the same time it emphasises the constraining nature of dense networks. Our study takes the network approach to tease out both the negative and positive effects of networks.

Following theoretical advances in social network analysis, the structural measures of density have been incorporated into some demographic studies. As discussed in Chapter 2, Kohler, Behrman and Watkins (2001) use density to differentiate between the effect of social learning and social influence in networks on family planning decisions in a recent study of family planning networks in Kenya. They argue that social learning is maximised in sparse networks as these may be more effective sources of information than dense networks. If social learning is the dominant influence in family planning networks, then the effect of density is expected to be insignificant or negative. On the other hand, if social influence dominates, variations in the proportion of family planning users in the networks should be associated quite strongly with a woman's contraceptive use in dense networks, since normative pressures are stronger in dense networks. Using personal networks data, Kohler, Behrman and Watkins (2001) tested these network effects separately for high and low market activity regions in Kenya. The results demonstrate that in regions with low market activity, dense networks with many contraceptive users greatly increased the chances of adoption of contraception by the respondent. Density alone had a negative effect on using contraceptives, but a different picture emerges for regions with high market activity. In this case, one of the most important factors explaining contraceptive use was the number of users in the network. The interaction between density and the percentage of network partners using contraceptives was negative but not significant. The results show markedly dissimilar patterns in different regions and suggest that networks provide information as well as impose constraints on individual behaviour depending on the context (Kohler, Behrman and Watkins 2001).

Network study of family planning in urban neighbourhoods of the Philippines also provides some indirect evidence on the role of density. A study by Liu and Duff (1972) found that most women learnt about different methods of contraceptives from neighbours or through weak ties, and that women who lived in mixed neighbourhoods were better informed about contraceptive methods. A greater proportion of these women obtained this information from their neighbours

than women in homogenous neighbourhoods. The findings suggest that diffusion effects benefit more from weaker ties than strong ties amongst close friends forming a densely knit structure. The importance of weak ties is also demonstrated by Rogers and Kincaid (1981) in their study of family planning networks in rural Korea. They found that women were more likely to adopt family planning as the proportion of adopters increased in their personal networks. The links between different groups of women in the villages were more likely to be provided by weak ties than strong ones; thus, in the absence of weak ties, women would not be exposed to family planning practices of others outside their strong circle of personal networks.

Following the empirical and theoretical literature, density measures are used here to identify the level of cohesion in the family planning networks of men and women. It is expected that dense networks will provide less diverse information and subject actors to increased pressures compared to sparse networks. Some basic problems of the density measure must be considered before applying these concepts. Personal network density (used in demographic studies on family planning) only considers nodes directly linked to the ego and ignores the indirect links that may constrain the ego's behaviour. This problem can be overcome by calculating density for the entire network; however, this measure proves to be extremely sensitive to network size. In large graphs, the possible number of lines will be much greater than the actual lines leading to a low value of density. This is because any individual can only maintain a finite number of ties given the time constraints involved in making and maintaining ties (Scott 2000). To overcome these problems, cohesion is analysed using subgroup methods along with personal network density.

Subgroups

One of the primary concerns of social network analysis is the identification of cohesive subgroups within networks. Cohesive subgroups are 'subsets of actors among whom there are relatively strong, direct, intense, frequent, or positive ties' (Wasserman and Faust 1994, p. 249).

This definition is motivated by well-established theoretical literature in social sciences that argues that people tend to be strongly influenced by others with whom they have regular interaction (Wasserman and Faust 1994; Frank 2003). As a result of high interactions, members of a cohesive group are likely to be more aware of others' views in the group than non-members**.** Members in a group are also likely to be subject to interpersonal pressures that encourage reciprocity and compromise, leading to conformity in behaviour (Friedkin 1993) and the force of these pressures will be stronger in very cohesive groups compared to relatively sparse networks (Wasserman and Faust 1994). Friedkin (1984) argues:

> Structural cohesion models are founded upon the causal propositions that pressures toward uniformity occur when there is a positively valued interaction between two persons; that these pressures may occur by being "transmitted" through intermediaries even when two persons are not in direct contact; and that such indirect pressures toward uniformity are associated with the number of short indirect communication channels connecting the persons. (p. 236)

Thus individuals are expected to share a degree of commonality with those with whom they have a direct connection or short indirect connections through intermediaries.[38] This proposition leads to the division of networks into cohesive subgroups such that members in a particular subgroup have greater direct and indirect interactions with each other than with members outside the subgroup (Friedkin 1984). The members of cohesive subgroups are likely to share a similar set of beliefs and knowledge, and exhibit similar behaviour (Frank 1995). Based on this theoretical literature, it is likely that contraceptive decisions are influenced by subgroup structure, and that members in the same subgroup will exhibit similar contraceptive choices. To explore this aspect, our study uses graph theory to identify the subgroup structure of both men's and women's family planning networks.

[38] The question of why individual actors sustain their subgroups is not explored here. Rational actors may follow group norms and remain committed to the group to secure benefits that arise from membership. Failure to adhere to the group norms may lead to sanctions and hinder access to benefits from membership (Bourdieu 1986; Frank and Yasumoto 1998).

A number of methods have been developed to identify cohesive subgroups in network analysis. These methods try to break the network into smaller substructures so that members with relatively intense interactions are grouped together. Some of the methods based on graph theory are reviewed here.[39]

A 'maximally cohesive' subgraph[40], with a minimum of three actors, is a clique (Seidman 1983). A clique requires that all actors have all possible connections present among themselves (as in Figure 4.4). If one tie is missing, the network cannot be classified as a clique. Defined in this restrictive way, most graphs in empirical research have numerous small cliques that overlap one another (Wasserman and Faust 1994). Moreover, cohesion does not require that all members of the group are adjacent but is 'based on the configuration of the group's network' (Friedkin 1993, p. 862).[41]

Recognising these limitations, alternative methods have been developed that aim to relax the strict definition of a clique. The adjacency conditions are relaxed in the subgroup definition of N-cliques. N-cliques allow for ties amongst actors in a subgroup to be at geodesic distance greater than one, thus unlike cliques, all nodes do not have to be adjacent but need to be connected at a specified geodesic distance. A 2-clique identifies nodes that are either adjacent or reachable through at least one intermediary. Alternative methods of relaxing the restrictive definition of cliques based on nodal degrees are K-plex and K-cores. A K-plex is a group of size n within which each person has ties missing to no more than k members of the group. On the other hand, K-cores is a group of size n within which each person must have k number of ties present in the group (Wasserman and Faust 1994). Although these methods provide a more inclusive definition

[39] All of these methods try to capture cohesive subgroups by studying properties of ties amongst a subset of actors. However, there is no agreement as to which properties best define a cohesive subgroup.
[40] A subgraph is a subset of nodes and the connections between these nodes (Iacobucci 1994).
[41] Cliques fail to capture the internal structure of a subgroup since all actors are identical in their connections (Wasserman and Faust 1994).

of subgroups, they fail to overcome the problem of overlap and sometimes identify groups that are not very cohesive.[42]

The approaches discussed so far start with relationships between two nodes or a dyad and apply this outward to find the subgroup structure. Other methods use a macro perspective to identify the subgroups structure, starting with the whole network and trying to identify weak spots that define the lines of division in groups. These weak spots can then be used to break a large network into smaller units (Hanneman and Riddle 2005). Component and bi-components are examples of such methods. Components are subgroups in which all actors are connected to each other by at least one tie and have no connection outside the subgroup. Each isolate is considered as a separate component.[43]

Building on the ideas of components, the notion of bi-components has been introduced which provides a way to study the internal structure of components. A bi-component, also called blocks, is a subgroup without cutpoints. A cutpoint is a pivotal point that holds two or more components together. These cutpoints provide a method of locating weak spots in a graph which are then used to identify relatively cohesive subgroups (Hanneman and Riddle 2005). As Moody and White (2000) argue 'a group so fragile that the removal of a single person would destroy the group is not very cohesive' (p. 4).

[42] With K-cores and K-plexes, it is unclear on what basis one should decide about the appropriate value of k or the number of interactions that are allowed to be present or absent from the subgroup (Frank 1995).

[43] Components can also account for the direction of ties. If two nodes have a directed path between them, they are considered to be in the same strong component. These paths need to be 'aligned in a continuous chain without any change of direction' (Scott 2000, p. 203). The nodes without such a path are disregarded. This is based on the assumption that paths indicate possible flows of information, resources or money amongst actors. A constant direction would ensure an uninterrupted flow of these resources. On the other hand, the presence of a line, regardless of direction, indicates the possibility of some communication. A weak component is thus used to identify a set of nodes that are connected without accounting for direction (Scott 2000). Strictly speaking, since the original data is directional, the use of the word 'component' refers to weak components in this chapter.

Figure 4.5: Bi-components and cutpoint

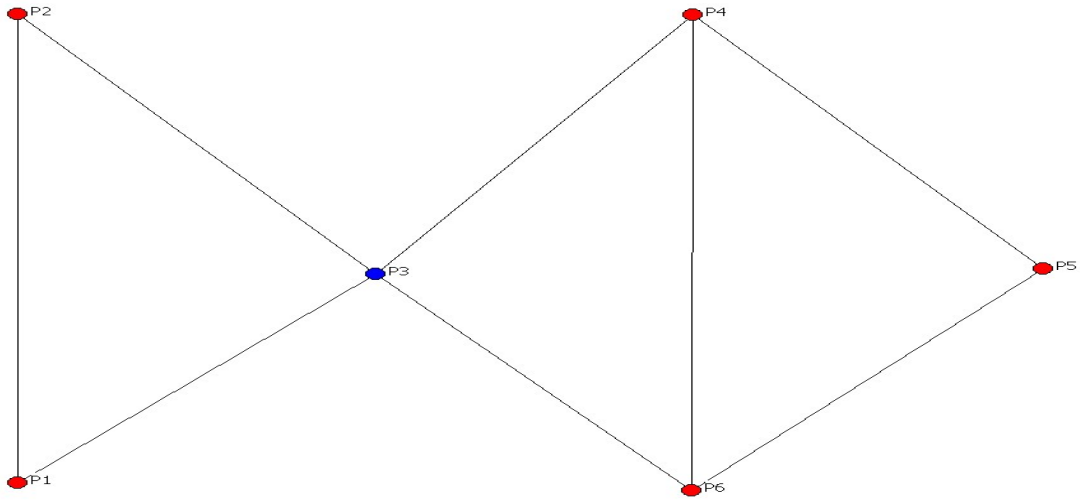


Figure 4.5 provides an example of bi-components. The network is composed of one component since all actors are directly or indirectly tied to each other. The node P3 is a cutpoint as its removal would disconnect the graph into two. Using this information, the graph can be divided into blocks or bi-components as {P1,P2,P3} and {P3,P4,P5,P6}. Defined this way, each node in a bi-component can reach the others through at least two paths and is not dependent on any one member (Hanneman and Riddle 2005). It is important to note that cutpoints are points of overlap between bi-components or blocks; however, this problem of overlap is not as widespread as in the case of cliques.

Despite the theoretical and methodological advances on cohesive subgroups, very few network studies on fertility have applied these concepts. Most demographic studies on networks use personal network data which provides little information about the overall network structure. As a result, only limited evidence exists about the importance of cohesive subgroups on family planning decisions. Some of the existing evidence is reviewed here.

Kincaid (2000) compared the contraceptive choices of Bangladeshi women participating in family planning discussion groups initiated by health workers to women who relied only on visits by

health workers at home or did not participate in either of these programs. He found that women were more likely to continue using contraception if they engaged in family planning discussions in the group initiated by the health worker. In another study conducted in Bangladesh, it was found that women who were members of cliques practised family planning more than women who were not members of any clique (Gayen and Raeside 2005).

Valente et al. (1997) studied the interaction effect on contraceptive choices between members of voluntary associations in Cameroon. They found that the most important variables in explaining whether or not the respondent ever used contraceptives were women's perception about their network partners' use of contraceptives, whether accurate or not, and the encouragement provided by network partners. They also found that the choice of contraceptive method was correlated with the choices of network partners in these voluntary associations (Valente et al. 1997, p. 683). This again points to the importance of investigating the structural properties of networks at a group level rather than restricting the focus to personal networks.

Based on the network literature and demographic studies, it is likely that contraceptive decisions are influenced by subgroup structure and are not restricted to personal networks. Individuals in cohesive subgroups are likely to share a similar set of beliefs and knowledge, and to exhibit similar behaviour (Frank 1995). They are also likely to come under stronger interpersonal pressure to conform compared to individuals in sparse networks (Wasserman and Faust 1994). Since little information has been collected beyond personal networks (especially for men), it is unclear from the current literature whether men's and women's planning networks show such clustering tendencies. This study, thus, uses bi-component analysis to identify the subgroup structure of both male and female family planning networks.

Bi-components are argued to be an effective system of communication and exchange in a network because actors can communicate through multiple paths and are not dependent on any one member (Scott 2000). Members of bi-components, like other cohesive groups, may also be effective in exercising pressures on each other (Hage 1979), since a particular message can be repeatedly transferred to a particular actor, leading to stronger pressures. Because bi-components identify groups that have several paths of communication present between nodes, the 'network it forms is both flexible and unstratified' (Scott 2000, p. 108). Following these advantages, bi-components will be used to identify the subgroup structures of both men and women in this study. It is important to note that the subgroups identified using bi-components may not necessarily be very cohesive; however, 'components and bicomponents are minimum requirements for primary groups, ensuring that the identified groups are connected and, if at least a bicomponent, structurally cohesive' (Moody 2001, p. 263). Bi-components can be seen as an essential first step in defining global properties of the network (Hage 1979) and provide building blocks which can be further broken into relatively more cohesive groups.

Centrality

Structural measures of centrality are often used in applied network studies to capture social power (Marsden 2002). Network analysts argue that power is inherently relational as the amount of power individuals can exercise is dependent on the number of others they can dominate. This approach is purely structural: power is a function of the social system and an individual's position in the system and is not determined by individual attributes (Brass and Burkhardt 1993). The amount of power an individual actor can exercise therefore depends on the individual's position in the network structure. Network analysts argue that the way individuals are embedded in relational network structure imposes constraints as well as provides opportunities, and actors that face fewer constraints and have more opportunities are considered to be in an advantageous position. Actors 'occupying advantageous positions in networks of relations' are viewed as

powerful (Hanneman and Riddle 2005), and different measures of centrality are employed to identify the actors in advantageous positions. Although the extent to which these measures of centrality successfully capture the notion of power is a matter of debate (Mizruchi and Potts 1998), most studies have revealed some significant association between the two variables (Mizruchi 1994). The association between centrality and power is also supported by social psychological literature. Using data on experimentally controlled communication networks, the research shows that the leadership role is typically undertaken by the most central actor in the network (Bonacich 1987; Leavitt 1951).

Centrality broadly represents the degree to which actors are connected to others. Central actors have a greater number of ties to other actors than peripheral actors. It is also recognised that centrality is a multidimensional concept leading to many different definitions of centrality (Mizruchi and Potts 1998). However, the commonly employed measures of point centrality include degree and betweenness centrality.[44] These two measures are not only popular but also capture different dimensions of power, hence both of these measures are used to capture centrality of individual actors and are reviewed below.[45]

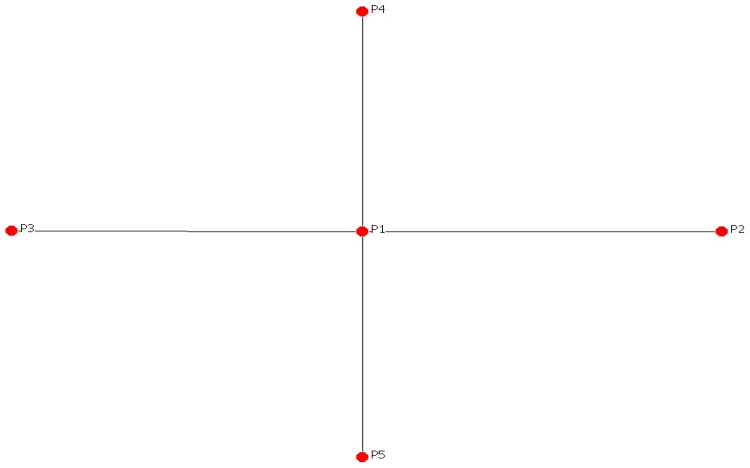
Degree Centrality: This is the simplest measure of centrality and captures the number of direct connections of each actor. According to this measure, each actor's centrality is given by its degree, which is the number of nodes adjacent to it. For example, P1 in figure 4.6 is the most

[44] Closeness centrality is also a well-known measure of positional advantage. This measure of centrality is based on distance. An actor who is closer to others is not dependent on intermediaries for transmitting messages and thus avoids the 'control potential of others' (Freeman 1979, p. 224). The closeness centrality for each actor is defined as a function of its geodesic distances from all the others in the network. The actors with small geodesic distances are considered to be close and hence more central, although closeness centrality can only be meaningfully applied to connected graphs. In disconnected graphs, some actors are at an infinite distance from others making it difficult to apply closeness centrality (Freeman 1979). Since the networks in this research are mainly divided into several components, closeness centrality is not explored here.

[45] Power is a controversial topic and this chapter does not claim to have successfully captured all the dimensions of power. The analysis in this chapter simply tries to identify the potentially powerful actors using a structural approach.

central actor since it has the highest degree of four, while others have a degree of one. The actor with the highest degree centrality can be seen as the focal point of communication, since the actor can directly communicate with others in the network (Freeman 1979). An actor with high degree centrality also has greater autonomy, since the actor is not dependent on any one node in the network, which provides the actor with greater power than actors with low degree centrality. Alternatively an actor with high degree centrality can be viewed as having greater choices, and hence more opportunities, than other actors in the network (Hanneman and Riddle 2005).[46]

Figure 4.6: Star network



Betweenness Centrality: This view of centrality captures the number of times an actor lies between a pair of nonadjacent actors. In a communication network, an actor with high betweenness can 'influence the group by withholding or distorting information in transmission' (Freeman 1979, p. 221). This potential for control gives the actor power (Hanneman and Riddle 2005).

[46] The measure can be further extended for directed graphs, where a distinction is made between choices received and sent. In-degree centrality is based on the count of number of choices received, whereas out-degree centrality captures the number of ties made by a particular actor. Actors with high out-degree are considered to be influential whereas actors with high in-degree are considered to be prestigious (Hanneman and Riddle 2005). In-degree centrality is used to capture prestige on the assumption that powerful actors are more likely to be receivers rather than senders of many choices (Brass and Burkhardt 1993). On the other hand, actors sending many choices are better able to inform others of their views and are thus likely to be influential in the network (Hanneman and Riddle 2005). This research does not account for direction for two reasons. Firstly, the number of choices is fixed by the study design and hence a comparison between in-degree and out-degree centrality is not meaningful. Secondly, the networks analysed in this research are discussion networks and therefore direction does not convey any particular meaning in terms of the content of exchange.

The measure is calculated by assuming that a pair of nonadjacent actors will communicate using the shortest path; thus, betweenness centrality is based 'upon the frequency with which a point falls between pair of other points on the shortest or geodesic paths connecting them' (Freeman 1979, p. 221). If there is only one geodesic connecting each pair of actors, then betweenness centrality of a particular actor is simply the number of times the actor falls on these geodesics. Figure 4.6 provides an example of a network in which there is only one geodesic connecting each pair of actors. In this case, the betweenness centrality of an actor is simply the sum of the number of times the actor falls on each of these geodesics. Using this approach, the betweenness centrality of P1 is six. However, if there is more that one geodesic connecting every point, then each is equally likely to be used. If g_{ij} is the number of geodesic linking p_i and p_j the probability that any one geodesic will be used is given by $1/g_{ij}$. If a particular actor does not fall on all of these geodesics then the actor's potential for control is diminished. In this case, the potential for control would depend on the probability that a particular point, p_k , falls on a randomly selected geodesic between a given pair of actors, p_i and p_j (Freeman 1979, Wasserman and Faust 1994). This probability is defined as:

$$b_{ij}(p_k) = \frac{g_{ij}(p_k)}{g_{ij}}$$

where $g_{ij}(p_k)$ = the number of geodesic linking p_i and p_j that contain p_k

The betweenness centrality of p_k is calculated by summing the estimated probabilities over all pairs of actors not including the kth actor. It has a minimum value of zero and the maximum is (g-1)(g-2)/2 (Wasserman and Faust 1994, Freeman 1979). A high betweenness centrality indicates that a particular actor lies between many others and hence can control information passing between actors who are not adjacent. Thus, the connecting actors derive power from this potential to control.

As evident from the above definitions, centrality is a multidimensional concept. Power arises from occupying advantageous positions in the network but the source of power varies according to the measure of centrality employed (Hanneman and Riddle 2005). Although both degree and betweenness centrality try to identify actors in advantageous position in the network, the source of advantage differs in the two approaches.[47] Degree centrality tunes into the sources of power that arise from having more opportunities as a result of having several direct connections, whereas betweenness centrality captures the power derived from the potential to control. Our study employs both these measures of centrality to capture the different dimensions of power.[48] Central actors are expected to be more influential in the network, and central actors identified through any of these methods are likely to be better informed in the network.

Centrality is found to be important in empirical research on networks and family planning. In their ground breaking research on diffusion, Rogers and Kincaid (1981) found centrality to be an important feature in Korean villages. The national family planning program in Korea aimed to spread awareness via women's groups in the villages, in addition to visits by health workers. The study showed that villages with active leaders of a women's group in the networks had a higher contraceptive adoption rate. The embeddedness of the leaders was captured using the average distance of the leader to other members in the network. Although some of the techniques used in this research are now obsolete, the results point to the importance of central actors in the network.

[47] In the star graph node, P1 is identified as the most central actor using any of the three measures.

[48] The measures of degree and betweenness centrality can also be standardised by network sizes. For example, in a group of size g any particular node can be adjacent to no more than g-1 nodes. Degree centrality, independent of network size, can be calculated by dividing degree centrality of each actor by g-1 (Wasserman and Faust 1994). This method is not deemed appropriate because even in large graphs each actor can only sustain a finite number of connections and thus this standardisation does not provide meaningful results in the context of this research.

In a more recent study, Stoebenau and Valente (2003) used measures of in-degree centrality, which is the total number of ties received by a node, when researching community-based family planning programs in a village in Madagascar.[49] The program workers were found to play a key role in both men's and women's networks. Two types of network information were collected to ascertain this. Respondents were asked to name their network partners from whom they sought advice on all important matters. Information was also collected on the network partners consulted for family planning related issues. The community-based workers were found to be central to both the advice and family planning networks. Respondents in either network with links to the community-based workers were found to be better informed about family planning. In the family planning networks, respondents were also found to have a more positive attitude towards using birth control methods if they were indirectly connected to the community-based workers (i.e. they were connected through other network partners). Direct links with the worker and having family planning discussion partners in the village only increased the likelihood of using modern contraceptives. The study thus showed that central actors can influence both attitudes towards family planning as well as contraceptive adoption.

The role of centrality was also explored in a study conducted on married women of reproductive age in Bangladesh (Gayen and Raeside 2005). This study calculated both in-degree (ties received) and out-degree (ties sent) centrality using information on each respondent's communication networks. The results of logistic regressions showed that out-degree centrality was significant in explaining contraceptive use; however, in-degree centrality was found to be unimportant (Gayen and Raeside 2005, p. 14).

[49] The community-based programs use locally-residing individuals for dispensing family planning information and contraceptive supplies (Stoebenau and Valente 2003).

Some indirect evidence on the role of central actors in networks is found in studies of contraceptive use in Bangladesh. The family planning program in Bangladesh utilises locally residing health workers to provide family planning services mainly to women through home visits.[50] It is likely that effective field workers exercise strong influence on contraceptive use as they are recognised as central actors in women's networks. Various studies have confirmed a strong statistical relationship between contact with field workers and contraceptive use (Arends-Kuenning 2001; Phillips, Hossain and Arends-Kuenning 1996) although a structural analysis to identify the position of field workers in the village networks has not been undertaken in the context of Bangladesh. The measures of centrality employed in this research help to identify important actors in the family planning networks, including the health workers. All of these measures can be aggregated across actors to achieve a group level measure of centrality, referred to as group centralization.

The group centralization measures allow an easy comparison between different networks as well as providing information on the degree of variability in the centrality of individual actors. It captures the extent to which a single actor has high centrality and others have low centrality (Wasserman and Faust 1994). A network with a high centralization index reflects concentration of power in the hands of few actors, whereas a low centralization index reflects the fact that power is relatively equally distributed in the network (Hanneman and Riddle 2005).

The general formula for calculating group level centralization, adapted from Wasserman and Faust (1994), can be defined as follows:

[50] The details of the Bangladeshi family planning program are provided in Chapter 3.

$$C_A = \frac{\sum_{i=1}^{g}\left[C_A(p^*) - C_A(p_i)\right]}{\max \sum_{i=1}^{g}\left[C_A(p^*) - C_A(p_i)\right]}$$

$$C_A(p^*) = \max_i C_A(p_i)$$

The above index centralization can be applied to both degree and betweenness centrality. In the above formula, $C_A(p_i)$ stands for the actor level centrality index. For example, if we are calculating group degree centralization then $C_A(p_i)$ will be the actor degree centrality index. $C_A(p^*)$ is the largest value of the particular centrality index obtained across g actors in the network. The numerator of the centralization index, $\sum_{i=1}^{g}\left[C_A(p^*) - C_A(p_i)\right]$, thus measures the sum of difference between the largest value and other observed values. The denominator is the theoretical maximum value possible for the numerator and is calculated by considering all possible graphs of g actors. The highest possible sum of difference is then used for the denominator. It can be shown that the highest possible sum of difference is for the star network (Wasserman and Faust 1994) and the index can therefore be interpreted as degree of variability in the network compared to the star graph of the same size (Hanneman and Riddle 2005).

Results

This section uses the concepts of networks analysis discussed above to determine the structure of men's and women's family planning networks in Matlab. The structural perspective adopted in this research helps to identify opportunities and constraints facing men and women in these networks. Furthermore, the analysis assists in measuring important gender differences in the makeup of men's and women's networks. This analysis has strong implications for social capital literature which has so far ignored gender differences in networks. The research also contributes

to the demographic literature that increasingly employs network principles in the study of fertility and family planning.

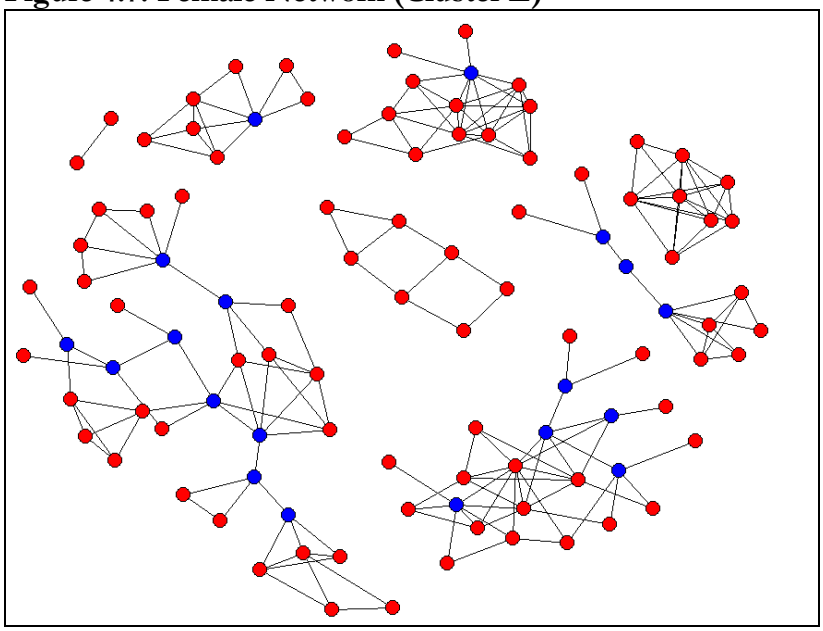
Basic graph theory concepts are used to explore the relational data in this section. The main structural measures used to analyse social networks include density and subgroups to capture network cohesion, whereas measures of centrality are applied to identify the distribution of power amongst actors in the network.

The data used for the research was gathered using snowball sampling methods in five clusters of the Matlab region in Bangladesh. The procedure resulted in a separate male and female network in each cluster, as the respondents usually did not report members of the opposite sex as their network partners; women in particular stuck to female network partners. The results are therefore presented separately for men and women.[51] The graph containing predominantly male actors is classified as 'the male network' and the graph containing predominantly female actors is classified as 'the female network'.[52]

Figure 4.7 and Figure 4.8, show the male and female network respectively in Cluster E of the government area. Cluster E is composed of one village in the non-treatment area. None of the female members reported talking to men and only two women were identified in the men's network. Surprisingly, no government health workers were identified in either men's or women's family planning networks in the government area.[53] Both male and female respondents are found to be embedded in disconnected networks, in which some actors are at an infinite distance from others in the network; beyond this similarity, the two networks diverge sharply.

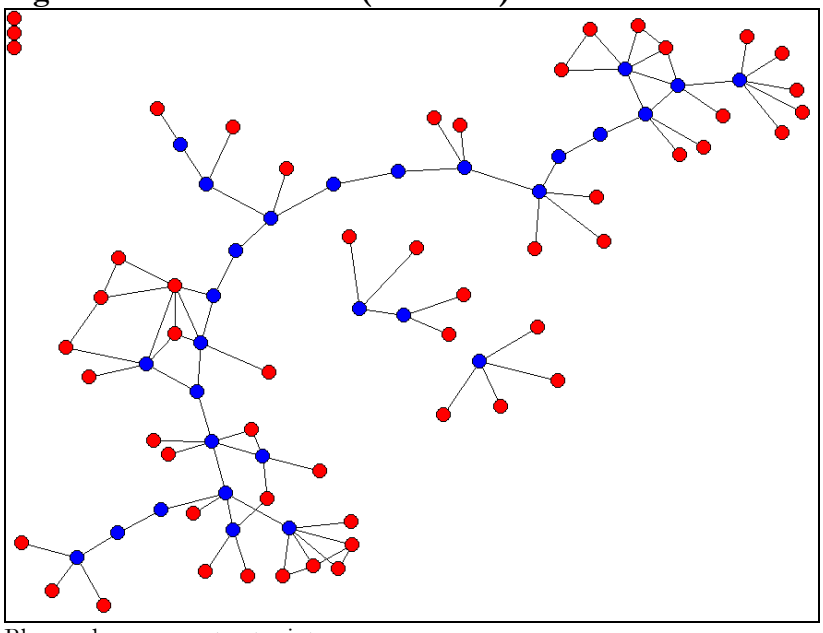
[51] The common links among the two networks are the spouses. This issue is not taken up in this research.
[52] The networks in this chapter are visualised using NetDraw program (Borgatti 2002) and are analysed using UCINET (Borgatti, Everett, Freeman 2002)
[53] This also holds for the other clusters in the government area.

Figure 4.7: Female Network (Cluster E)



Blue nodes represent cutpoints

Figure 4.8: Male Network (Cluster E)

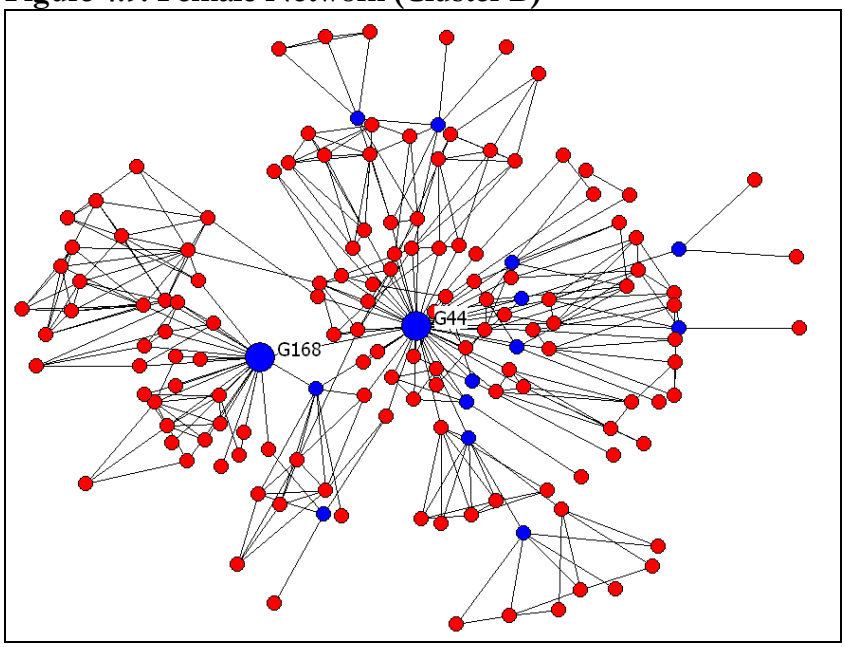


Blue nodes represent cutpoints

As Figure 4.7 shows, the female network is divided into several components of three or more actors. On average, women can reach a small proportion of network members either directly or through intermediaries and are at an infinite distance from the majority of actors in the network. The male network contains three weakly-connected components although most actors belong to one main component and hence can reach others either directly or by using several

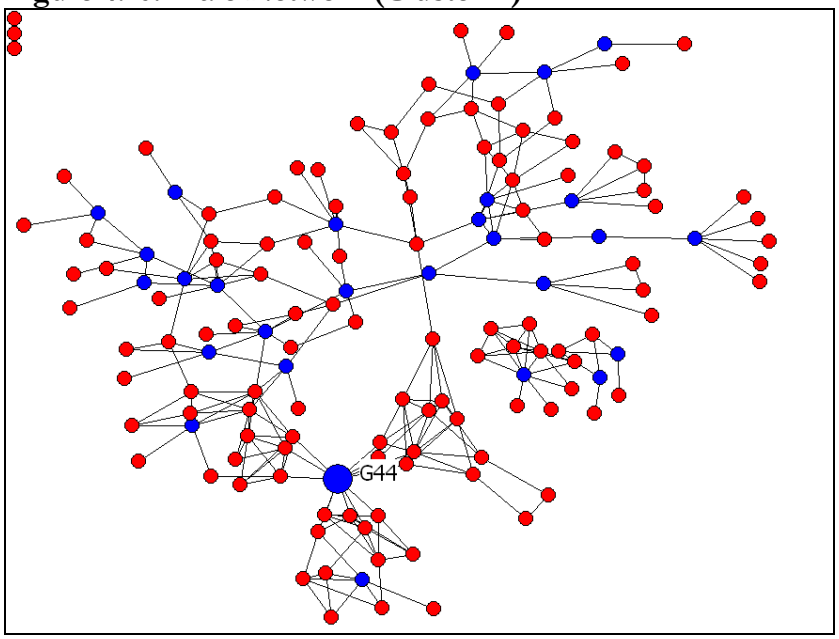
intermediaries. This higher level of connectivity suggests that uninterrupted information flow can occur in the male network as opposed to the female network. The pattern of ties in the ICDDR,B area, however, provides a very different view. Figure 4.9 and Figure 4.10 show the female and male network in the ICDDR,B area.

Figure 4.9: Female Network (Cluster B)



Blue nodes represent cutpoints

Figure 4.10: Male Network (Cluster B)



Blue nodes represent cutpoints

Unlike Cluster E, the female network in the ICDDR,B cluster shows a centralized network structure in which G44 and G168 are the focal nodes. These two actors are identified as the health workers responsible for providing ICDDR,B services at the field level. The network shows that women can reach everyone in the network, mainly through the health workers. The health worker G44 is identified in the male network as well, but is not as prominent as in the female network. Similar to Cluster E, the male network is composed of one main component, but in Cluster B, males are embedded in dense neighbourhoods rather than the tree-like structures seen in the sociogram of Cluster E. Comparable pattern of ties are observed while viewing the graphs in other clusters (Appendix 4).

The stark differences across the graphs of government and treatment areas suggest that different models of health care delivery alter the network structures, although examining the statistics for each cluster suggests that the pattern of ties hardly differs across the sampled Matlab villages, especially in the case of women.

Table 4.1: Proportion of network partners of the opposite sex

	% of male respondents in the female network	% of female respondents in the male network
Government Area		
Cluster D	0.7%	20.80%
Cluster E	0%	2.40%
Cluster F	0%	-
ICDDR,B Area		
Cluster B	0%	22.06%
Cluster C	1.3%	5.20%

Table 4.1 shows that the communication networks are mainly sex-segregated across all clusters. Male network partners are either altogether absent or negligible proportions of males are present in the female networks in both the government and ICDDR,B clusters. Examining the male networks shows that Cluster B in the ICCDR,B area has the highest proportion of females, with more than one fifth of the network partners being females (22.06%). This figure is closely

followed by Cluster D (20.80%), which is in the government area. Although the figures in Table 4.1 suggest that a significant proportion of interactions in the male networks in Cluster B and Cluster D are between members of the opposite sex, examining the data more closely provides a less optimistic assessment. In both clusters, less than 10% of men reported female contacts; in Cluster B only 7.1% of the male respondents identified female network partners, and this figure was 9.5% in Cluster D. When these female contacts were interviewed, they mainly identified other women network partners, leading to a substantial number of female links in the male networks (reported in Table 4.1). This indicates that family planning communication primarily occurs between members of the same sex, although the issue of sex segregation is more acute in the female networks.

Examining the number of components (Table 4.2) points to consistencies in the pattern of ties between the two areas and to the differences in the male and female networks. The size of components is restricted to three or more actors. Isolates are not included in the measures of components but are shown separately.

Table 4.2: Basic structure of the Networks in the Government Area

	Obs	Isolates	Number of Components (more than two actors)	Avg. no of ties/ Avg. Degree	Std. Dev.	Average distance between actors in the same component	Std. Dev.
Female							
Cluster D	146	0	10	3.7	2.2	2.0	0.9
Cluster E	104	0	7	3.6	2.0	2.2	1.0
Cluster F	106	0	9	3.5	1.8	1.9	0.6
Male							
Cluster D	106	1	2	2.3	1.7	4.1	3.9
Cluster E	83	3	3	2.2	1.6	4.0	3.9

Table 4.2 shows that the female networks are divided into many more components compared to the male networks in the government area. Although the female networks show more divisions,

none of the sampled respondents is completely isolated in the networks and the average number of ties to other actors in the network is higher for women than it is for men, showing that women are more likely than men to be involved in family planning discussions. Significantly, within each component, women can reach other members at much shorter distances than men; for example, in Cluster D the average distance between women in the same component is only 2.0, whereas between men it is 4.1. The figures on distance point to the cohesive nature of ties between women compared to men.[54]

Table 4.3: Basic structure of Networks in the ICCDR,B Area

	Obs	Isolates	Number of Components (more than two actors)	Average Degree	Std. Dev.	Average distance between actors in the same component	Std. Dev.
Female							
Cluster B	153	0	1	4.6	4.5	3.5	.
Cluster C	151	0	1	3.6	2.5	5.4	.
Cluster B (no health worker)	151	7	11	3.7	2.1	2.1	0.6
Cluster C (no health worker)	149	8	8	3.2	1.9	2.4	1.1
Male							
Cluster B	145	3	3	3.5	2.3	3.0	2.3
Cluster C	96	1	1	2.7	1.8	5.1	
Cluster B (no health worker)	144	3	4	3.4	2.1	2.7	1.9
Cluster C (no health worker)	95	1	1	2.6	1.8	5.3	

Superficially, the ICDDR,B clusters appear to be very different. As Table 4.3 shows, women are embedded in a fully-connected network structure in the treatment areas, whereas networks in the government area are divided into several components. The average distance between women in the same component in the government area was barely two, but in Cluster C in the ICDDR,B area, the average distance is 5.3. Deleting the ICDDR,B health workers who were working in the

[54] Deleting the female ties in Cluster D does not alter the conclusion. The average degree in Cluster D is 2.3 and average distance is 3.7 after deleting all the female ties.

sampled communities at the time of the survey changes these results dramatically.[55] Without the health workers, the female networks break into several disconnected components and most women are at a small distance from others in the same component (graphs shown in Appendix 4). When the health workers are deleted, the average number of ties also reduces in the female networks to levels similar to the government area, because substantial numbers of ties are directed to the health workers. By contrast, the exclusion of health workers from the male network does not have such a dramatic impact. This is mainly due to the fact that the health workers are located on the peripheries of the networks, whereas they are central to the female networks.

After deleting the health workers from the two clusters, similar differences to those in the government area emerge between the male and female networks The results in Table 4.3 show that without the health workers, the female network is divided into many more components, have a greater number of ties and have short distances between members of the same component compared to the male network in the same cluster. For example, the female network in Cluster C without the health worker is divided into eight components, where on average women have 3.2 ties and the distance between members of the same component is 2.4. The male network in Cluster C (without the health worker) has just one component with an average degree of 2.6 and average distance of 5.3.

The only prominent difference between men's and women's networks in the ICDDR,B area that is not observed in the government area is that the female network (without health worker) has many more isolates. This suggests that in the ICDDR,B area, some women opt out of their peer networks and only discuss family planning issues with the health workers. Also notable is the

[55] Only the health workers officially working in the sampled clusters are deleted. Any other members of the network who are working as health workers in another area are not excluded.

difference between male ties in Cluster B and all the other clusters. The average number of ties in the male networks is below 3 in all clusters except for Cluster B, where the average is 3.5 ties. If the female ties are deleted from the male network in Cluster B, the average number of male ties reduces to 2.9 but so does the average distance between actors in the same component, from 3.0 to 2.9. These results suggest that men in Cluster B tend to have more ties and belong to more cohesive networks compared to the other sampled clusters in this study. Even so, the difference between the male and female pattern of ties is similar to the other clusters.

Reachability provides yet another measure that reveals the differences in the range of male and female ties.

Table 4.4: Reach in the Government Area

Variable	Average Reachability (%)	Std. Dev.	Min	Max
Female				
Cluster D	22.6	18.6	0.7	43.4
Cluster E	18.5	10.7	1.0	32.0
Cluster F	14.5	7.3	2.9	22.9
Male				
Cluster D	92.6	18.1	0.0	96.2
Cluster E	69.7	29.6	0.0	82.9

Table 4.4 shows that in all the clusters in the government area, women on average cannot reach more than 25% of the network partners, either directly or through intermediaries, and are at an infinite distance from the majority of actors in the network. The maximum value obtained by anyone on this measure in the female networks is only 43.4% in the government area. The maximum value attained in the male networks is 96.2% in Cluster D, which also has an average reachability of 92.6%.[56] The average reach in Cluster E for males is only 69.7%; however, this value is still greater than the average reach in the female network in Cluster E which is only 18.5%.

[56] Deleting the female ties reduces the average reach to 88.5%, mainly because of an increase in the number isolates in the network.

Table 4.5: Reach in the ICDDR,B Area

Variable	Average Reachability (%)	Std. Dev.	Min	Max
Female				
Cluster B	100.0	0.0	100.0	100.0
Cluster C	100.0	0.0	100.0	100.0
Cluster B (no hw)	12.2	9.3	0.0	26.7
Cluster C (no hw)	20.2	15.7	0.0	39.2
Male				
Cluster B	76.0	27.9	0.0	86.8
Cluster C	97.9	10.1	0.0	98.9
Cluster B (no hw)	61.7	29.9	0.0	77.6
Cluster C (no hw)	97.9	10.2	0.0	98.9

The ICDDR,B clusters are not much different. Table 4.5 shows that in Cluster B and C on average women can reach all the other members in the network either directly or through intermediaries, but the average reach drops remarkably in the female networks in both clusters if the health workers are deleted, and in Cluster B it reduces from 100% to 12.2%. Conversely, the average reach of actors changes from 76% to 61.7% in the male network in Cluster B after deleting the health worker,[57] and there is barely any change in the male networks in Cluster C as a result of removing the health worker. These results show that, in contrast to men, women can reach fewer network partners in both areas if the health workers are excluded from the analysis.

Women's networks show a greater tendency than men's networks to create dense neighbourhoods which are likely to form the basis of greater social control and provide redundant information. Average personal network density, also known as clustering coefficient (Hanneman and Riddle 2005), is above 0.5 in all the female networks, as shown in Table 4.6 and Table 4.7. [58] On the other hand, the male network shows no pattern of local clustering except in the case of Cluster B. In the male network, the clustering coefficient is less than 0.3 in all the clusters but Cluster B, where it is 0.4. If the female contacts are excluded in Cluster B, the

[57] Excluding the female ties in Cluster B increases the average reach in 67.1%, which is very similar to the average obtained in Cluster E.

[58] The theoretical maximum of clustering coefficient is 1, which means that all the network partners are interconnected.

clustering coefficient is unchanged at 0.4. This suggests that the male ties in Cluster B are more cohesive than the male ties in other Clusters, but the degree of cohesion is still greater than the female network in Cluster B. These figures on clustering coefficient only apply to actors with at least two connections, since density calculations cannot be made if there is only one actor in an ego's neighbourhood. A greater proportion of men have fewer than two contacts compared to the females and hence a clustering coefficient is not available for a larger proportion of males.

Table 4.6: Clustering Coefficient in the Government Area

	Proportion of actors with one connection	Clustering Coefficient	Std. Dev.
Female			
Cluster D	16.4	0.6	0.3
Cluster E	14.4	0.6	0.4
Cluster F	8.5	0.5	0.3
Male			
Cluster D	50.0	0.2	0.3
Cluster E	47.0	0.3	0.4

Table 4.7: Clustering Coefficient in the ICDDR,B Area

	Proportion of actors with one connection	Clustering Coefficient	Std. Dev.
Female			
Cluster B	11.8	0.6	0.3
Cluster C	15.9	0.6	0.4
Cluster B (no_hw)	15.9	0.6	0.3
Cluster C (no_hw)	22.1	0.6	0.3
Male			
Cluster B	23.4	0.4	0.3
Cluster C	36.5	0.2	0.3
Cluster B (no_hw)	24.3	0.4	0.3
Cluster C (no_hw)	38.9	0.2	0.4

Personal network density does not identify the network connectedness beyond a respondent's immediate neighbourhood. To further explore the issue of cohesion, the network is divided into

subgroups using the definition of bi-components. Bi-components are subgroups without cutpoints so that there are always at least two ways to get from any point to any other.

Table 4.8: Bi-components in the Government Area

	Total number of bi-components with more than two actors	Avg. Density	Std. Dev.	% of actors in blocks of more than 2 actors	No. of nodes acting as Cut-points
Female					
Cluster D	18.0	0.7	0.2	83.6	2
Cluster E	12.0	0.6	0.2	85.6	2
Cluster F	12.0	0.6	0.2	91.5	1
Male					
Cluster D	4.0	0.7	0.5	37.1	1
Cluster E	5.0	0.7	0.2	32.5	1

Substantial numbers of bi-components of sizes greater than two are identified in the female networks, and at least 80% of the actors are members of bi-components in each of the female networks in the government area. The rest of the actors belonged to blocks containing only two actors. These were mostly caused by tree-like structures and pendants (nodes with degree one) connected to a component through cut points. This can be evidenced in Figure 4.7 and Appendix four, which shows the graphs with cutpoints for all the networks.

The majority of actors in the male networks did not belong to bi-components of size greater than two. This is not surprising as the male network in Figure 4.8 shows fewer cycles and is largely composed of trees; for example, 59 blocks were found in the male network in Cluster E, but only five blocks contained more than two actors. 32.5% of the respondents belonged to these five blocks. The remaining actors were embedded in blocks containing two actors where one of the nodes was the cut point. Even fewer blocks of more than two actors were identified in the male network in Cluster D.[59] Thus greater numbers of women are found to be embedded in cohesive

[59] After deleting the female ties, the total number of bi-components in the male network reduces to two with 33% of the actors embedded in these blocks. Again, this result is not substantively different from Table 4.8.

subgroups compared to men. The in-group density in each of these components is not substantially different in the male and female networks. Thus male and female bi-components are equally cohesive. The number of nodes acting as cutpoints in blocks of three or more actors are minimal, which points to the fact that the problem of overlap is not acute in subgroups identified by using the definition of bi-components.[60]

Table 4.9: Bi-components in the ICDDR,B Area

	Total number of bi-components with more than two actors	Avg. Density	Std. Dev.	% of actors in blocks of more than 2 actors	No. of nodes acting as Cutpoints
Female					
Cluster B	14.0	0.6	0.3	87.6	5
Cluster C	17.0	0.7	0.3	84.1	8
Cluster B (no_hw)	17.0	0.7	0.3	87.4	4
Cluster C (no_hw)	16.0	0.8	0.2	83.2	6
Male					
Cluster B	8.0	0.7	0.4	74.5	3
Cluster C	4.0	0.7	0.4	56.3	3
Cluster B (no_hw)	9.0	0.7	0.3	73.6	2
Cluster C (no_hw)	5.0	0.8	0.4	51.6	2

The same pattern is repeated in the ICDDR,B area. Women's networks are divided into many more blocks of three or more actors and a greater percentage of females are members of blocks compared to males. Similar to the government area, density measures show that bi-components of men and women are equally cohesive; nevertheless, unlike the male networks in the government area, more than half the members of the male networks in ICCDR,B area belong to bi-components. This proportion is particularly high in Cluster B. Furthermore, as many as nine blocks are identified in Cluster B (after deleting the health worker). Excluding the female ties in Cluster B reduces the number of blocks to seven and the proportion of members embedded in blocks to 66.4% from 74%. Even though these results suggest that the cohesiveness of the network diminishes after deleting the female ties in Cluster B, the male networks in the

[60] This measure is calculated after deleting blocks containing two actors.

ICDDR,B show a greater degree of cohesion compared to the male networks in the government area and Cluster C. Another difference that emerges in the ICDDR,B area is that many more actors play the role of cutpoints in both the male and female networks, compared to the government area. Despite this, the problem of overlap is not acute in either the government or ICDDR,B area.

The measures of distance, density and subgroups facilitate the establishment of the interconnectedness of actors in the network but provide limited insights into the distribution of power within these networks. To explore this aspect, centrality measures were utilised. Degree centrality measures, which capture the number of direct connections of each actor, show that women have a greater number of ties as well as demonstrating a greater variation in degree centrality in the government area compared to men. The highest degree centrality of 17 is scored by an ICDDR,B worker, responsible for collecting data in the area, in the female network in Cluster D.

Table 4.10: Degree Centrality in the Government Area

	Obs	Mean	Std. Dev.	Min	Max	Centralization Index
Female						
Cluster D	146	3.7	2.2	1	17	9.3%
Cluster E	104	3.6	2.0	1	10	6.3%
Cluster F	106	3.5	1.8	1	9	5.3%
Male						
Cluster D	106	2.3	1.7	0	7	4.6%
Cluster E	83	2.2	1.6	0	6	4.7%

Although the values in the above table suggest that women show a greater variation in degree centrality, the centralization scores for each of the network are low across all clusters.[61] The highest value of centralization index is 9.3% in the case of the female network in Cluster D. This is not unexpected, since no one actor is connected to everyone in any of the networks; thus,

[61] The centralization score for male network in Cluster D without female ties is low too at 5.9%.

according to the measures of degree centrality, neither individual men nor women exercise influence over the whole network. Calculating the graph centralization measure for each component reveals a different picture. The following tables provide centralization scores for each component and also show the proportion of respondents in each of the components.[62]

Table 4.11: Degree Centralization scores by component in the Government Area (Female Network)

Component	Centraliz. Cluster D	Proportion of res. (Cluster D)	Centraliz. Cluster E	Proportion of res. (Cluster E)	Centraliz. Cluster F	Proportion of res. (Cluster F)
1	20.0%	4.1%	8.9%	32.7%	20.7%	23.6%
2	20.9%	43.8%	10.0%	6.7%	22.3%	21.7%
3	22.2%	6.8%	28.6%	7.7%	25.6%	13.2%
4	27.9%	11.6%	30.3%	12.5%	26.7%	6.6%
5	33.3%	4.8%	32.9%	21.2%	30.0%	5.7%
6	33.3%	7.5%	41.7%	9.6%	38.1%	7.5%
7	36.7%	7.5%	47.6%	7.7%	40.0%	5.7%
8	40.0%	4.8%			40.9%	12.3%
9	46.7%	4.8%			66.7%	3.8%
10	66.7%	4.1%				

Table 4.12: Degree Centralization scores by component in the Government Area (Male Network)

Component	Centraliz Cluster D	Proportion of res. (Cluster D)	Centraliz Cluster E	Proportion of res. (Cluster E)
1	4.7%	96.2%	5.4%	83.1%
2	100.0%	2.8%	40.0%	7.2%
3			100.0%	6.0%

The centralization index reaches 100% in the case of the star network, observed in Figure 4.6. The highest centralization score is observed in the male networks in Cluster D and Cluster E in Table 4.12, but only a small number of the sampled respondents belong to components with a centralization score of 100%. The majority of the respondents in the male networks are part of decentralized networks. The centralization score is only 4.7% in Cluster D and 5.4% in Cluster E

[62] Centralization analysis by components is conducted on components consisting of more than two actors.

for the largest components in these clusters.[63] The women's centralization scores are more varied, as shown in Table 4.11, and the majority of women are embedded in networks with a centralization score greater than 20%, suggesting that women are more likely to have influential actors in the local neighbourhood compared to men.

Table 4.13: Degree Centrality in the ICDDR,B Area

	Obs	Mean	Std. Dev.	Min	Max	Centralization Index
Female						
Cluster B	153	4.6	4.5	1	50	30.3%
Cluster C	151	3.6	2.5	1	20	11.1%
Cluster B (no_hw)	151	3.7	2.1	0	11	4.9%
Cluster C (no_hw)	149	3.2	1.9	0	8	3.3%
Male						
Cluster B	145	3.5	2.3	0	12	3.0%
Cluster C	96	2.7	1.8	0	9	6.8%
Cluster B (no_hw)	144	3.4	2.1	0	9	4.0%
Cluster C (no_hw)	95	2.6	1.8	0	9	7.0%

Slightly different results emerge for the ICCDR,B clusters, shown in Table 4.13. The centralization index in women's networks is 30% in Cluster B and 11.1% in Cluster C. These indexes are much higher than in the government area. The mean degree centrality is also much higher in Cluster B. These results were found to be primarily driven by the presence of the health workers in the ICCDR,B clusters. In Cluster B, the two designated health workers had the highest degree centrality and received a total of 73 ties, resulting in a highly centralized network, whereas in Cluster C the two designated health workers received a total of 36 ties, resulting in a lower centralization index compared to Cluster B. Not surprisingly, eliminating the health workers results in low centralization scores for the female networks and reduces the mean of degree centrality in both the clusters. On the other hand, the male networks with the health workers show a low centralization index compared to the female networks with the health workers. In addition, excluding the health workers from the male networks results in somewhat

[63] Network centralization is 6.11% for the largest component in Cluster D after excluding the female ties, which is fairly low.

higher centralization scores. This further shows that health workers are marginal in the male networks whereas they are an integral part of the female networks.

Omitting health workers from the analysis (Table 4.13) shows that on average women have a greater number of ties than men. Furthermore, deleting the female network partners reduces the mean degree centrality to 2.9 in Cluster B from 3.5; however, the standard deviation scores are alike across the male and female networks in the same cluster. Also, unlike the government area where centralization indexes were consistently higher in the female network, the network centralization score is higher in the male network in Cluster C (without the health worker) at 7% whereas in the female network (without the health worker), it is 3.3%. Excluding the female ties from the male network in Cluster B shows a centralization index of 5.5% which is higher than the female network in Cluster B (without the health workers) at 4.9%; thus, the results do not suggest that there is a greater variation in the female degree centrality. To explore this further, network centralization is analysed for each component.

Centralization scores for each component after deleting the health worker show that centrality is more varied in the female networks than the male networks (Table 4.15 and Table 4.16), which is similar to the government area. Excluding the health workers breaks the female networks into several components in which a significant number of respondents are embedded in networks with a centralization index above 20%. However, a majority of male network partners are embedded in networks with a centralization score of less than 8%.

Table 4.15: Degree Centralization scores by component in the ICDDR,B Area (Female)

Component	Centraliz Cluster B	Prop of res (Cluster B)	Centraliz Cluster B (no hw)	Prop of res (Cluster B no hw)	Centraliz Cluster C	Prop of res (Cluster C)	Centraliz Cluster C (no hw)	Prop of res (Cluster C no hw)
1	30.3%	100%	10.9%	7.9%	11.1%	100.0%	7.7%	39.6%
2			16.2%	27.2%			19.0%	14.1%
3			20.0%	4.0%			25.0%	6.7%
4			24.3%	11.9%			25.5%	8.1%
5			24.8%	10.6%			28.9%	7.4%
6			25.0%	4.0%			30.0%	4.7%
7			30.0%	6.6%			35.2%	10.7%
8			35.6%	6.0%			100.0%	2.0%
9			44.6%	6.6%				
10			50.0%	3.3%				
11			52.8%	6.6%				

Table 4.16: Degree Centralization scores by component in the ICDDR,B Area (Male)

Component	Centraliz Cluster B	Prop of res (Cluster B)	Centraliz Cluster B(no_hw)	Prop of res (Cluster B no_hw)	Centraliz Cluster C	Prop of res (Cluster C)	Centraliz Cluster C (no_hw)	Prop of res (Cluster C no_hw)
1	3.4%	86.9%	5.2%	77.8%	6.8%	99.0%	7.0%	97.9%
2	20.0%	4.1%	16.7%	9.0%				
3	66.7%	6.9%	20.0%	4.2%				
4			66.7%	6.9%				

The degree centralization scores by components clearly show that the positional advantage varies more greatly in the female network than the male networks. Excluding female network partners does not alter this conclusion in Cluster B.[64]

Betweenness centrality, which captures the number of times an actor lies between a pair of nonadjacent actors, shows that men score higher on this measure than women. As is evident from the male networks in Figure 4.8 and Figure 4.10, there is often only one path connecting a pair of non adjacent actors, providing a key connecting role to the actors in between. Conversely, in the female network, fewer actors play a connecting role between disjoint pairs. The scores of betweenness centrality confirm this intuition in Table 4.17.

[64] The majority of respondents are embedded in one component with network centralization of 5.6%, after deleting the female ties in Cluster B.

Table 4.17: Betweenness Centrality in the Government Area

	Obs	Mean	Std. Dev.	Min	Max	Centralization Index
Female						
Cluster D	146.0	50.7	185.6	0.0	1600.8	14.95%
Cluster E	104.0	21.8	48.6	0.0	255.2	4.49%
Cluster F	106.0	11.7	30.1	0.0	191.2	3.32%
Male						
Cluster D	146.0	284.3	502.2	0.0	2528.3	41.49%
Cluster E	83.0	212.4	389.1	0.0	1291.0	32.87%

The average betweenness centrality scores for female networks are consistently lower than the scores for the male networks in the government area. For example, in Cluster D the mean is 50.7 and the standard deviation is 185.6 for the female network. 86% of actors have a betweenness centrality of less than 50. Only one actor, who belongs to the ICDDR,B team of workers, has a betweenness score as high as 1600 in the female network in Cluster D. On the other hand, betweenness centrality ranges from 0 to 2528.3 in the male network in Cluster D. The mean is 284.3 and the standard deviation is 502.2. Only 60% of actors in the male network have a betweenness centrality of less than 50 as opposed to 86% of actors in the female network.

The graph centralization index also shows that male networks have a greater degree of inequality in the distribution of betweenness centrality compared to the female networks. The highest graph centralization index for the female network is found to be 14.95% whereas for the male network it is 41.49% in Cluster D.

In analysing graph centralization measures by components, however, caution must be exercised against taking these findings too far. Table 4.18 and 4.19 lists the graph centralization measure for each component in the male and female networks.

Table 4.18: Betweenness Centralization scores by component in the Government Area (Female Network)

Comp	Centraliz Cluster D	Prop of res (Cluster D)	Centraliz Cluster E	Prop of res (Cluster E)	Centraliz Cluster F	Prop of res (Cluster F)
1	5.8%	6.8%	5.4%	7.7%	12.0%	5.7%
2	27.4%	11.6%	15.9%	6.7%	24.0%	13.2%
3	33.3%	4.8%	26.1%	21.2%	27.2%	6.6%
4	34.0%	4.1%	28.5%	12.5%	34.0%	5.7%
5	36.2%	7.5%	39.7%	32.7%	36.3%	12.3%
6	36.7%	4.8%	49.0%	7.7%	38.3%	7.5%
7	50.7%	7.5%	51.3%	9.6%	50.7%	21.7%
8	62.2%	4.8%			63.1%	23.6%
9	66.7%	4.1%			66.7%	3.8%
10	77.6%	43.8%				

Table 4.19: Betweenness Centralization scores by component in the Government Area (Male Network)

Comp	Cluster D	Prop of res (Cluster D)	Cluster E	Prop of res (Cluster E)
1	44.7%	96.2%	46.1%	83.1%
2	100.0%	2.8%	56.0%	7.2%
3			100.0%	6.0%

The results show that although women score poorly on the overall graph centralization measure, there is a great deal of inequality in the distribution of power in components. This again points to issues of power in women's local networks. The analysis by components does not alter the conclusions for men, as the scores are consistently high. All the actors in the male network, except for isolates, are embedded in components with a centralization score of 40% or more, while in the female networks centralization, scores are less than 40% for the majority of actors, except in Cluster D where 60.2% of actors have a score greater than 40%. The results show that positional advantage is unequally distributed in both the male and female networks on the measure of betweenness centrality. On average, however, men score higher on this measure than women in the government area.

Table 4.20: Betweenness Centrality in the ICDDR,B Area

	Obs	Mean	Std. Dev.	Min	Max	Centralization Index
Female						
Cluster B	153.0	187.8	859.7	0.0	9841.2	84.67%
Cluster C	151.0	329.9	910.3	0.0	8184.2	70.75%
Cluster B (no_hw)	151.0	16.7	41.4	0.0	250.4	2.10%
Cluster C (no_hw)	149.0	45.1	106.1	0.0	679.2	5.87%
Male						
Cluster B	145.0	251.9	469.1	0.0	2427.3	21.27%
Cluster C	96.0	192.3	296.3	0.0	1551.5	30.76%
Cluster B (no_hw)	144.0	199.0	424.0	0.0	2249.2	20.33%
Cluster C (no_hw)	95.0	200.1	321.2	0.0	1837.9	37.87%

Yet again, the results in the ICDDR,B region in Table 4.20 differ from the government area due to the presence of health workers. The highest centrality score reaches 9841 in Cluster B for the female network. The mean centrality scores, standard deviation and centralization indexes are also higher in the female network than the male network in Cluster C. This suggests that positional advantage is more varied in the female networks, although these results are mainly driven by the strong presence of health workers in the female network. The highest between centrality was scored by health workers in the female networks in both Cluster B and Cluster C. Leaving out the health workers from the analysis results in a significant drop in the mean scores and centralization index in the female networks, and the results obtained are similar to the government area. In Cluster B graph, for example, centralization is 84.67% in the female network with the health worker. However this figure drops to 2.10% if the health workers are excluded in the female network in Cluster B. On the other hand, in the male network in Cluster B, graph centralization changes slightly from 21.27% to 20.33% if the health workers are deleted, and in Cluster C the centralization index actually increases from 30.76% to 37.87% after deleting the health worker. This again shows that health workers are marginal in the male networks.

Comparing men's and women's networks without the health workers shows that the average betweenness centrality, standard deviation and centralization indexes are all higher in the male

networks. The lowest centralization score amongst all the male networks is attained in Cluster B. Deleting the female network partners from the male network in Cluster B increases the centralization index to 22.28% and these results suggest that the communication patterns of men in Cluster B are different from men in other clusters.

Table 4.20 shows that if the health workers are ignored, the positional advantage is greater in the male networks, yet it is not intended to imply that inequalities in betweenness centrality are non-existent in the female networks. The centralization indexes in Table 4.21 show that within each component, betweenness centrality is unequally distributed in the female networks.

Table 4.21: Betweenness Centralization scores by component in the ICDDR,B Area (Female Network)

	Centraliz Cluster B	Prop of res (Cluster B)	Centraliz Cluster B (no_hw)	Prop of res (Cluster B no_hw)	Centraliz Cluster C	Prop of res (Cluster C)	Centraliz Cluster C (no_hw)	Prop of res (Cluster C no_hw)
1	84.7%	100.0%	14.0%	4.0%	70.8%	100.0%	12.0%	4.7%
2			21.2%	6.6%			21.7%	6.7%
3			26.9%	27.2%			28.4%	8.1%
4			29.3%	6.6%			35.8%	39.6%
5			31.1%	6.0%			47.1%	7.4%
6			42.4%	11.9%			52.3%	14.1%
7			46.1%	7.9%			61.8%	10.7%
8			48.0%	10.6%			100.0%	2.0%
9			50.0%	3.3%				
10			58.0%	6.6%				
11			61.4%	4.0%				

Table 4.21 also shows that like the government area, the majority of the women are embedded in networks with centralization indexes less than 40%. By contrast, the results for the male networks diverge from the results in the government area. In the government area, the majority of male respondents are embedded in networks with centralization scores more that 40%, but in the ICDDR,B area, the majority of the respondents are embedded in networks with centralization scores of less than 40%. After excluding the health worker, the graph centralization for the largest component in Cluster C is 38.6% and in Cluster B it is 33% (Table 4.22). Although the

figures show high betweenness centrality in the male networks, these figures are not higher than the female networks.

Table 4.22: Betweenness Centralization scores by component in the ICDDR,B Area (Male Network)

Comp	Centraliz Cluster B	Prop of res (Cluster B)	Centraliz Cluster B (no_hw)	Prop of res (Cluster B no_hw)	Centraliz Cluster C	Prop of res (Cluster C)	Centraliz Cluster C (no_hw)	Prop of res (Cluster C no_hw)
1	24.0%	4.1%	15.6%	9.0%	31.4%	99.0%	38.6%	98.9%
2	27.8%	86.9%	24.0%	4.2%				
3	50.5%	6.9%	33.0%	77.8%				
4			50.5%	6.9%				

To explore centrality further, betweenness centrality is calculated for Cluster B after excluding all the female actors. The results in Table 4.23 confirm that the majority of respondents in the male network in Cluster B are embedded in networks with a centralization index of less than 40%.

Table 4.23: Betweenness Centralization scores by component in Cluster B (Male Network without female contacts)

Comp	Centraliz Cluster B (no_Fem)	Prop of res (Cluster B)
1	33.0%	81.4%
2	24.0%	5.3%
3	50.5%	8.8%

The scores for betweenness centrality show that on average men in both ICDDR,B and the government area are more likely to derive power by connecting disjoint pairs of actors, whereas the analysis by component shows that women are also central in connecting actors within their local networks. In the ICDDR,B area, inequalities in the distribution of power within the networks are not any more unequally distributed in the female networks than in the male networks, although in the government area, the male networks are more unequal than the female networks on betweenness centrality. It is likely that the measure of betweenness centrality is particularly sensitive to the snowball sampling techniques because male networks display chain like properties, the length of which could increase many times if few more rounds of snowball

were followed. Although this is probable, the analysis of betweenness centrality shows that men are more likely to connect disjoint pairs of actors than women. This basic conclusion is unlikely to be altered even if the snowball was conducted indefinitely.

Conclusion

The practice of purdah and associated seclusionary practices start as early as the age of eleven for most women in Bangladesh. Gender norms, which are further reinforced by the family and kin-based networks, act as a severely limiting factor for women trying to achieve better outcomes for themselves or their children. In this context, it would be unrealistic to expect that women behave like independent economic agents when making fertility-related choices. Previous research in Bangladesh (Gayen and Raeside 2005) and other developing countries shows that family planning choices by women are often made in accordance with their social networks (Valente et al. 1997; Behrman, Kohler, Watkins 2002; Kincaid 2000; Rutenberg and Watkins 1997; Marten 2002; Gayen and Raeside 2005). Women's choices have also been shown to be strongly influenced by their spouses (Kamal 2000; Khan and Rahman 1997). A rare study on men's networks in Kenya suggests that even men consult their social networks while making contraceptive decisions (Behrman, Kohler, Watkins 2002). In light of this evidence, it is necessary to study fertility choices in relation to both men's and women's networks. This chapter has shown that both men and women are actively involved in discussions of fertility related issues with peers. Ignoring either men's or women's networks is thus unjustified in network studies on family planning.

Social capital however is an inappropriate analytical tool for studying the complex web of social relations. By analyzing selected social networks in a positive light, the social capital view provides a misleading and shallow understanding of the social world. It ignores important aspects such as the role of power, gender subordination and unequal distributions of resources in networks. Our use of social network analysis cautions against this approach.

The research shows that both men and women have abundant so-called, 'social capital' networks, but these networks are segregated along gender lines. The structural analysis further highlights that the patterns of male and female networks are inherently different. Women are embedded in small substructures with limited contact with most members in their network, and with the exception of the ICDDR,B area, the female networks are divided into several weakly-connected components in which women are at an infinite distance from the majority of actors in the network. Even in the ICDDR,B area, women's ability to reach other members in the network is substantially weakened if the health workers are removed from the network; thus, in the absence of a strong health program, female networks provide limited opportunity for information flow between women in different parts of the network. The majority of men are found to be at least weakly connected to most others in their respective networks and potentially have access to information from diverse sources. Furthermore, the connectivity in the male networks is not dependent on the health workers.

Women's networks are also found to be more cohesive than the male networks, as shown by the distance and clustering coefficient. Unlike men, women cannot reach most members in their networks, but they are at short distance from actors in their respective components in both the ICDDR,B and the government area if the ties to health workers are ignored. Women also have many more overlapping connections compared to men. The measure of personal network density is found to be consistently higher for women than for men in each cluster, irrespective of the presence of ICDDR,B health workers. This suggests that women are more likely to be constrained and to receive redundant information in these networks than men. Dense ties amongst women are likely to be composed of strong connections between homophilous individuals with similar information; whereas sparse networks of men may contain many more weak ties between socially distant individuals providing varied information. The strength of

normative influences towards conformity is also likely to be greater in dense networks, as network members can jointly influence a particular actor (Marsden 1987).

The pressures towards conformity, however, may not be limited to personal networks. Such pressures can also be transmitted through intermediaries, especially amongst members of closely interacting cohesive subgroups. Using the definition of bi-components for subgroup identification, the majority of women are embedded into cohesive subgroups composed of three or more actors. Only a small degree of overlap is found between members of cohesive subgroups, as few women act as cutpoints connecting large substructures; however, the overlap is greater in the ICDDR,B area. Apart from this difference, the structure of the bi-components in the networks is similar in the two areas. By contrast, men belong to fewer bi-components of three or more actors compared to women in each of the clusters. A vast majority of men belong to bi-components of size two, where one node acts as the cutpoint. These structural dimensions of networks suggest that men are more likely to be exposed to richer information and face fewer pressures to conform to norms of a particular group.

The centrality measures further reveal the differences in the pattern of ties between men and women. The centrality measures employed seek to identify whether certain actors occupy advantageous positions in each of these networks, providing them with the structural basis of power (Hanneman and Riddle 2005). Degree centrality shows that while men are similarly positioned to other members in the network, women face a greater degree of inequality in positional advantage in networks in the government area. Furthermore the female networks are highly centralised in the ICDDR,B area and these effects reduce to the patterns observed in the government area after deleting the health worker.

The betweenness centrality measure shows that positional advantage is more unequally distributed in the male network compared to the women's network, except in the ICDDR,B area where betweenness centrality are highest, mainly due to the ICDDR,B health workers. Excluding the health workers from the analysis shows that in both the areas men have higher betweenness centrality scores than women. Even though the average betweenness centrality is higher in the ICCDR,B area, component analysis reveals that positional advantage is just as unequally distributed in the female networks as in the male networks in the ICDDR,B area. These differences in measures of centrality reveal that even though some women occupy central positions in the respective substructures, they are unlikely to defy the norms of purdah to act as bridges between different parts of the network.

The structural analysis thus suggests that in providing information on contraceptives, social networks are likely to play the role of limiting women's choice by encouraging behavioural conformity, whereas men's networks are unlikely to suffer from similar problems. At the same time, men's networks are better equipped to acquire and spread family planning information due to the greater number of bridging connections. The gender analysis reveals the inequalities in social networks and shows that social relationships are embedded in issues of power and conflict. Social capital literature has failed to engage with these issues and has continued to view social networks in gender-blind terms, which renders the social capital concept inadequate for most policy purposes in developing countries.

It can be argued that women have more bonding social capital and men have more bridging social capital, but although this is found to be true in our Bangladeshi networks, social capital does not clarify the sources of these inequalities and fails to take into account the issues of power and conflict in both bonding and bridging social capital. Even if we accept the view that deficits of bridging social capital are the cause of female disadvantage in developing countries, the

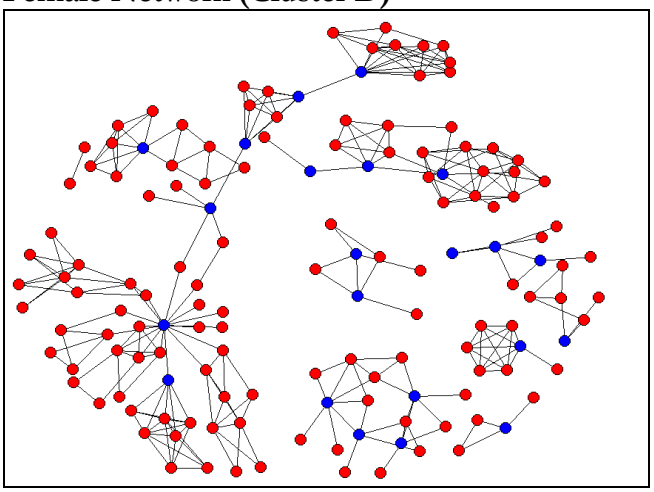
creation of this type of social capital is unlikely to be an easy task. As discussed earlier, the pattern of ties in the female networks are almost identical in the government and the ICDDR,B area, if the health workers are ignored. This is despite decades of intense intervention in the ICDDR,B area. Although the ICDDR,B program does not aim to transform the communication networks in the targeted communities, the analysis does suggest that networks can be highly resistant to change, even in the face of strong external influences. Men's networks offer more hope in this direction. As discussed in the results section, Cluster B in ICDDR,B stands out from male networks in other clusters on many measures such as degree, cohesion and centrality. The reasons for this cannot be attributed to ICDDR,B intervention based on data from one village; however, this research does suggest that a greater degree of variation exists in the male networks.

Finally, this chapter has discussed the differences in male and female family planning networks. The results show that even though both men and women are likely to receive useful information from networks, women are embedded in networks that provide fewer opportunities, greater constraints and are more unequal than men. Social capital literature has failed to engage with gender inequalities in networks and provides few reasons for these structural differences. To explore the gender issue further, the next chapter shows that the networks are constructed around dominant gender norms that continue to disadvantage women. In undertaking this analysis, we provide further evidence that cautions against the celebration of 'solidarity networks'.

Appendix 4

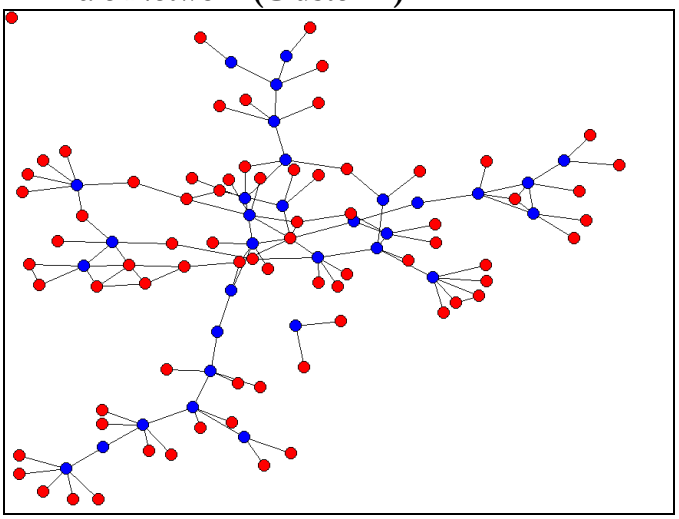
Government Area

Female Network (Cluster D)

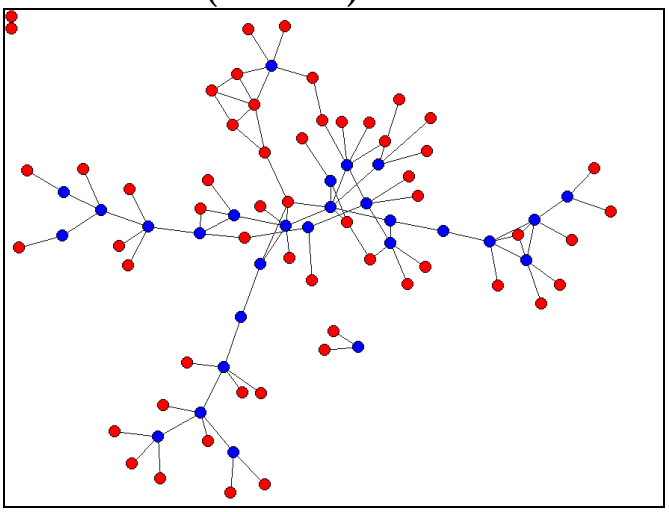


Blue nodes represent cutpoints

Male Network (Cluster D)

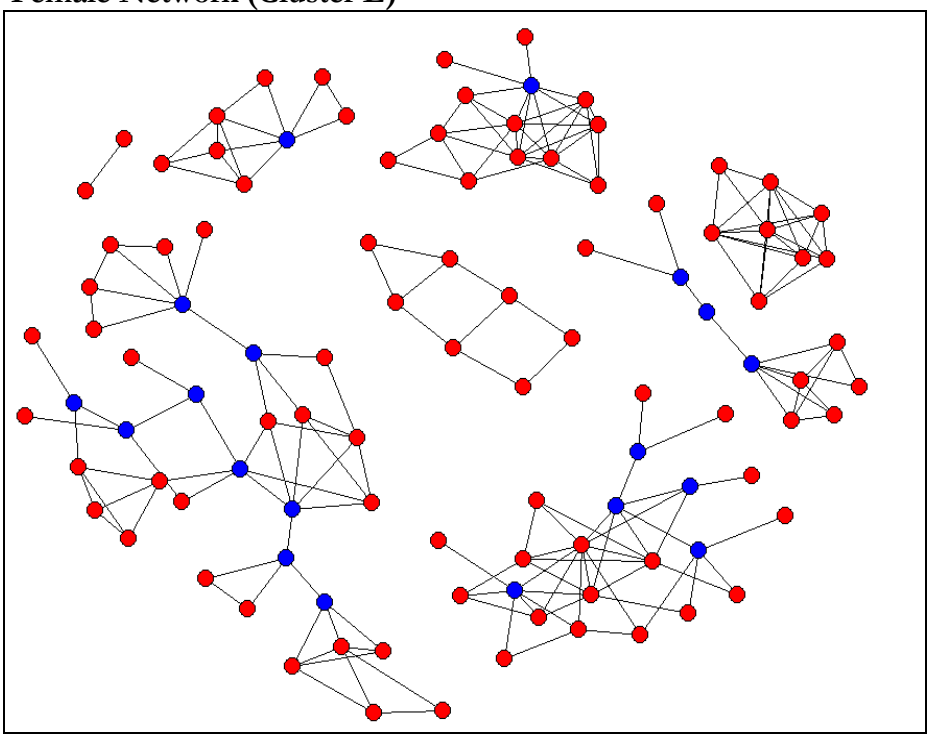


Male Network (Cluster D) without Female Ties



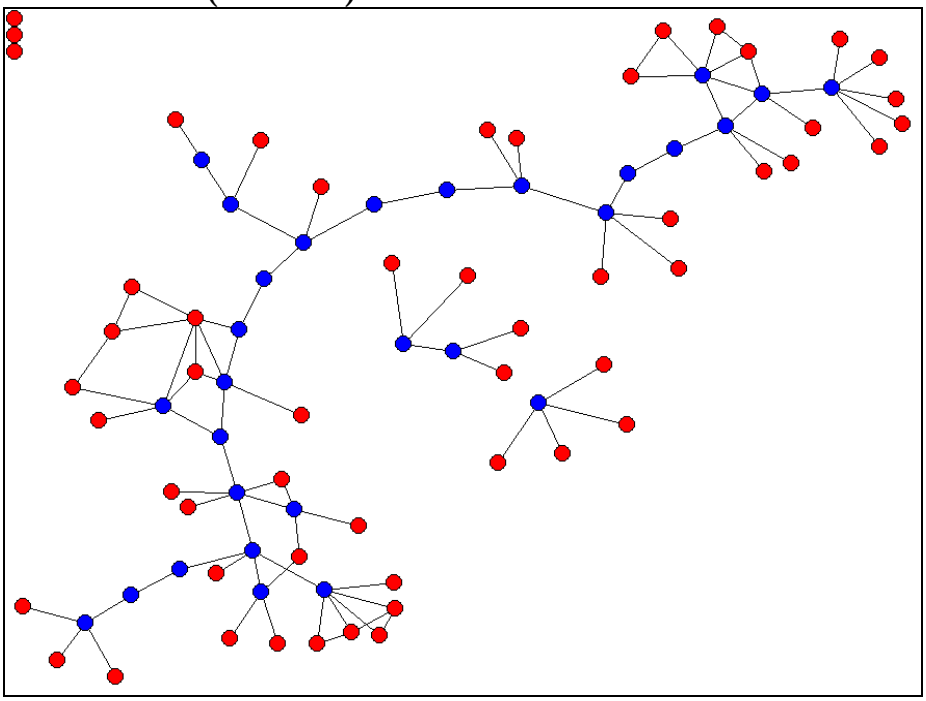
Government Area

Female Network (Cluster E)



Blue nodes represent cutpoints

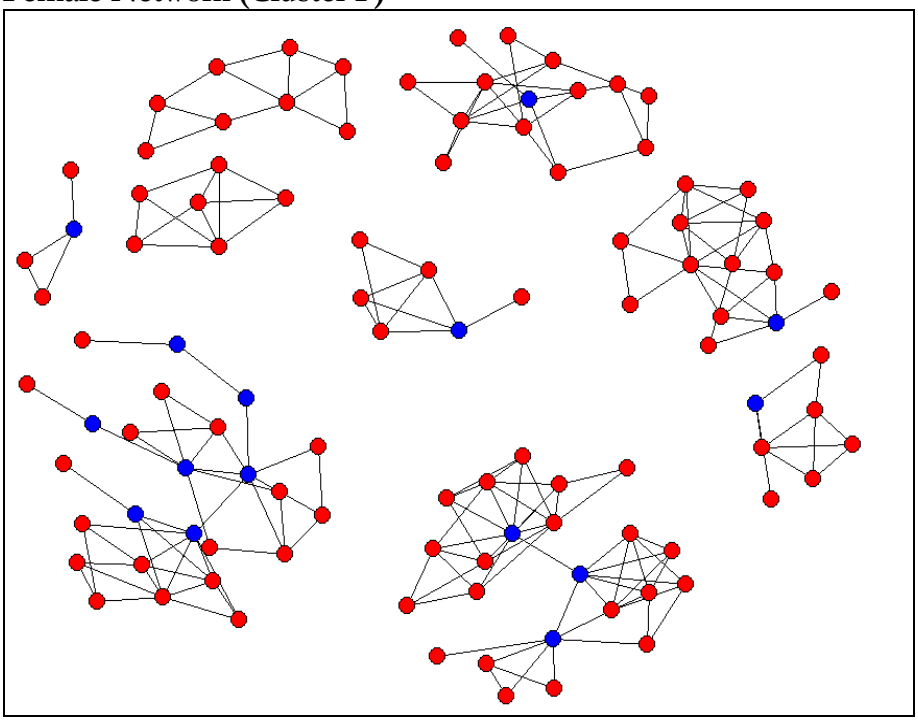
Male Network (Cluster E)



Blue nodes represent cutpoints

Government Area

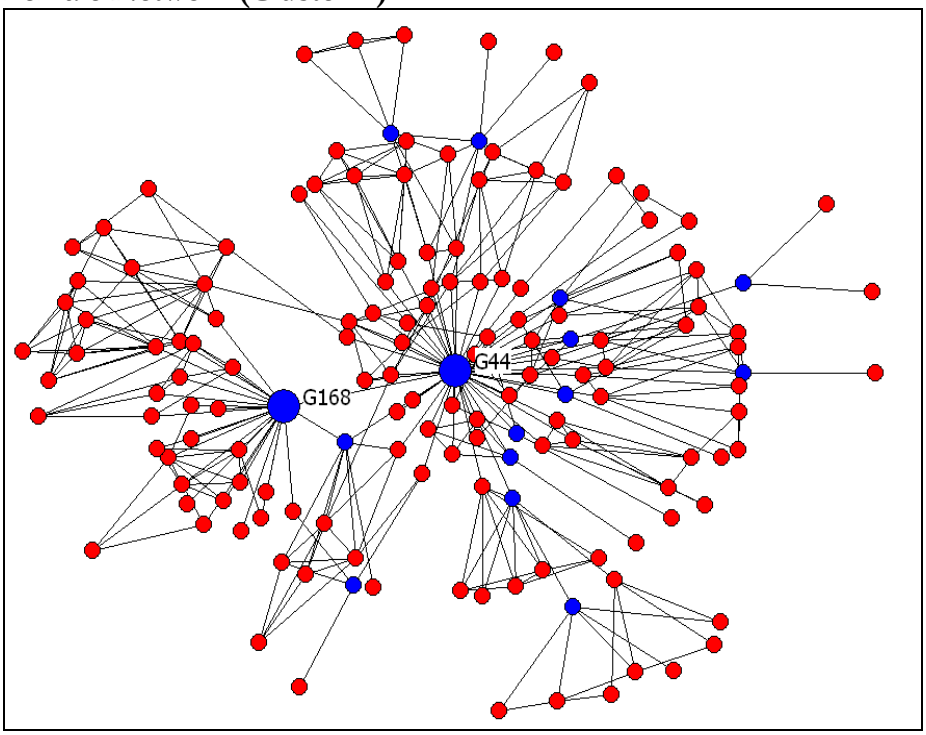
Female Network (Cluster F)



Blue nodes represent cutpoints

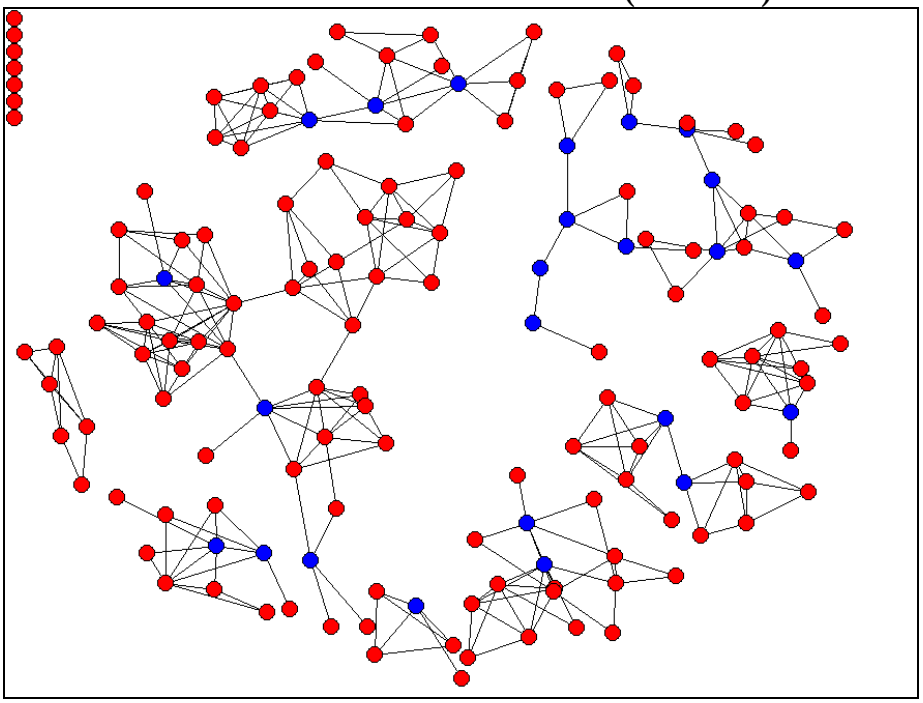
ICDDR,B Area

Female Network (Cluster B)



Blue nodes represent cutpoints. Nodes G44 & G168 represent the health workers

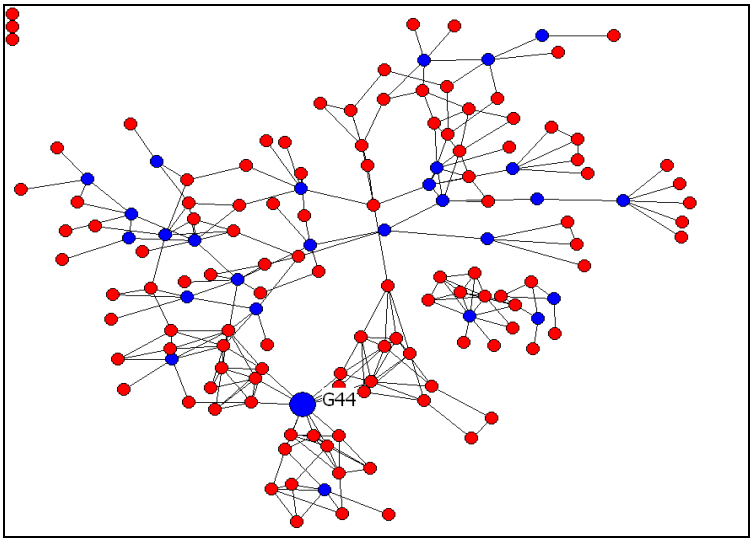
Female Network without the Health Workers (Cluster B)



Blue nodes represent cutpoints

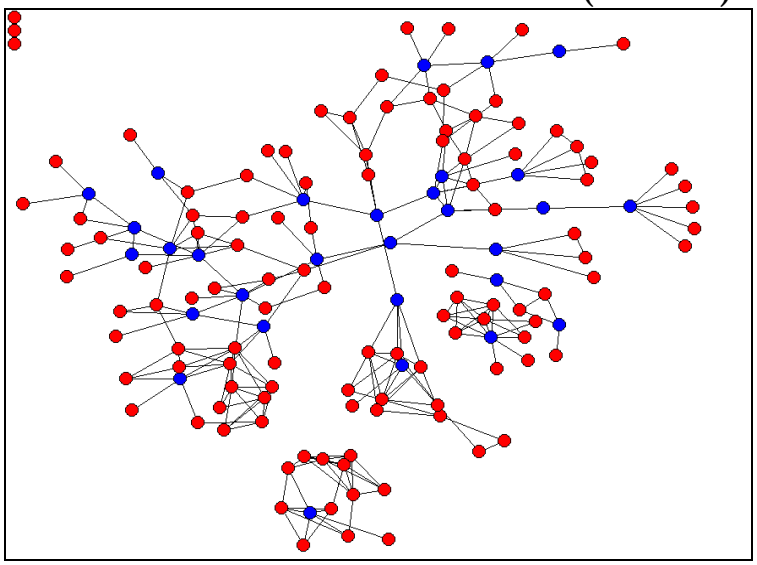
ICDDR,B Area

Male Network (Cluster B)

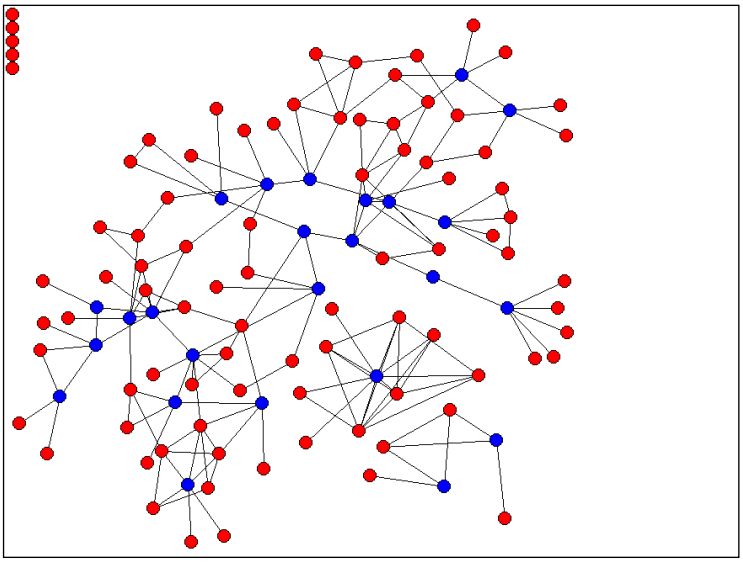


Blue nodes represent cutpoints. G44 represents the health worker.

Male Network without the Health Worker (Cluster B)

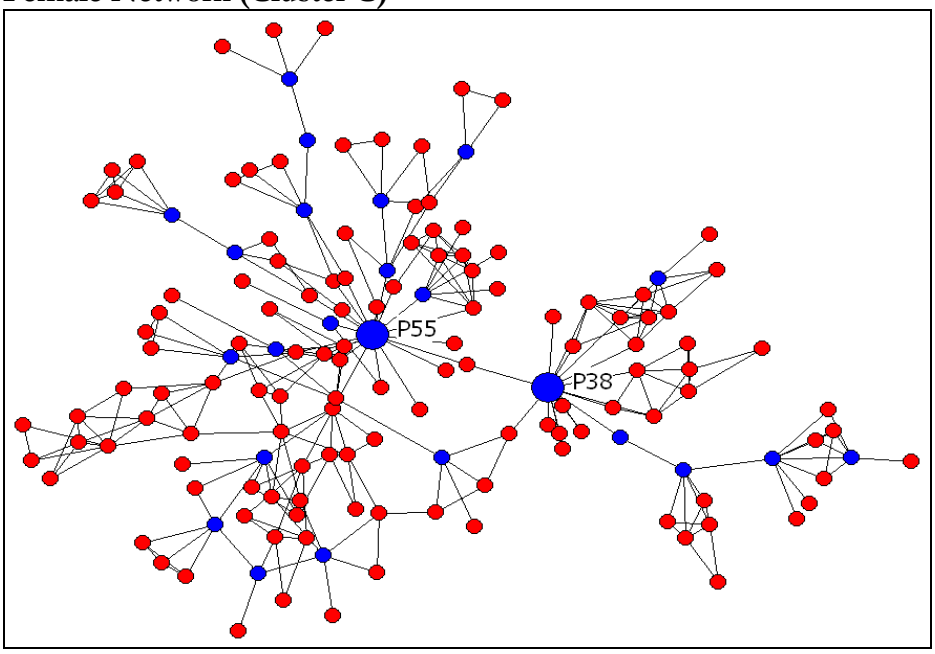


Male Network without the Health Worker and Female Ties (Cluster B)



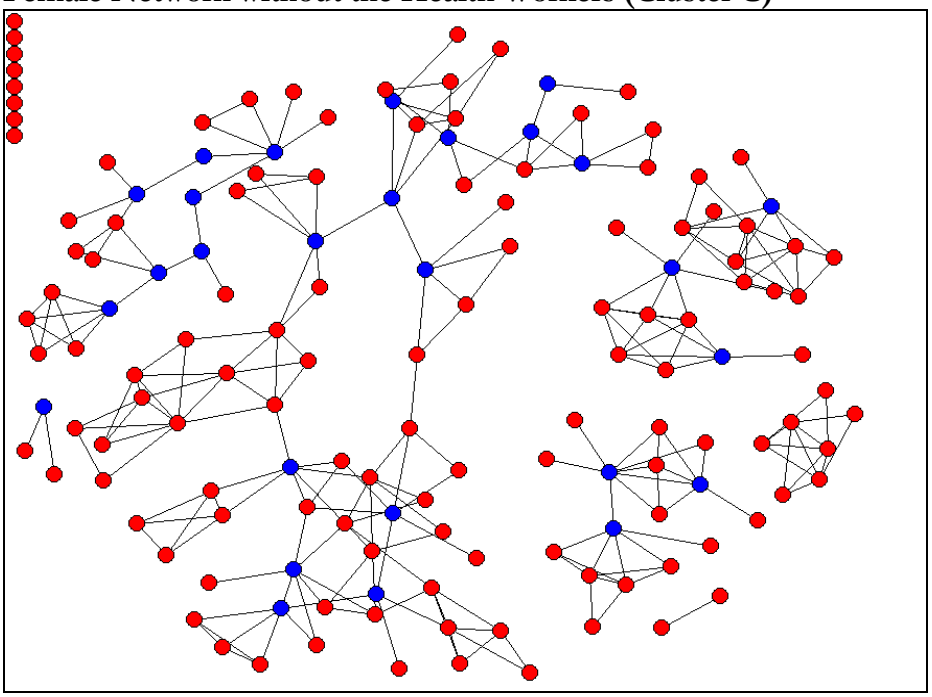
ICDDR,B Area

Female Network (Cluster C)



Blue nodes represent cutpoints. Nodes P55 and P38 represent the health workers.

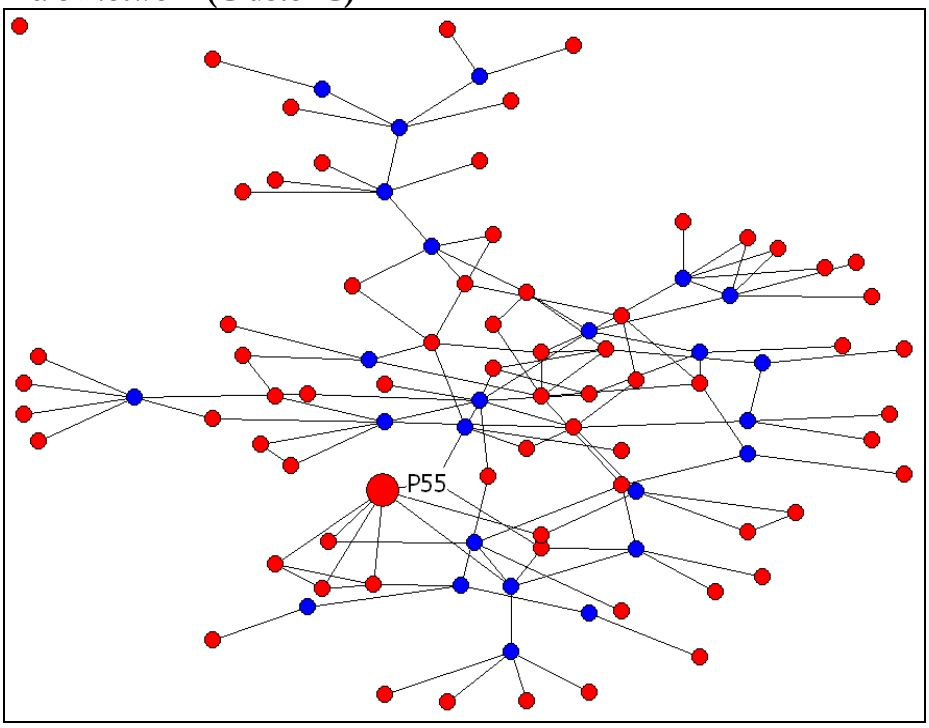
Female Network without the Health Workers (Cluster C)



Blue nodes represent cutpoints

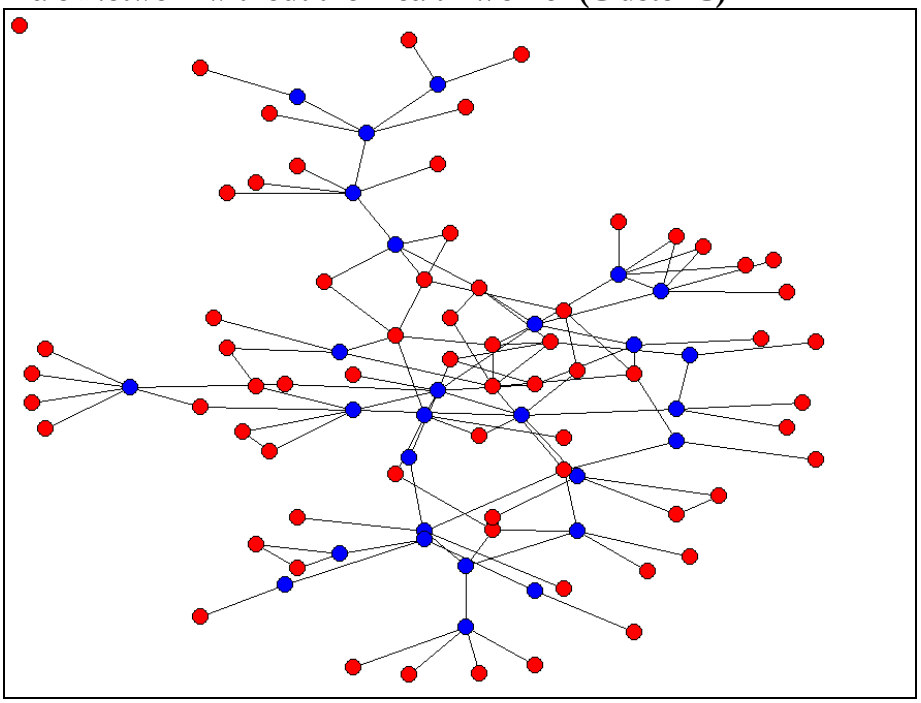
ICDDR,B Area

Male Network (Cluster C)



Blue nodes represent cutpoints. P55 represents the health worker.

Male Network without the Health Worker (Cluster C)



Blue nodes represent cutpoints

5. Formation of Ties: Transitivity, Homophily and Immobility

The analysis in the preceding chapters has mainly presented a global or macro perspective of male and female family planning networks in Bangladesh.[65] Using this perspective, we have been able to unveil stark structural disparities in these networks. The results illustrate that both men and women are likely to receive useful information on family planning through their networks. Compared to female networks, however, male networks are better equipped to provide information from diverse sources and are less likely to be constraining. Furthermore male networks are found to have a more equal distribution of power within the networks than female networks.[66] This chapter aims to extend the analysis by identifying the reasons behind these inequalities and to investigate why women find themselves to be part of networks that are not only unequal but so deficient in opportunity. These questions are explored by studying local or micro structures in social networks and also by incorporating the broader social context in our analysis. The results in this chapter suggest that the so-called social capital networks are governed by stringent local norms leading to gender inequalities. Furthermore, these networks are likely to reinforce existing inequalities rather than provide avenues for change.

To explore the processes of networking that cause the observed network structure, we investigate the formation of ties within triads by evoking the concept of transitivity and dyadic patterns of homophily. Also included in the analysis are gender norms of restriction on women's mobility. The results show that transitivity and homophily are important features of the female networks, but these interactions are constrained by dominant gender norms of purdah that continue to disadvantage women by restricting their mobility. This is despite health interventions in the

[65] The analysis so far has mainly used structural measures such as group membership and centralization index, which provide a global view of the entire structure without indicating how ties are formed between actors at the micro level.

[66] Exceptions to this are the male networks in the government area on the measure of betweenness centrality.

region that encourage women to access health care outside the household and link them to the broader community through the health workers. The results also show transitivity to be an important feature of male networks. Unfortunately homophily is not tested for in the male networks because of the unavailability of data, but needless to say, male networks are not found to be constrained by severe restrictions on mobility.

The subsequent sections review the relevant literature and outline the methodology followed by a detailed analysis of results. Finally, a discussion of the implications of the findings is provided. Like has been the case in Chapter 4, the analysis in this chapter is based on symmetrised data; however, the triadic analysis accounts for the direction of ties, as it is concerned with network partner choices at a micro scale.[67]

Triads

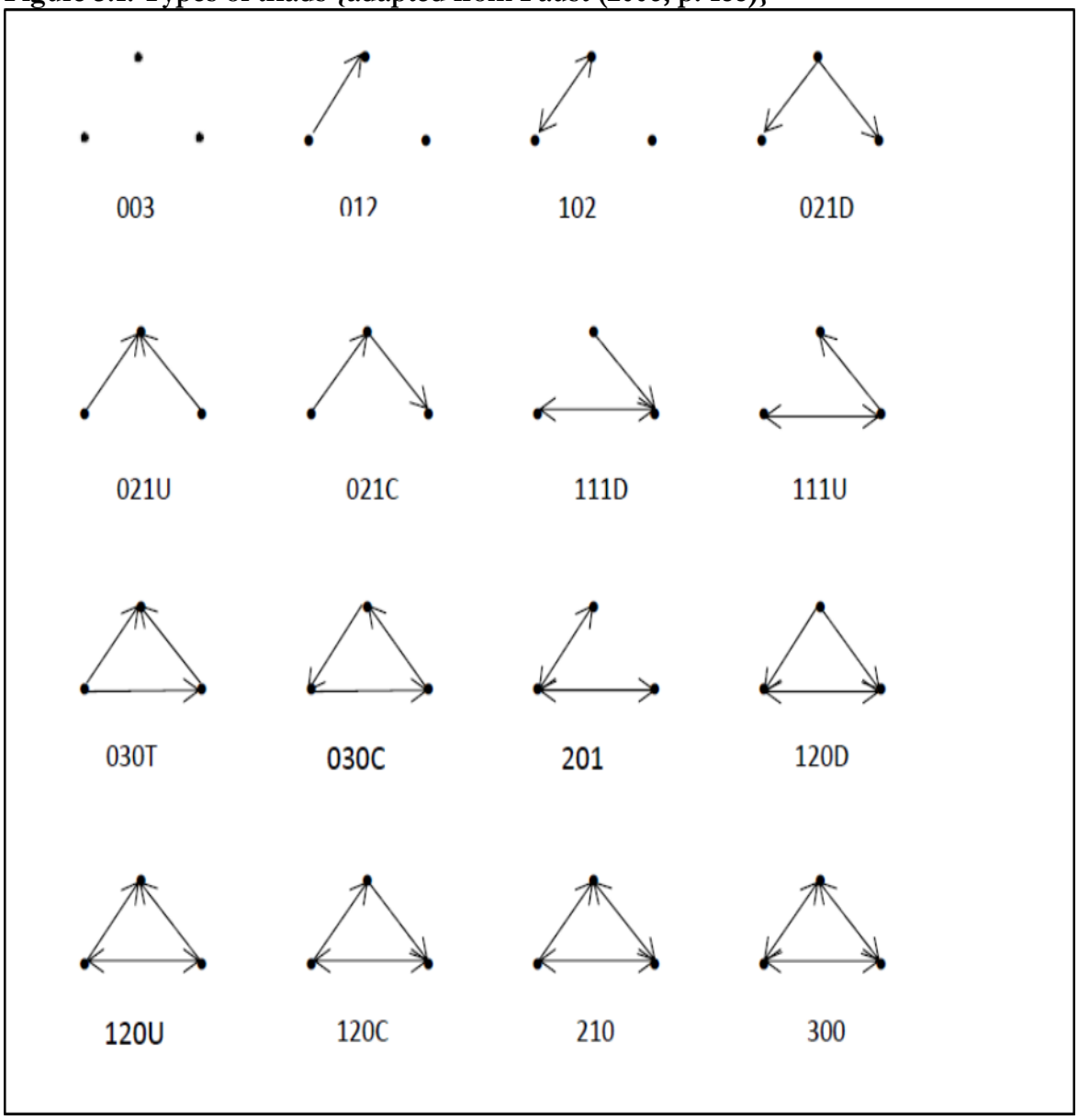
Social network analysis has a well recognised tradition of analysing local structure in networks, which consists of 'configurations and properties of small subgraphs of nodes and arcs, most notably dyads and triads' (Faust 2006, p. 187). The most basic and smallest subgraph is the dyad which consists of a pair of actors and all ties between them. A directed graph consists of three types of dyads: mutual, asymmetric and null. These are called the 'dyadic isomorphism classes' (Wasserman and Faust 1994, p. 512). A triad is a subgraph of three actors and all ties between them. A directed graph consists of sixteen isomorphism classes for triads[68], as shown in Figure 5.1.

[67] The homophily analysis undertaken in this chapter could also benefit from accounting for direction in networks. This aspect will be explored in future research.

[68] Isomorphism classes are defined as the types of triads that are possible in any digraph if the labels of the nodes are not taken into account

The frequencies with which each of these dyadic or triadic isomorphic classes arises in a directed network form the basis of subgraph analysis. For example, a dyad census provides a count on the number of mutual, asymmetric and null ties in a network. Similarly, the triad census provides a count of the number of each of the sixteen triad types (Figure 5.1) in a network. The obtained dyadic and triadic census can be used to compare the observed network with random networks to identify the presence of any structural pattern. The triadic census, however, does not shrink the original data as much as the dyadic census, thereby providing richer information for analysis (Wasserman and Faust 1994). Furthermore, many important theoretical properties have been articulated in terms of triads rather than dyads (Faust 2006). This section will therefore focus on the analysis of triads.

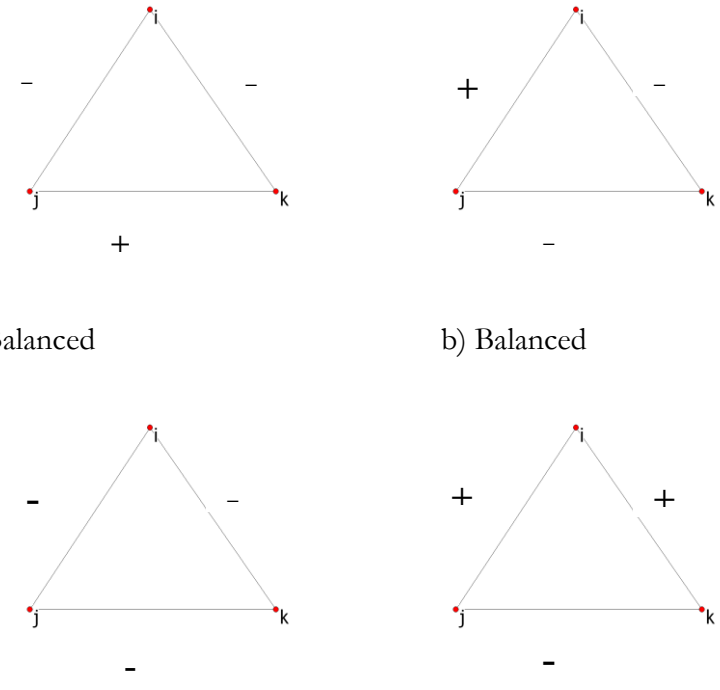
Figure 5.1: Types of triads {adapted from Faust (2006, p. 188)}



Theories that have been articulated by means of triads include structural balance, clusterability, ranked clusters, and transitivity (Faust 2006). A brief review of each of these theories is provided here to motivate the discussion of transitivity, which is the main focus of triadic analysis in this chapter. The triadic analysis provides insight into how the observed network structures emerge, as well as showing that the networks are non-random.

The earliest studies of triads arose out of the notion of Heider's theory of cognitive balance, which recognised that ties between two people may be affected by the tie of each to a third person (Leik and Meeker 1975). For example, a balanced state exists if two friends are consistent in their evaluations of a third person. They both either like or dislike the same third person. Figure 5.2a provides an example of a balanced graph where j and k have a positive relation and both have a negative relation with actor i. A balanced state also exists if people with negative ties are inconsistent in their evaluations; for example two enemies dislike the same other person, such as in Figure 5.2b. If these conditions do not hold, i.e. friends are inconsistent in their evaluations of a third person or enemies are consistent in their evaluations, then people will feel uncomfortable and try to modify their perceptions (Leik and Meeker 1975; Wasserman and Faust 1994).

Figure 5.2



a) Balanced b) Balanced

c) Unbalanced d) Unbalanced

Extensions to the concept of balance to more than three actors led to the theory of structural balance. Structural balance holds when a graph can be divided into two subgroups such that all ties within the subgroup are positive and ties between the two subgroups are negative. Structural balance can also be applied to directed graphs by assuming that mutual ties represent positive relations and null ties represent negative relations (Faust 2006). The triads allowed for balanced digraphs are 300 and 102 (Figure 5.1). If structural balance holds, then social structures with negative relations develop into two disconnected cliques (Leik and Meeker 1975; Wasserman and Faust 1994).

The theory of balance, which proved to be too restrictive, was extended by relaxing the assumption that people with negative ties disagree in their evaluation of a third person. This led to the theory of clustering which assumes that people avoid getting into triples with exactly one negative relationship;[69] thus the triad in Figure 5.2c is allowed under clustering, but not under balance. This modification allows the graph to be divided into several subgroups with negative ties between subgroups and positive ties within subgroups. For directed graphs, mutual ties are considered positive and null ties are considered negative. The triads allowed under clustering are 102, 300 and 003, and under clustering, a social structure will arrange itself into several cliques (Leek and Meeker 1975; Faust 2006).

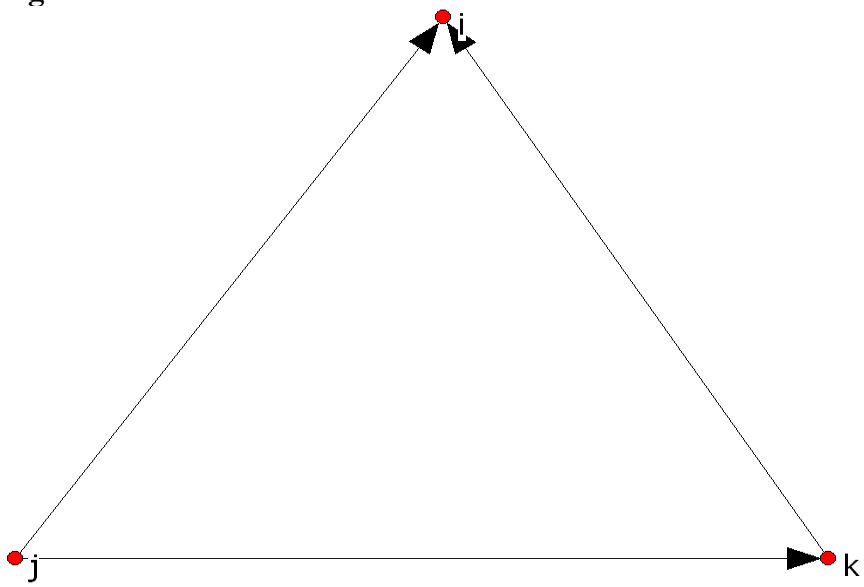
Although clustering provides a sociologically more plausible idea of several groups (Faust 2006), it does not account for asymmetric ties. Ranked cluster models incorporate asymmetric ties by allowing for hierarchy between clusters. In this model, mutual ties are assumed to exist between people in a cluster within the same level, and null ties between people in different clusters but within the same level. Asymmetric ties are permitted only between clusters at different levels,

[69] Under clustering, the actors in the triad with only negative ties with each other (Figure 2c) can be simply divided into three separate groups. This was not possible under balance, which allows for only two subgroups.

where everyone in a lower cluster sends ties to higher clusters. Actors in higher clusters do not reciprocate the choices received from lower ranked clusters. The triads permitted for the ranked clusterability model are 300, 102, 003, 120D, 120U, 030T, 021D and 021U (Faust 2006).

The failure of the ranked clustering model to adequately explain the data led to a further modification of the theory (Leek and Meeker 1975). Transitivity was introduced as a general model of positive relationships. A triplet is classified as transitive if for nodes i, j, k whenever i→j and j→k then i→k. However if i↛j and or j↛k then the triple is vacuously transitive, i.e. the triple is neither transitive nor intransitive, which does not violate the transitivity principle since the initial conditions of transitivity are not met. The transitivity principle can be extended from triples to triads. For a triad to be transitive, 'all ordered triples of actors present in a triad must be either transitive or vacuously transitive' (Wasserman and Faust 1994, p. 245). Triads that violate the transitivity principle are forbidden (Wasserman and Faust 1994).

Figure 5.3: Transitive Triad



Triple1 $p_i p_j p_k$: Vacuously transitive : $p_i \nrightarrow p_j \quad p_j \rightarrow p_k \quad p_i \nrightarrow p_k$

Triple2 $p_i p_k p_j$: Vacuously transitive: $p_i \nrightarrow p_k \quad p_k \nrightarrow p_j \quad p_i \nrightarrow p_j$

Triple3 $p_j p_i p_k$: Vacuously transitive : $p_j \rightarrow p_i \quad p_i \nrightarrow p_k \quad p_j \rightarrow p_k$

Triple4 $p_j p_k p_i$: Transitive: $p_j \rightarrow p_k \quad p_k \rightarrow p_i \quad p_j \rightarrow p_i$

Triple5 $p_k p_i p_j$: Vacuously transitive: $p_k \rightarrow p_i \quad p_i \nrightarrow p_j \quad p_k \nrightarrow p_j$

Triple 6 $p_k p_j p_i$: Vacuously transitive: $p_k \nrightarrow p_j \quad p_j \rightarrow p_i \quad p_k \rightarrow p_i$

Figure 5.3 provides an example of a transitive triad, 030T. The triad consists of six ordered triples. Each of the six triples needs to be analysed to ascertain whether or not the triad is transitive. As Figure 5.3 shows, 030T triad is transitive since it has one transitive and five vacuously transitive triples. On the other hand, a triad such as 021C (Figure 5.1) is intransitive since it contains one intransitive and five vacuously transitive triples.

The total numbers of triads allowed under transitivity are 300, 102, 003, 120D, 120U, 030T, 021D, 012U and 012 (Figure 5.1). The triads allowed under balance, clustering and ranked clustering are transitive. A triad such as 012 is also allowed under transitivity since the principle allows ties to be absent between clusters of different ranks. Unlike the ranked clustering model, it is not necessary for transitivity that everyone from lower ranks will choose people in higher

ranks. Transitivity predicts a social structure with 'multiple, disconnected systems of ranked clusters in a population' (Faust 2006, p. 217).

Although transitivity has its roots in structural balance, it is not as restrictive and simply states that people will try to achieve balance in their relationships by reducing intransitive triads (Valente 2010). The theory is also supported in a variety of empirical studies. Holland and Leinhardt (1976) test transitivity using 408 sociomatrices. They find strong statistical evidence that transitivity holds in a majority of cases. Karlberg (1999) provides further evidence of transitivity using a large set of classroom sociomatrices. Louch (2000) uses ego network data to show that transitivity is important in explaining ties amongst people even after controlling for many important variables such as sex, race and education.

Transitivity Index

Transitivity can be measured in digraphs using a transitivity index. This index is defined in terms of triples. The transitivity index measures the number of transitive triples in a digraph divided by the sum of transitive and intransitive triples.

Let a directed graph without loops, $G_d(P,L)$, consists of a set of g nodes, $P=\{p_1, p_2,..., p_g\}$, and a set of l arcs, $L=\{l_1,l_2,....l_l\}$. Each arc is an ordered pair of distinct nodes, $l_k=(p_i, p_j)$. Let X represent the associated sociomatrix of the digraph $G_d(P,L)$. The sociomatrix is a square matrix with g rows and g columns. The value of the tie from p_i to p_j is placed in the (i,j)th element of X. If there is a tie from p_i to p_j then the value of x_{ij} is 1 and is 0 if there is no tie from p_i to p_j.

An ordered triple of nodes (i,j,k) is transitive if $x_{ij} = x_{jk} = x_{ik} = 1$ and intransitive if $x_{ij} = x_{jk} = 1,\ x_{ik} = 0$; and potentially transitive $x_{ij} = x_{jk} = 1$. The number of transitive and intransitive triples can be defined as (Karlberg 1999)

$$\text{Transitive(Trans)} = \sum_{\substack{i=1 \\ j \neq i}}^{g} \sum_{\substack{j=1 \\ i \neq k \neq j}}^{g} \sum_{k=1}^{g} x_{ij} x_{jk} x_{ik}$$

$$\text{Intransitive Triples (Intrans)} = \sum_{\substack{i=1 \\ j \neq i}}^{g} \sum_{\substack{j=1 \\ i \neq k \neq j}}^{g} \sum_{k=1}^{g} x_{ij} x_{jk} (1 - x_{ik})$$

The transitivity index is the ratio of transitive triples to the number of potentially transitive triples, which is the sum of transitive and intransitive triples (Snijders 2002).

$$Trans_{index} = \frac{Trans}{Trans + Intrans}$$

While the above index provides a descriptive measure of transitivity, it does not provide a statistical test of whether or not transitivity is a significant property of our networks. In order to test for transitivity, the observed index is compared to the one expected by chance. We use uniform distribution conditional on the number of indegrees and outdegrees to calculate the expected value of the transitivity index. This distribution is considered to be extremely important in social network analysis since it can be used to statistically control for both the choices made and received and hence can ensure that the observed transitivity is not an artefact of actor degrees (Wasserman and Faust 1994; Karlberg 1999).

The indegree of node i, represented by x_{+i}, is the number of ties received by node i. The outdegree of node i, represented as x_{i+}, is the number of ties sent out by node i. The indegrees and outdegrees can be calculated as

$$x_{+i} = \sum_{j=1}^{g} x_{ij}$$

$$x_{i+} = \sum_{j=1}^{g} x_{ij}$$

The uniform distribution conditional on in and out degrees is represented as $U \mid X_{i+}, X_{+i}$. Under this distribution every digraph with specified indegrees (calculated from the data),

$X_{+1} = x_{+1}, X_{+2} = x_{+2}, ...X_{+g} = x_{+g}$, and specified outdegrees,

$X_{1+} = x_{1+}, X_{2+} = x_{2+}, ...X_{g+} = x_{g+}$, is equally likely. The sample space contains only those digraphs with specified in and out degrees.

Despite the importance of $U \mid X_{i+}, X_{+i}$ in network analysis, much remains unknown about the properties of this distribution. For this reason many earlier studies, such as Holland and Leinhardt (1976), used simpler conditional uniform distributions for transitivity analysis. The work of Snijders (1991) has, however, made it possible to generate random digraphs with fixed in and out degrees using Monte Carlo simulation methods. This analysis therefore uses Snijders's (1991) algorithm to generate $U \mid X_{i+}, X_{+i}$ distribution and calculate the expected value of the transitivity index.

Homophily

The triad analysis focuses on the structural dimensions of tie formation but ignores the content of social relationships, although ties between two individuals may exist because of common

attributes such as age or race. This section examines the content of social relationships by incorporating the notion of homophily. Homophily means that interactions are more likely to occur amongst people with similar attributes (McPherson, Smith-Lovin and Cook 2001).

This attribute similarity can be based on status and/or values of interacting pairs or systems. Similarity based on acquired status, such as education, occupation and behaviour pattern, and on ascribed status, such as age, race and sex, is classified as status homophily. Similarity based on internal states such as values, attitudes and beliefs is classified as value homophily (McPherson, Smith-Lovin and Cook 2001; Lazarsfeld and Merton 1954). Since homophily assumes dyadic independence, it may seem to be in conflict with the theory of structural balance in which a balanced state occurs only if two individuals are consistent in their evaluations of a third person, but if the 'third person' is replaced by an attribute in such interactions then homophily is not inconsistent with structural balance (Robins, Elliott and Pattison 2001).

Homophilous interactions have powerful implications for information flow amongst individuals and systems. Individuals with similar personal characteristics are likely to have similar worldviews (Ibarra 1993; Ibarra 1992). This social homogeneity implies that communication will be easier and thus more effective between homophilous individuals (Rogers and Bhowmik 1970); however, such interactions will also cause the information flow to be localised in the social space (McPherson, Smith-Lovin and Cook 2001). At system level, therefore, homophily can act as a barrier to information flow (Rogers and Bhowmik 1970). In addition, new ideas are often introduced by more innovative and higher status individuals. If these individuals mainly interact with each other, information about new innovations will be restricted to higher status individuals or spread to others very slowly (Rogers and Bhowmik 1970).

These theoretical developments in homophily have been backed by substantial empirical research. Considerable evidence shows that homophily is a pervasive fact of a wide range of relationships such as marriage, friendship, work and school ties. Furthermore, homophily in these relationships is not restricted to one particular dimension, but holds for many diverse characteristics such as race, gender, age, education, occupation and attitudes (McPherson, Smith-Lovin and Cook 2001).

The principle is supported in the family planning literature. Rogers (1973) argues that similarity of characteristics of the 'resourcer' and 'receiver' are critical in the successful transfer of innovations such as family planning. Data from Indonesian family planning provides support for this hypothesis; results show that family planning workers of similar age, marital status and education to their clients are more successful in motivating those clients for family planning adoption. In accordance with the homophily hypothesis, it was found that family planning workers with less education were more effective than more qualified workers in reaching Indonesian women who had less than primary school education (Repetto 1977).

The prevalence of homophily has also been observed in informal male and female family planning discussion networks. In a qualitative study in Kenya, Rutenberg and Watkins (1997) found that women select other women 'like themselves' or who 'they see all the time' to discuss contraceptive-related information. This occurred despite the presence of trained medical professionals in the area, who were seen as socially distant to the users. The women thus supplemented information from official sources with discussions with others whose bodies were perceived to 'rhyme' with their own bodies (Rutenberg and Watkins 1997, p. 301). Women selected network partners who were similar in social and economic status. More importantly, network partners were of similar race, nationality and ethnicity, which provided clues to the 'underlying similarity or differences among bodies' (Rutenberg and Watkins 1997, p. 301).

A large proportion of these network members were also found to be contraceptive users, twice the proportion of contraceptive users in the area, suggesting that network partners may be selected on the basis of their experience with family planning (Rutenberg and Watkins 1997). Women already interested in family planning may be strategically selecting network partners that have experience in this area to obtain information or support, but further analysis of the Kenyan data by Watkins and Warriner (2003) shows that strategic selection of network partners on the basis of family planning knowledge is unlikely to be operating in the majority of cases (some strategic selectivity is, however, confirmed). This conclusion is based on qualitative evidence, which shows that family planning was often discussed by women spontaneously during the course of other daily conversations. The survey data also shows that the characteristics of family planning network partners are not hugely different from other discussion networks concerning women's reproductive health. The cross-sectional nature of the data and heavy reliance on qualitative results nevertheless make it difficult to assess the degree of 'selectivity bias' present in the population. On the other hand, homophily is found to be the more probable explanation behind network partner selection, in both quantitative and qualitative analysis (Watkins and Warriner 2003).

Homophily patterns emerging in the Kenyan networks show noteworthy consistencies with another study conducted in culturally and geographically far-removed Nepal. In a longitudinal study of Nepalese networks, women were found to be more likely to select homogeneous network partners based on ethnicity, even when they lived near women of other ethnicities and age, although age is not found to be statistically significant. The results also show that women select network partners based on their contraceptive use status. Women who were using a contraceptive method or had a positive attitude towards family planning were found to be more likely to add contraceptive users to their network. This suggests that women may be motivated to

seek other contraceptive users 'to confirm their existing attitudes and behaviours, rather than obtain new information about family planning' (Boulay and Valente 2005, p. 532).

The principle is not limited to female family planning networks; male networks show similar patterns. In a study of male networks in urban Mozambique, Agadjanian (2002) observed that, compared to women, men have more diverse networks due to greater participation in public settings. The family planning discussions of men seldom crossed social class, age and gender boundaries, however. Men mostly reported speaking about family planning privately with peer confidants and hesitated to participate in open discussions, leaving little room for heterophilous partners or dissimilar individuals in their discussion networks.

In summary, both theoretical and empirical literatures point towards the importance of homophily in ties. Homophilous network partners are likely to have identical information, common interests and possibly similar worldviews (Ibarra 1993; Ibarra 1992; Rogers and Bhowmik 1970). They are also likely to make similar contraceptive choices, simply because the shared attributes that bring them together are likely to influence individual decisions (Watkins and Warriner 2003). Identifying homophily effects therefore not only sheds light on the processes involved in tie formation, but also needs be taken into account when making causal inferences of network effects on contraceptive behaviour. Similar issues arise with strategic selection based on contraceptive use status and network effects on family planning decisions (Watkins and Warriner 2003). Although direct tests of strategic selection are not possible with this data, the analysis in this chapter suggests that strategic selection is unlikely to be operating in the majority of cases.[70]

[70] These issues will be of importance to the analysis in the next chapter.

Since two actors cannot possibly be homophilous on all characteristics, we focus on the relevant socio-economic and demographic variables. It is highly plausible that ties in this context are also based on value homophily, such as having a modern attitude or strong religious beliefs. These value variables are also likely to be correlated, positively or negatively, with the adoption of family planning. Due to the limitations of our data, the analysis will be restricted to variables mostly classified as status homophily; furthermore, the results only include female networks because data on male attributes is not available.

The variables used to test for status homophily include age, education, husband's occupation, proxies for wealth and women's social status. Husband's occupation is used to capture the economic standing of women as very few women in the sample were engaged in work outside the household. Additional proxies for wealth include assets and income from overseas.

The proxies used to capture women's status are 'whether or not the respondent is working' and 'whether or not the respondent is the head of the household'. These variables are used as an indicator of women's status on the assumption that women who are the heads of their own household or are working are likely to have greater autonomy in the patriarchal and extended family system of Bangladesh.[71]

Methodology

To capture homophily, bivariate tests are conducted using join count analysis for binary data, Moran and Geary statistics for interval data and variable homophily models for categorical data. All of these measures determine homophily by testing for network autocorrelation—the

[71] In the patriarchal society of Bangladesh, bearing children, especially male children, is considered to be the most important duty of women. Successfully bearing male children is likely to result in increased status for women (Balk 1997). Regrettably, detailed fertility information was only collected for women of childbearing age and cannot be used to test the homophily hypothesis. One of the solutions could be to exclude women with missing information from the network; however, this causes a significant loss of network connections making it difficult to interpret the results. Similar issues arose with some additional variables in the data that could be argued to proxy women's status.

interdependence between network partners' attribute scores for any given variable. Each of these measures is described in the next section.

Join Count

The join-count statistics are the simplest measure of network autocorrelation and are used for binary variables. The procedure divides actors into two groups, for example male and female, and counts the number of ties within and between the two groups. These observed counts are then subtracted from the expected number of ties in each group if the ties were randomly distributed across groups, this will be referred as actual differences. Significance tests are then conducted to determine whether the observed counts show a departure from randomness (Hanneman and Riddle 2005; Cliff and Ord 1981).

These tests are typically undertaken assuming a standard normal distribution, which requires the observations to be independent of one another. Since this assumption is violated in the case of networks, the permutation method is used instead. This approach calculates the sampling distribution using the observed data by repeatedly permuting the dependent variable; for example, in the case of the binary dependent variable (sex), the actors are randomly assigned a score of zero or one, holding the pattern of ties and total number of ones constant. This process is repeated several times and the difference between the actual counts and those obtained from the permuted data is calculated for each permutation. These differences are then compared to the actual differences, to assess whether the observed counts could have been generated by the process of random assignments. On the basis of this analysis, the null hypothesis of no network autocorrelation can be accepted or rejected (Hanneman and Riddle 2005).

Moran's I and Geary's c

Moran's I and Geary's c statistics provide a method to capture attribute similarity between actors based on continuous variables such as age or education. Both of these statistics are closely related and have their roots in geography, where they are used to measure spatial autocorrelation—the spatial interdependence of a variable (Hanneman and Riddle 2005). By substituting spatial with social relationships, these measures are easily adapted to capture network autocorrelation.

Network autocorrelation using Moran's I is calculated by comparing the cross-products of deviations from the mean for each pair of related actors for a given attribute to the variance. To put it formally, let X represent the connection matrix with g rows and columns such that

$$X= \left(x_{ij}\right)_{1\leq i,j\leq g}$$

The value of $x_{ij}=1$ if node i sends a tie to node j and 0 otherwise. The diagonal terms are assumed to be 0. Let z_i is the score of node i on attribute z (e.g. age or education).

Moran's I can now be defined as (Cliff and Ord 1981)

$$I= \frac{g\sum_{i=1}^{g}\sum_{j=1}^{g}x_{ij}(z_i-\bar{z})(z_j-\bar{z})}{\sum_{i=1}^{g}\sum_{j=1}^{g}x_{ij}\sum_{i=1}^{g}(z_i-\bar{z})^2}$$

Moran's I ranges between +1 and -1. Values close to 1 indicate strong positive autocorrelation (homophily) and values close to -1 indicate a strong negative autocorrelation (heterophily). The expected value of Moran's I is -1/g-1 if the observations are independent or if there is no autocorrelation.

The closely-related Geary's c statistic is based on the squared differences of attribute scores of each pair of related actors divided by the variance. It is defined as (Cliff and Ord 1981)

$$c = \frac{g-1\sum_{i=1}^{g}\sum_{j=1}^{g}x_{ij}(z_i - z_j)^2}{2\sum_{i=1}^{g}\sum_{j=1}^{g}x_{ij}\sum_{i=1}^{g}(z_i - \bar{z})^2}$$

Geary's c ranges from 0 to 2. A value of 1 indicates perfect independence between observations. Values less than 1 indicate positive autocorrelation (homophily) and values more than one indicate negative autocorrelation (heterophily). The expected value of Geary's c is 1 if the observations are independent or if there is no autocorrelation.

As illustrated by the above formulas, the Moran's I and Geary's c statistics are similar but not equivalent. Moran's I is based on cross products of deviations of each value from the mean, whereas Geary's c is based on the squared differences of attribute scores of each pair of related actors. This difference in focus leads Moran's I to be more sensitive to global autocorrelation and Geary's c to local autocorrelation (Hanneman and Riddle 2005). Both these measures are computed to capture different dimensions of association and to check the validity of the results.

The sampling distribution for Moran's I and Geary's c is constructed using permutation trials. The scores of the dependent variable are randomly assigned to actors in the network under the assumption that the null hypothesis of no network autocorrelation is true, holding the network structure constant. The Moran and Geary statistics are recalculated for the permutated data for each trial. The results obtained through random assignment are then compared to the actual coefficients to ascertain whether our results are significantly different from those obtained by random assignments (Hanneman and Riddle 2005).

Variable Homophily model

Homophily for categorical variables (e.g. occupation) is tested using a variable homophily model. To estimate this model, actors are divided into groups according to their attribute score. The model tests whether ties within the group are different from ties outside the group. The model is essentially a linear regression of presence or absence ties on a series of dummy variables capturing whether dyads belong to the same group.[72] Separate parameters are estimated for each group on the assumption that every group has a different tendency towards homophily (Hanneman and Riddle 2005; Cross, Borgatti and Parker 2001).

To test for significance, standard statistical tests are again found to be inadequate due to non-independent observations causing error terms to be correlated. Although the coefficient estimates are unbiased, the p values are unreliable. As a result, permutation methods are used to calculate the standard errors. For each permutation trial, the actors are randomly reassigned attribute scores and the parameter values are re-estimated. Repeating this process several times provides the sampling distribution of each of the regression coefficients, which is then used to calculate the probability of obtaining the estimated values simply by chance (Hanneman and Riddle 2005; Burris 2005; Krackhardt 1988). The method is also called a dummy variable Quadratic Assignment Procedure (QAP) regression (Cross, Borgatti and Parker 2001), which essentially uses standard OLS regression techniques to calculate the coefficient estimates. The probability of obtaining these coefficient estimates is calculated using a permutation method while preserving the underlying network structure. This method has been shown to provide an unbiased test of the coefficients regardless of the degree of network autocorrelation[73] (Krackhardt 1988).

[72] For example, a dummy for Group1=1 if both actors of the dyad belong to group1, otherwise Group1=0.

[73] For binary dependent variables, logit models are often considered more appropriate rather than OLS regressions, commonly referred to as linear probability models. This research uses linear probability models because of the ease of interpretation of regression coefficients. Because the sampling distribution is estimated using permutation methods, the problems associated with using linear regression for binary dependent variable are not as severe (Burris 2005).

Gender Norms

The principles of homophily and transitivity provide a framework for studying ties at the dyadic and triadic level but do not include the social context within which relationships are formed. The social contexts remain largely ignored by network analysts (Entwisle et al. 2007) and as a result, social networks are typically analysed as independent structures in space and time. This is not an insignificant omission since a large volume of literature has accumulated to support the importance of context on individual action (Entwisle et al. 2007). These studies mainly measure socioeconomic and demographic characteristics at the relevant contextual level and show their impact on a range of outcomes, including fertility and contraceptive choice (Entwisle et al. 2007; McNay, Arokiasamy and Cassen 2003).

Some direct evidence on the close relationship between social context and network structure in developing countries is also provided by Entwisle et al. (2007) using data on sibling and rice harvesting networks from 51 Thai villages. The results of this study show that network structure co-varies with variables such as village size, type of crop production, socio-economic status, degree of out-migration and village sex ratio. Cohesiveness of sibling network, for example, is found to be positively correlated with village size but is negatively related to out migration, and the number of ties outside the village in the rice harvesting network is positively associated with economic status. In another study of tractor hiring networks in Thai villages, Faust et al. (1999) show that tractor hiring ties between villages is correlated with the type of production. The results confirm the strong relationship between context and network structure for both inter- and intra-village ties.

This study demonstrates the importance of context on network structure by incorporating the role of gender norms into the analysis. Norms can be defined as 'customary rules of behaviour

that coordinate our interactions with others' (Young 2008) and are found to have sustained influence on individual actions (Young 2008; Blau 1960; Valente 2010). One such prevailing rule that has a pervasive effect on all dimensions of Bangladeshi life is the norm of purdah, as discussed in Chapter 3, which restricts women's mobility in the public sphere (Kabeer 2000). Furthermore, the patriarchal customs of marriage removes women from their own family home to the husband's house (Larance 1998), and these traditions not only remove women from their own family networks but also provide little opportunity for women to network outside the husband's household.

The degree to which these purdah norms govern women's behaviour is unclear. In the most recent demographic and health surveys conducted in Bangladesh, 82% of currently married women reported that they could go alone or with children to seek medical services, and 57% reported taking decisions independently or with their husband to visit family or relatives (NIPORT et al. 2009). Previous research shows that women's choice of network partners is mostly confined to the *bari*[74] (Larance 1998; Gayen and Raeside 2005). This research clarifies these issues by studying the spatial arrangement of ties for both male and female social networks.[75] Combining information on social networks with spatial information reveals the role played by geographic distance in shaping social relationships. The analysis thus provides a straightforward and objective method of determining the significance of restriction on women's mobility or purdah norms on women's network choices. A comparison of male and female networks helps to ascertain whether or not the spatial pattern of ties observed in the female networks is an artefact of the highly personal subject matter of this research; for example, if both male and female network partner choices are confined to the household, this suggests that family

[74] Bangladeshi households are usually part of a *bari*. *Bari* refers to a set of households with a common courtyard (Fauveau 1994).

[75] It is expected that women will largely form networks within the *bari*. But what is not clear, is the extent to which women follow the traditional norms of behaviour, particularly in a context such as Matlab, which has come under many influences that were previously foreign to the region.

planning discussions are mainly conducted with close relatives. On the other hand, if female networks are limited to the household and male networks are spread throughout the village, it points to the disparities in gender norms.

Methodology

The assessment of the role of geographic distance on network formation is primarily conducted using maps prepared in GIS (Geographic Information Systems). GIS is a computer system used for managing and mapping spatial data. The visualisation tools of GIS software allow the creation of maps where each node can be spatially referenced together with social linkages between nodes. The edges represent not just a connection between a set of nodes but also the Euclidean distance,[76] or straight line distance, between two points (Rosenberg and Anderson 2011). These maps thus provide a powerful tool to analyse geographic patterning in the data.

The spatial information used for this analysis was not collected as part of the fieldwork but was provided by ICDDR,B. This effected a substantial cost saving, but it also resulted in some missing information. The data provided by ICDDRB contains the exact *bari* location of the majority of the male and female respondents that lie within the boundary of the chosen sampling clusters,[77] although the exact locations were not available for respondents residing outside the selected villages. To overcome this issue, all the respondents not residing in the chosen sampling clusters were randomly assigned a location outside of the map. This does not result in visual distortions, but it does limit the analysis to the individuals within the village boundary.

[76] Euclidean distance is the length of a straight line connecting two points. The formula for calculating Euclidean distance between two points (x_i, y_i) and (x_j, y_j) is: $d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$ (Rosenberg and Anderson 2011).

[77] In the first stage of snowballing, the respondents were selected from a predefined cluster of villages. These clusters are referred to as 'the chosen sampling clusters'.

Another concern that arises with the maps is the issue of a confidentiality agreement with the respondents (Faust et al. 1999). All survey participants in this research were assured that their identity would be protected. Even though the *bari* location rather than the exact household location is used in this research, there is a potential danger that respondents could be identified through the maps. To protect the identity of the respondents, maps are presented for only two clusters without specifying names.[78] These maps are also reoriented to eliminate any possibility of identifying the respondents of this research. These strategies, coupled with the fact that not all the *baris* were sampled in any particular village, make it nearly impossible to trace the respondents.

The choice of clusters for the maps is based on the visual clarity of the maps, and these clusters are also representative of the general situation. To illustrate the generalisabilty of the visual patterns observed in the two clusters to the whole data, QAP regressions and constant homophily models are used. QAP regressions are used to show the effects of Euclidean distance on the pattern of ties.[79] Although this test sheds light on the role of distance in tie formation, it could be that female networks are largely restricted to the *bari* due to norms of purdah and that the distance to other *bari* in the village has plays no role. Male networks may also have a significant tendency to form ties between the *bari*. The constant homophily model, which is based on dummy variable QAP regression, is used to test this proposition. The model divides actors into groups – in this case they are divided on the basis of *bari* locations – and tests whether actors have a tendency to interact with members of their own *bari*, on the assumption that all actors have the same inbreeding tendencies. Thus the model regresses whether or not a pair of actors has a tie on a dummy that represents whether or not the pair belongs to the same *bari* (Hanneman and Riddle 2005). The assumption of the same inbreeding tendencies across all

[78] A similar strategy is used in Faust et al. (1999).
[79] In this case, the dependent variable is whether or a not a pair of actors has ties and the independent variable is Euclidean distance between the pair.

actors greatly simplifies the model to just two parameters. Since there is no reason to believe that social norms are likely to have dissimilar effects on actors residing in different *baris*, this model is deemed appropriate.

Results

Transitivity

The results for the female and male networks, obtained after 1000 simulations, are presented in Table 5.1 and Table 5.2 respectively.[80]

Table 5.1: Transitivity Index (Female Networks)

	No. of actors	Transitivity Index	Estimated Mean	SD	Minimum	Maximum
Cluster B	153	37	4.70	0.61	3	7
Cluster C	151	31	2.09	0.55	1	4
Cluster D	146	43	2.12	0.48	1	3
Cluster E	104	45	2.92	0.67	1	5
Cluster F	106	38	2.24	0.57	1	4

Table 5.2: Transitivity Index (Male Networks)

	No. of actors	Transitivity Index	Estimated Mean	SD	Minimum	Maximum
Cluster B	145	34	2.32	0.69	1	4
Cluster C	91	7	2.02	0.92	0	6
Cluster D	106	11	1.43	0.81	0	4
Cluster E	83	19	2.04	1.15	0	6

The results are remarkably consistent across different clusters. The transitivity index in female networks is found to be much higher than male networks, except in the case of Cluster B, which is the only cluster in which a substantial number of network partners are females.

Both male and female networks show a significant tendency towards transitivity after controlling for in and out degrees. The observed transitivity index in each cluster did not occur even once in

[80] The tests are conducted using StOCNET software (Boer et al. 2006).

1000 simulations. The estimated mean is also much lower than the observed transitivity index, with a very small standard deviation.

The results show that the male and female networks are non-random and justify the conclusion that transitivity is a significant tendency in the data. The tendency towards transitivity is much stronger in the female networks, pointing to the fact that women's networks are driven by notions of balance to a much greater degree than those of men.

Homophily

The previous section has shown that transitivity is an important feature in the formation of ties, but it is far from being the only relevant explanatory variable. The results presented in this section highlight that homophily also plays a role in the formation of female networks.[81] The variables used to analyse homophily include 'whether or not the respondent is the head of the household', 'whether or not the respondent is working', 'age', 'education', 'husband's occupation', 'whether or not the respondent owns TV or Radio' and 'whether or not the respondent received money from overseas in the last 12 months'.[82] The descriptive statistics on each of these variables is provided in Chapter 3.[83]

Join-count statistics are used to test whether respondents form dyadic ties based on headship and employment status. Tables 5.3 and 5.4 show the results. The columns labelled as 'expected' show the number of ties in each category if the actors picked networks partners randomly. The columns 'observed' give the count of the actual number of ties in each category. As illustrated in these tables, the difference between 'expected' and 'observed' is not very large.

[81] Although hompohily cannot be ignored in the female networks, it is not a strong predictor of dyadic ties.
[82] The homophily analysis is conducted using UCINET software (Borgatti, Everett and Freeman 2002).
[83] As discussed in Chapter 3, some of these variables suffer from missing values. To deal with this problem, the actors with missing values were deleted wherever relevant. For example, if complete information was available for all the variables but age for a particular respondent, the actor was only deleted in the age analysis. Also religion is not included in the ensuing discussion because most respondents in the sample belong to one religion.

Table 5.3: Headship Status

Cluster B					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither heads the hh.	285.83	316	30.17	0.000	1.000
One actor is the head	58.42	29	-29.42	1.000	0.000
Both are hh. head	2.75	2	-0.75	0.708	0.543
Cluster C					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither heads the hh.	222.93	219	-3.93	0.751	0.287
One actor is the head	45.90	49	3.10	0.318	0.725
Both are hh. head	2.18	3	0.82	0.362	0.823
Cluster D					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither heads the hh.	211.37	201	-10.37	0.915	0.103
One actor is the head	56.15	61	4.85	0.264	0.78
Both are hh. head	3.48	9	5.52	0.011	0.996
Cluster E					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither heads the hh.	150.96	159	8.04	0.095	0.931
One actor is the head	36.10	29	-7.10	0.912	0.122
Both are hh. head	1.94	1	-0.94	0.871	0.418
Cluster F					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither heads the hh.	144.52	140	-4.52	0.832	0.22
One actor is the head	40.84	43	2.16	0.362	0.705
Both are hh. head	2.64	5	2.37	0.117	0.953

To test for statistical significance, we conduct 10,000 permutation trials. The probabilities of observing the values greater than or equal to actual difference and values less than or equal to actual difference using permutation methods are listed in the last two columns of the tables. In Cluster B, for example, the expected number of dyadic ties between women who do not head their own household is 286 and the actual number of ties observed in this group is 316. Since more than the expected number of ties is observed, the difference is positive. To ascertain the significance of this result, the probability of obtaining a difference as large as this in random trials is examined (listed in the column 'P >= Diff'). The difference of 30 is not equalled or exceeded even once in 10,000 permuted trials, or the probability of observing a difference as large is zero. The result is therefore significant and could not have been obtained simply by chance. The results

also show that ties between actors who head their own household and those who do not head their household are less likely in Cluster B (p=0.000), but ties between household heads are not significantly different from those expected by chance. Thus in Cluster B, actors who are not the head of their own household are more likely to form ties, but ties between household heads are no more likely than could be expected by chance. In the other four clusters, ties between actors who are not heads of their households are not significant at the conventional 5% level, and only Cluster D shows that ties between household heads are more likely than a random result (p=0.011).

Similar to headship status, results show that homophily based on employment is minimal. Table 5.4 shows the pattern of ties for working and non-working actors. The ties between respondents who are working and not working are more likely in three out of five clusters (Clusters B, C, D) at the 5% level, which provides evidence of heterophily rather than homophily, but ties between actors who are both working is highly significant in Cluster B (p=.005) and marginally significant in Cluster C (p=0.098). A further examination of the data shows that seven out of eight of the observed ties and all three of the observed ties in Cluster C between working respondents are directly linked to the ICCDR,B health workers. The result thus captures the pattern of ties between health workers rather than homophily in the surveyed population.

Table 5.4: Employment Status

Cluster B					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither works	298.44	258	-40.44	0.974	0.032
One actor work's	46.90	81	34.10	0.046	0.957
Both actors work	1.66	8	6.34	0.005	0.998
Cluster C					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither works	236.18	213	-23.18	0.995	0.007
One actor work's	33.74	55	21.26	0.01	0.993
Both actors work	1.08	3	1.92	0.098	0.971
Cluster D					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither works	231.57	229	-2.57	0.709	0.343
One actor work's	38.02	39	0.98	0.436	0.622
Both actors work	1.41	3	1.59	0.155	0.945
Cluster E					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither works	178.20	177	-1.20	0.699	0.404
One actor work's	10.69	12	1.31	0.394	0.709
Both actors work	0.11	0	-0.11	1	0.901
Cluster F					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither works	154.05	139	-15.05	0.999	0.003
One actor work's	32.43	46	13.57	0.006	0.997
Both actors work	1.52	3	1.48	0.171	0.941

Moran and Geary's statistics are examined next to test for similarity based on education and age. The coefficients along with p-values are listed for age and education in Table 5.5 and Table 5.6 respectively. The p-values are based on the results of 10,000 permutation trials. They show the probability of getting a value greater than or equal to the observed value using the procedure of random assignments.

Table 5.5: Age

	Age (Moran)	p-values	Age (Geary)	p-values
Cluster B	0.34***	0.000	0.55***	0.000
Cluster C	0.33***	0.000	0.63***	0.000
Cluster D	0.18**	0.006	0.65***	0.000
Cluster E	0.26**	0.003	0.49***	0.000
Cluster F	0.23**	0.005	0.65***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

Table 5.6: Education

	Education (Moran)	p-values	Education (Geary)	p-values
Cluster B	0.28**	0.001	0.83*	0.014
Cluster C	0.31***	0.000	0.68***	0.000
Cluster D	0.36***	0.000	0.56***	0.000
Cluster E	0.26***	0.000	0.79*	0.016
Cluster F	0.31***	0.000	0.71***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

Moran's I is interpreted like the standard correlation coefficient. The results show a positive network autocorrelation (homophily) for age and education. These values are also significant at the conventional 5% level. Geary's c coefficient ranges from 0 to 2, where 1 indicates perfect independence. Since both age and education coefficients are less than one, they indicate positive network autocorrelation (homophily) and are also significant at the 5% level. As discussed previously, both measures capture slightly different dimensions of network autocorrelation and for this reason both are computed to cross check the validity of our results. These measures confirm that women tend to select network partners who are similar in age and education. Although these effects are statistically significant, the size of the coefficients suggests a modest degree of homophily in these networks.

In order to test for homophily based on economic standing, the husband's occupation is analysed using variable homophily models. The model tests whether ties within a group (each occupational category is treated as a group) are different from ties outside the group using a variable homophily model. The results are listed in Table 5.7.

The intercept gives the probability of ties between members of different groups. The other parameter estimates in the model provide the probability of ties within the group, or homophily. The significance tests are based on 10,000 permutation trials. For farmers in Cluster B, for

example, the probability of ties within the group is 0.012, and the probability of obtaining this result purely by chance is 16%.

Table 5.7: Husband's Occupation

	Cluster B		***Cluster C***	
	R-square=0.015 p=0.0000		R-square= 0.002 p=0.0734	
	Un-stdized		Un-stdized	
Independent	Coefficient	p-values	Coefficient	p-values
Intercept	0.029	0.982	0.021	1.000
Farmer	0.012	0.158	0.007	0.153
Wage Labourer	-0.009	0.171	0.005	0.319
Business	0.029*	0.013	0.016**	0.003
Service	0.030	0.072	0.029*	0.033
Service Overseas	0.030	0.073	0.024	0.076
Other	-0.029	0.952	-0.021	0.929
Not Working	-0.029	0.437	0.009	0.205

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

Table 5.8: Husband's Occupation

	Cluster D		***Cluster E***		***Cluster F***	
	R-square=0.004 p=0.0005		R-square=0.015 p=0.0000		R-square=0.002 p=0.1243	
	Un-stdized		Un-stdized		Un-stdized	
Independent	Coefficient	p-values	Coefficient	p-values	Coefficient	p-values
Intercept	0.022	1.000	0.030	1.000	0.031	0.951
Farmer	0.015*	0.021	-0.001	0.462	0.002	0.355
Wage Labourer	0.033***	0.0005	0.118***	0.000	0.020	0.122
Business	0.010	0.122	0.059*	0.023	0.007	0.269
Service	-0.022	0.298	-0.030	0.569	-0.031	0.562
Service Overseas	0.067**	0.003	0.017	0.075	0.034*	0.020
Other	0.049*	0.039			-0.031	0.918
Not Working	0.011	0.187	0.025	0.131	0.058	0.026

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

As the results show, the R-square for these models is very low and for Cluster F is not significant, which indicates that there are more ties between groups rather than within groups. Most of the coefficients are not significant; even when they are, the probability of within group ties is very

low[84]. The results therefore suggest that economic status is not a likely factor in tie formation.[85] It may be that the 'husband's occupation' is a poor proxy for economic status. For this reason, 'whether or not the respondent owns TV or Radio' and 'whether or not the respondent received money from overseas in the last twelve months' are tested. The results are listed in Tables 5.9 and 5.10. When both actors own a TV or Radio, the observed ties between actors is more than expected in each cluster. This difference is also significant in Clusters B, C and F at the 5% level and in Cluster D the difference is significant at the 10% level.

Table 5.9: Own TV or Radio

Cluster B					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither owns TV/Radio	102.90	91	-11.90	0.746	0.277
One actor owns TV/Radio	173.17	157	-16.17	0.961	0.048
Both actors own TV/Radio	70.94	99	28.06	0.012	0.991
Cluster C					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither owns TV/Radio	72.99	71	-1.99	0.617	0.426
One actor owns TV/Radio	134.61	111	-23.61	0.998	0.003
Both actors own TV/Radio	60.40	86	25.60	0.001	1
Cluster D					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither owns TV/Radio	36.83	42	5.17	0.211	0.834
One actor owns TV/Radio	125.09	106	-19.09	0.987	0.018
Both actors own TV/Radio	103.08	117	13.92	0.063	0.95
Cluster E					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither owns TV/Radio	75.69	88	12.31	0.052	0.962
One actor owns TV/Radio	88.50	74	-14.50	0.983	0.024
Both actors own TV/Radio	24.81	27	2.19	0.337	0.732
Cluster F					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither owns TV/Radio	34.40	34	-0.40	0.557	0.524
One actor owns TV/Radio	88.67	78	-10.67	0.949	0.068
Both actors own TV/Radio	54.94	66	11.07	0.042	0.971

[84] An exception to this is the category 'wage labourer' in Cluster E. This variable is highly significant and the coefficient estimate is 0.12; however, coefficient estimates as large as those for the category 'wage labourer' only occurred in Cluster E and the probability of within group ties is low and/or insignificant in other clusters.

[85] Logit transformation could have been applied to the dependent variable, but the poor model fit did not justify any further investigations into this variable.

Ties between actors who received money from overseas are significantly more likely than expected by chance in Clusters C and D. This pattern does not hold in the other clusters, but in Cluster E there is a significant and positive difference between the number of ties observed and expected between actors who do not receive any remittances. Clusters B, C and D show a significant tendency towards fewer ties between actors who receive money from overseas and those who do not.

Table 5.10: Received remittance

Cluster B					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither receives money from overseas	187.95	205	17.05	0.176	0.845
One actor receives money from overseas	135.46	120	-15.46	0.902	0.116
Both receive money from overseas	23.59	22	-1.59	0.549	0.511
Cluster C					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither receives money from overseas	139.70	149	9.30	0.191	0.841
One actor receives money from overseas	104.45	85	-19.45	0.991	0.011
Both receive money from overseas	18.86	29	10.14	0.023	0.987
Cluster D					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither receives money from overseas	145.40	162	16.61	0.034	0.973
One actor receives money from overseas	105.24	78	-27.24	1	0.001
Both receive money from overseas	18.37	29	10.63	0.017	0.989
Cluster E					
	Expected	Observed	Differenc	P >= Diff	P <= Diff
Neither receives money from overseas	60.38	84	23.62	0.001	0.999
One actor receives money from overseas	93.69	76	-17.69	0.994	0.009
Both receive money from overseas	34.94	29	-5.94	0.887	0.159
Cluster F					
Neither receives money from overseas	60.82	60	-0.82	0.573	0.494
One actor receives money from overseas	87.17	86	-1.17	0.617	0.441
Both receive money from overseas	30.01	32	1.99	0.36	0.711

The results suggest that some economic differences can be expected within groups[86], also that ties may be patterned by age and education;[87] however the effects are modest.

Gender Norms

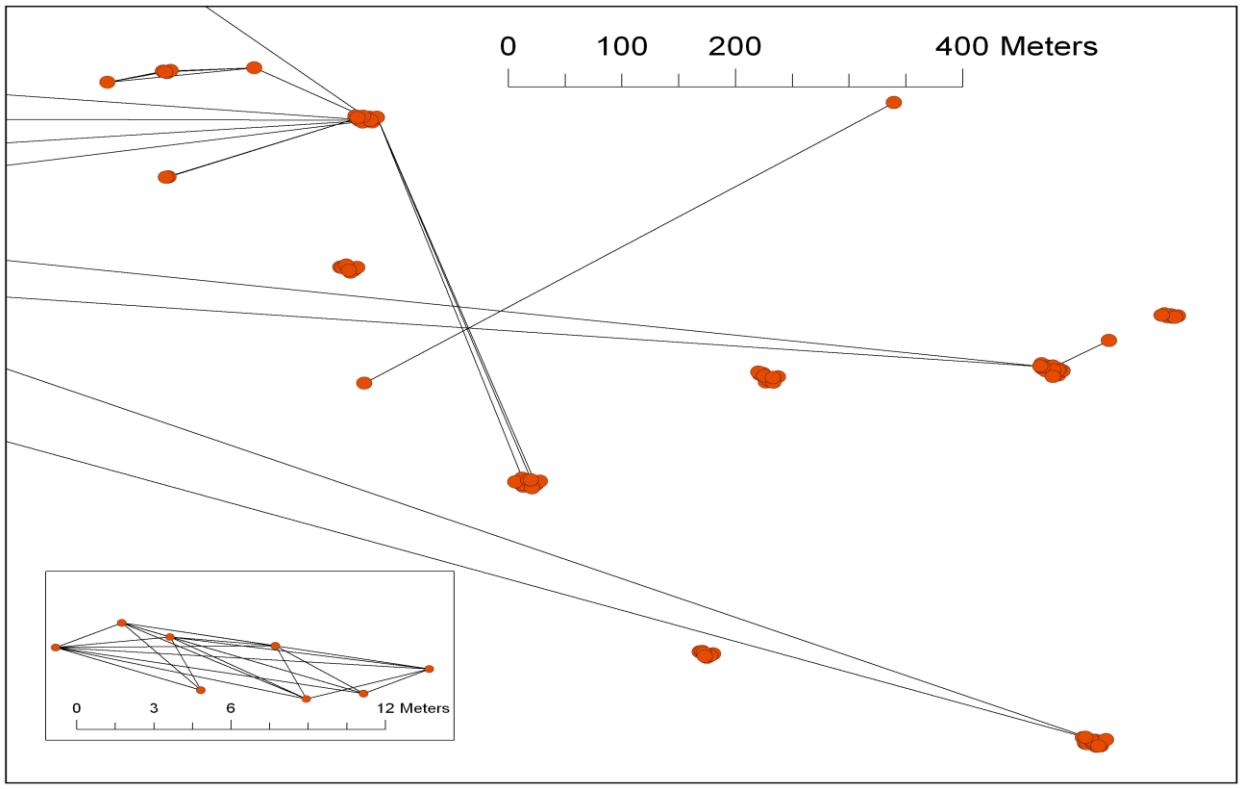
The role of gender norms in tie formation is mainly analysed using maps which show the spatial pattern of ties in male and female networks. These maps were constructed by superimposing the social networks on the spatial locations of actors in each cluster using Alan Glennon's Flow Data Models Tool in ArcGIS software version 9.1.[88] The spatial coordinates used for these maps were only available at the *bari* level, reducing the risk of identifying the respondents. To further preserve the identity of the respondent, the maps have been reoriented and the names of clusters changed. Figure 5.4 provides an example of maps constructed in this fashion for a female network in the government area.

[86] The variable 'main wall type is cement or tin' was also tested for homophily. However the results were not significant and are not reported.

[87] The observed homophily in ties may be due to the selection of network partners on the basis of socio-economic characteristics. As shown in the next section, however, women mainly communicate with others in the same *bari*. Since most members in the same *bari* are related through familial ties, they are likely to be similar in socio-economic characteristics. It is likely that the homophily results show *bari* level differences rather than a process of selection based on attribute similarity. In order to test this hypothesis, information on all the members in the *bari* would be needed, and is not available.

[88] Alen Glennons Flow Data Model Tools are available at: http://www.alanglennon.com/flowtools/fdmthelp.htm

Figure 5.4: Female Network in non-treatment area (Cluster X)



The red dots in the maps represent nodes, the lines represent the geographic distance between a set of connected nodes, and the larger rectangular frame represents the boundary of the map. To avoid unnecessary visual clutter, both mutual and asymmetric connections are represented by a single line without arrowheads. Connections to actors residing outside the chosen cluster are illustrated by lines terminating at the map frame. The lengths of these lines are arbitrarily assigned because spatial information on actors residing outside the chosen villages was not available.

Several overlapping nodes in the map indicate that a number of actors share the same *bari*. This was found to be a common phenomenon in all the clusters. In order to demonstrate this feature clearly, the geographic coordinates of overlapping nodes were altered by a few units, resulting in a change in geographic distance between a set of overlapping nodes. To minimise the risk of creating visual distortions in the maps, this change in distance was restricted to less than equal to twenty metres.

An archetype of the pattern of ties between a set of overlapping of nodes is displayed in a rectangle inset within the map of each cluster; for example, the map in Figure 5.4 shows a sparsely connected female network with several overlapping nodes present in nearly all the *baris*. A typical pattern of ties amongst actors residing in the same *bari* is represented in the inset on the left of the map. The map suggests that women mainly interact with residents of their own *bari* and have limited social connections to people living in the same village but in a different *bari*. Furthermore they have very few connections to surrounding villages.

The map (Figure 5.4) also indicates that the seclusion of women in their respective *baris* is not a result of a highly expansive layout of village *baris*, which could possibly hinder communication because of factors such as travelling time. The map clearly demonstrates that this is unlikely to be the case since the surveyed *baris* are reasonably close in terms of geographic distance. Also note that not all the *baris* in a particular cluster are shown on the map, as the display is restricted to the *bari* locations of the sampled members. The villages are thus likely to be more densely populated than appears on the maps presented here. Appendix 5, which shows the village layout and all the *baris* in the selected clusters, lends support to this supposition. For reasons of confidentiality, Cluster X is not identified, but examination of the maps in Appendix 5 supports the conclusion that the geographic distance between *baris* is modest in all the surveyed clusters.[89]

It is clear that the lack of interconnections between residents of different *baris* in the female network is likely to be the result of deeply entrenched norms of purdah rather than geographic constraints. It can nevertheless be argued that the highly personal nature of the family planning discussions is a more plausible reason for the lack of interconnections between residents of

[89] The maps presented in Appendix 5, were provided by ICDDR,B. Although every effort was made to get maps that identify all the *baris* in the village, some omissions were observed. In the course of the analysis we noted that some *baris* were missing from the maps. Our investigations, however, suggests that such omissions are minimal. Also the maps provided by ICDDR,B are mainly restricted to the village boundary and hence do not show the health facilities, which were located outside of the sampled clusters.

different *baris* rather than gender norms. After all, women living in the same *bari* are likely to be related by marriage and thus have a strong personal bond, making it easier for them to interact on intimate matters. This issue is clarified by comparing the results with the male network in Cluster X.

Figure 5.5: Male Network in non-treatment area (Cluster X)

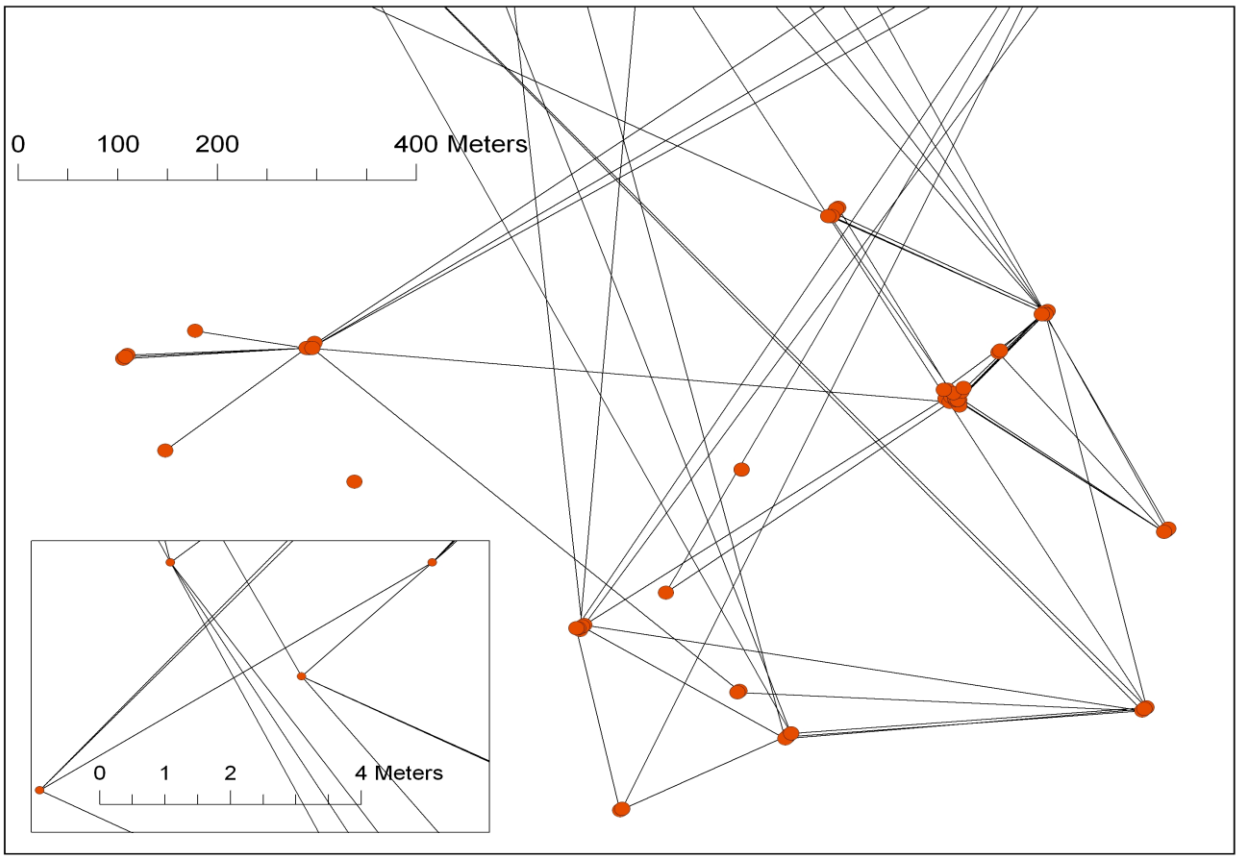


Figure 5.5 shows the male network in Cluster X, which is in the government or non-treatment area. The male network is markedly different from the female network. As Figure 5.5 shows, the male network has fewer nodes with the same spatial location, and these overlapping nodes have limited interconnections. Most of the network connections in the male network are to residents of different *baris* in the same or neighbouring villages. This is evident in the view of the entire cluster as well as in the enlarged view of a single *bari* (shown in the left-hand corner of the map).

The comparison of male and female patterns of ties confirms that the confinement of network partner selection to the *bari* in the female network is not related to the subject matter of this research; if this were the case then the selection male network partners would also have been confined to the *bari*. Given that only women exhibit the tendency to network within the *bari*, gender norms of purdah are the stronger explanation of the pattern of seclusion of women in their *baris* observed in Figure 5.4. These conclusions are also supported in the examination of the remaining four clusters.

An example of a female network in the treatment or ICDDR,B area is shown in Figure 5.6. To preserve the confidentiality of the respondents, this network is labelled as Cluster Y. The map of Cluster Y (Figure 5.6) shows more interconnections between residents of different *baris* compared to the female network in Cluster X (Figure 5.6), but even more striking is the much larger number of connections with actors residing outside of Cluster Y compared to Cluster X. This is mainly due to the health workers in the region; in Cluster Y, two ICDDR,B health workers were found to be responsible for the provision of basic health care services, and both of these ICDDR,B workers were residing outside of Cluster Y. Most of the ties in Figure 5.6 that terminate at the boundary of the map are directed to these two health workers. To illustrate this, ties to the two health workers were deleted from the network and the spatial patterns were reassessed. The resulting network is shown in Figure 5.7. The spatial pattern of ties in Figure 5.7 is very similar to Cluster X. The majority of connections in Cluster Y are to members in the same *bari* with only a handful of connections to residents living outside of Cluster Y. Although there are a few more interconnections between members of different *bari* in cluster Y compared to Cluster X, the predominant pattern of networking in the female network is with residents of the same *bari*.

Figure 5.6: Female Network in Treatment Area with ties to the health workers(Cluster Y)

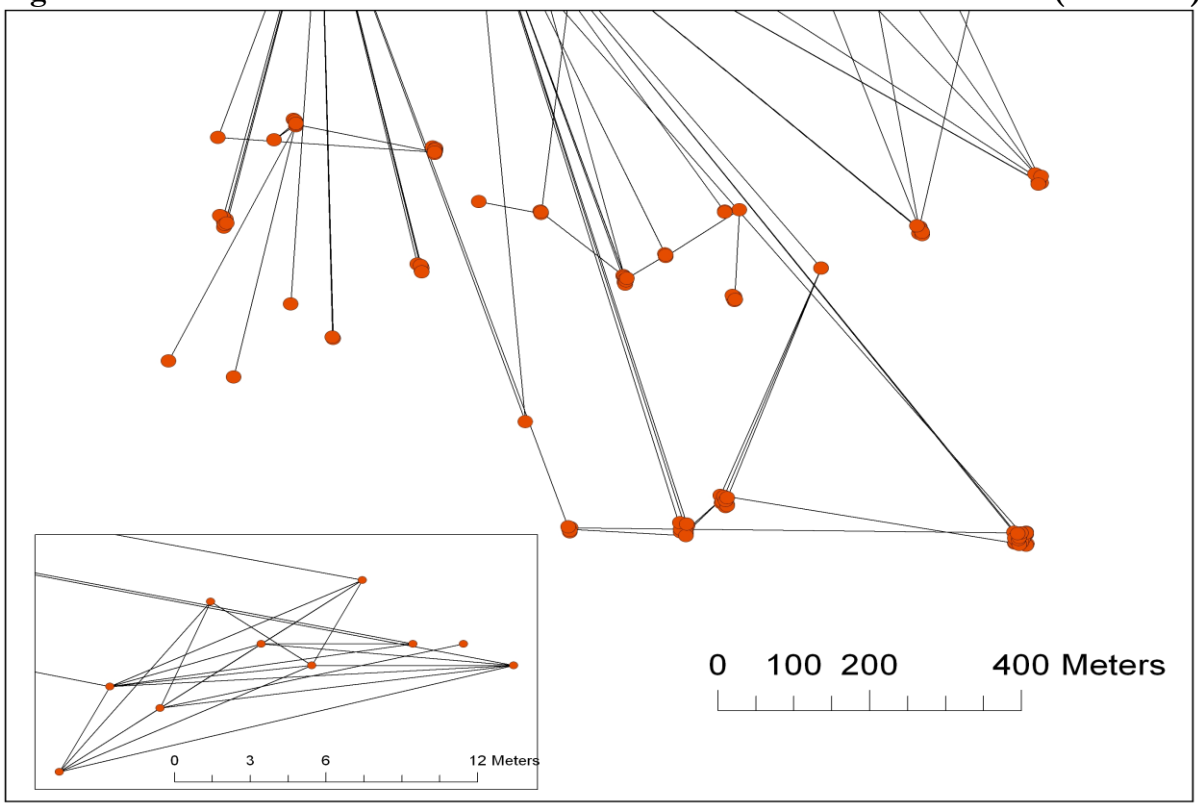
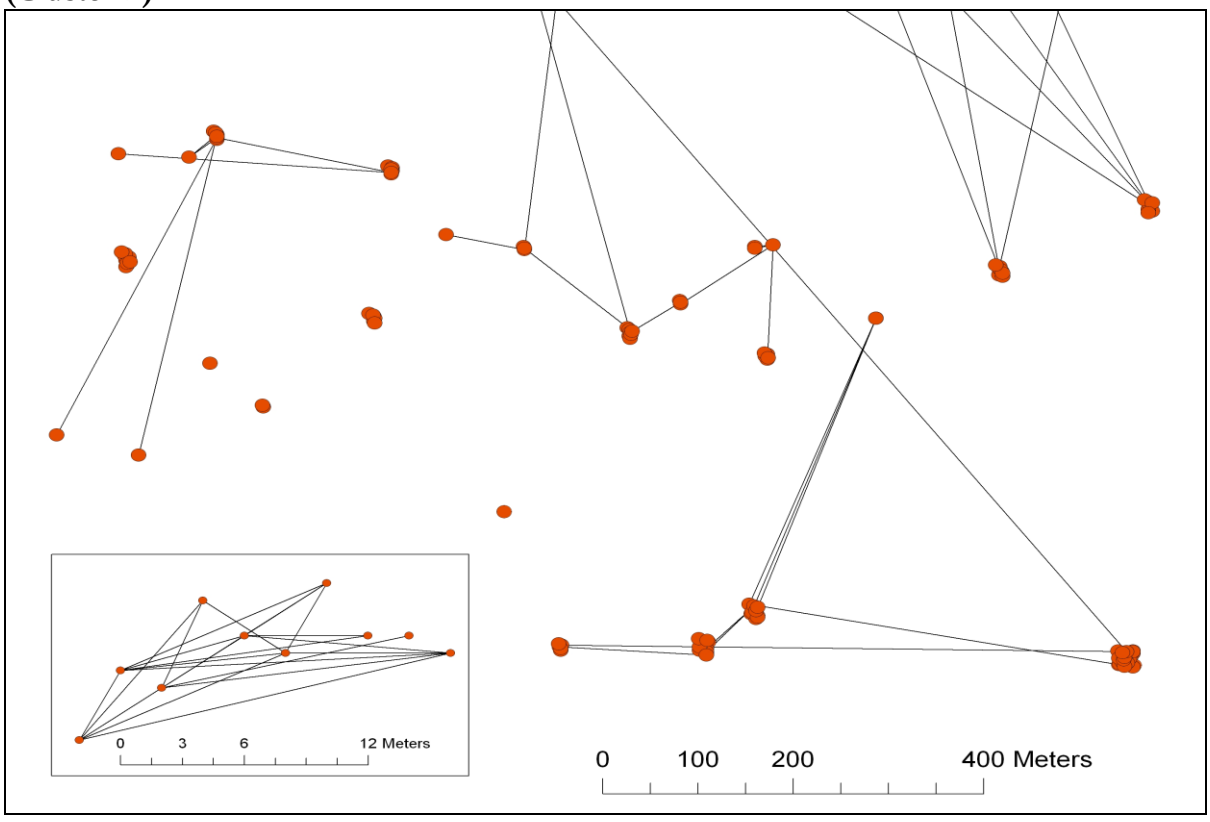


Figure 5.7: Female Network in Treatment Area without ties to the health workers (Cluster Y)



Again, the results obtained for the female network in Cluster Y cannot be attributed to geographic constraints or the topic of this research. The maps of Cluster Y show that the distance between *baris* is minimal, and comparison with the male network (Figure 5.8) provides evidence that the isolating communication patterns are unique to the female network.

The male network in Cluster Y is shown in Figure 5.8. The results show that, like the male network in Cluster X (Figure 5.5), the men are well-connected to residents of other *baris* and also have a substantial number of network partners living outside of Cluster Y. An enlarged view of a single *bari*, shown in the lower left hand corner of the map, supports this conclusion. The largest *bari* in Cluster Y was selected for the purposes of this demonstration and is indicated by an arrow in Figure 5.8. Unlike the female network in Cluster Y, the results were essentially unchanged after deleting the two main ICDDR,B health workers, as demonstrated in Figure 5.9.

Figure 5.8: Male Network in Treatment Area with ties to health workers (Cluster Y)

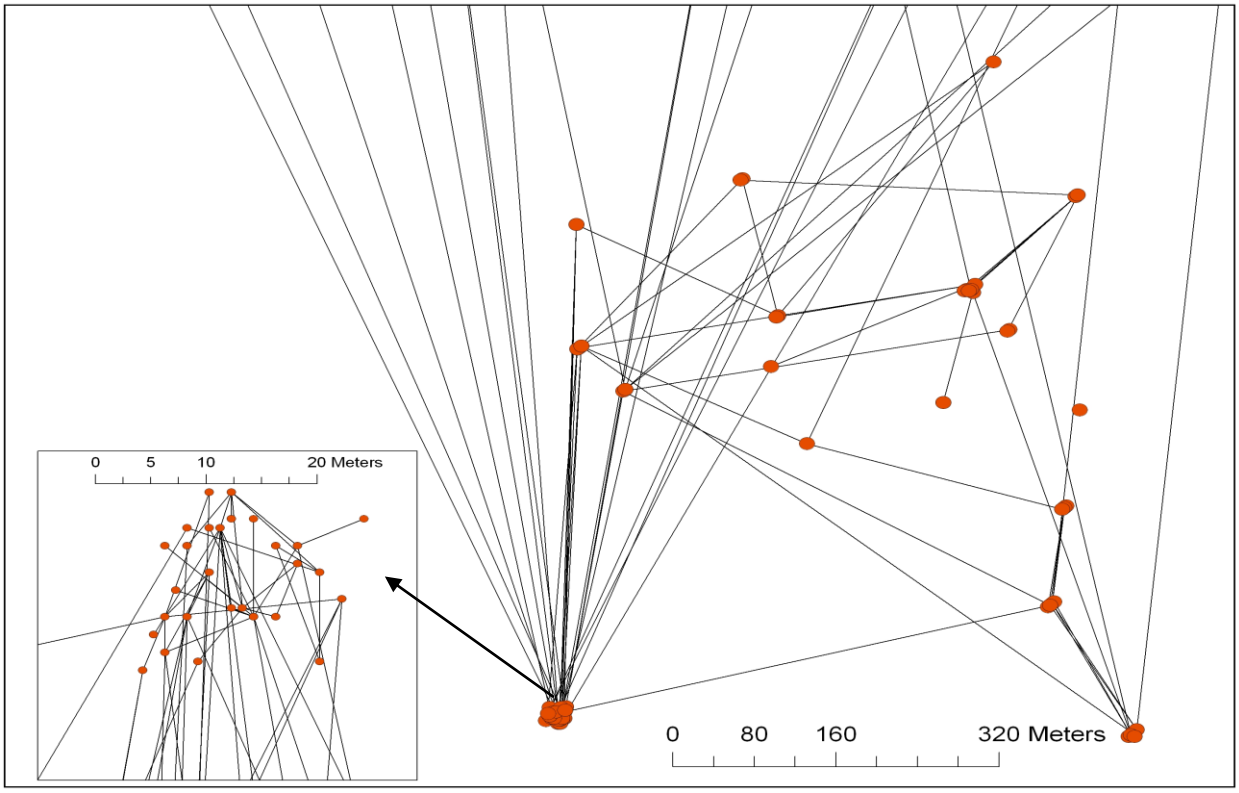
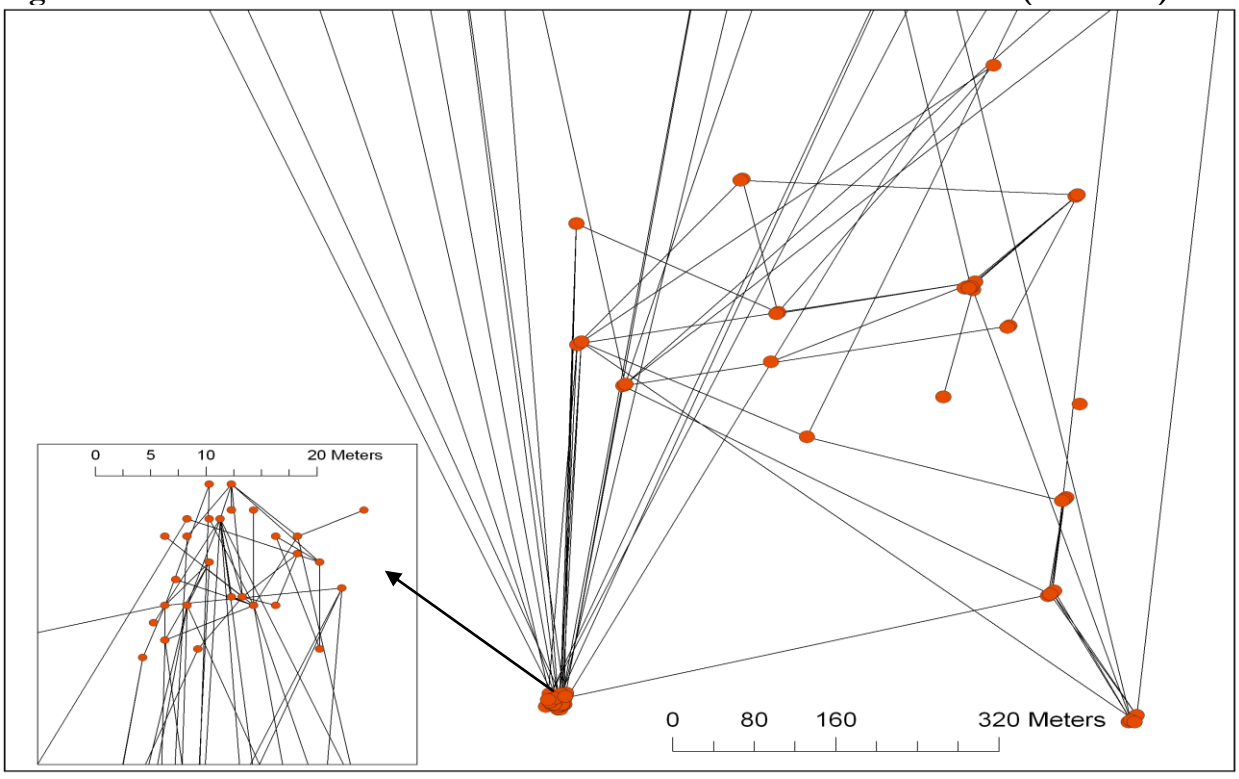


Figure 5.9: Male Network in Treatment Area without ties to health workers (Cluster Y)



The maps of both Cluster X and Cluster Y support the conclusion that gender norms in the region play a strong role in determining the network partners of women. This is despite long-term intervention by ICDDR,B which encourages women to seek health care services outside the *bari*. To maintain the confidentiality of the respondents, the GIS results for all the clusters are not illustrated here. Instead, QAP regressions are used to illustrate the generalisabilty of the results obtained above to other clusters. QAP regressions show the effect of Euclidean distance (measured in metres) on tie formation. Due to the unavailability of data, these tests are restricted to network ties between the residents of the cluster in question; consequently, all the network members living outside the cluster were excluded. Tables 5.11 and 5.12 show the number of actors excluded from the tests.

Table 5.11: Female Networks

	Total no. of actors	No. of actors living outside	% of actors living outside
Cluster B	153	28	18.30
Cluster C	151	17	11.26
Cluster D	146	15	10.27
Cluster E	104	9	8.65
Cluster F	106	11	10.38

Table 5.12: Male Networks

	Total no. of actors	No. of actors living outside	% of actors living outside
Cluster B	145	39	26.90
Cluster C	96	29	30.21
Cluster D	106	43	40.57
Cluster E	83	25	30.12

Tables 5.11 and 5.12 show that men have a greater percentage of network partners residing outside the clusters than women. In the case of Cluster B, women also have a substantial number of actors living outside the cluster, and the proportion of male network partners living outside is the smallest in Cluster B compared to other male networks. There are two reasons for this.

Firstly, Cluster B is relatively close to the main Matlab centre[90], and this has historically caused greater out migration from Cluster B to Matlab centre. Many women who migrated with their husbands from Cluster B to Matlab centre still maintained ties to family living in Cluster B (Field Notes). Secondly, Cluster B has the greatest proportion of women in the male network (as discussed in Chapter 4), which makes it unique in relation to other male networks. Despite this anomaly, the differences in the pattern of ties between the male and female networks in Cluster B are largely similar to the other clusters, as will be shown.

Table 5.13 and Table 5.14 show the results of QAP regressions for the female and male networks amongst actors living within the cluster boundaries. A small proportion of actors living inside the cluster boundary were excluded because of difficulties matching spatial information. This is indicated in the column labeled as 'no. of missing'.

Table 5.13: QAP regressions for distance on dyadic ties within the cluster boundary (Female Networks)

	No. of actors living within the cluster boundary	No. of missing	Intercept	p-values	Distance	p-values	R-square	p-values
Cluster B	125	0	0.094***	0.000	-0.000166***	0.000	0.059	0.000
Cluster C	134	0	0.063***	0.000	-0.000087***	0.000	0.046	0.000
Cluster D	131	0	0.060***	0.000	-0.000056***	0.000	0.04	0.000
Cluster E	95	0	0.099***	0.000	-0.000163***	0.000	0.073	0.000
Cluster F	95	0	0.100***	0.000	-0.000164***	0.000	0.073	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

Table 5.14: QAP regressions for distance on dyadic ties within the cluster boundary (Male Networks)

	No. of actors living within the cluster boundary	No. of missing	Intercept	p-values	Distance	p-values	R-square	p-values
Cluster B	106	7	0.062***	0.000	-0.00011***	0.000	0.024	0.000
Cluster C	67	1	0.050***	0.000	-0.00008***	0.000	0.02	0.000
Cluster D	63	1	0.030***	0.000	-0.00003***	0.000	0.006	0.000
Cluster E	58	0	0.053***	0.000	-0.00008***	0.000	0.021	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

[90] Matlab centre is used to refer to the main commercial locus in the area and is usually identified by locals as Matlab bazaar (*market*).

The results show that an increase in distance has a negative and significant effect on tie formation for both men and women. Although the coefficient is calculated using standard OLS techniques, the significance test is based on 10,000 permutation trials. The estimated coefficients for distance are significant in all the clusters with p<.001; however, the magnitude of the coefficients and R-square is very low in each of the male and female clusters, indicating that distance is not a very important factor in determining ties. This conclusion is especially strong for the male networks due to the comparatively lower R-square results.

These results are not surprising. For the male networks, the GIS maps clearly illustrate that men show little concern for distance and have network partners spread out all over their respective clusters[91], as well as outside, whereas the female networks are largely restrained to the *bari*. Outside the *bari*, distance plays a moot role for women, since women barely have network partners in other *baris* irrespective of the location.[92] These conclusions are confirmed using the constant homophily model. The constant homophily model treats the *bari* as a group and tests whether actors have significant tendencies to form ties within their own group. The results are presented in Tables 5.15 and 5.16 and are based on 10,000 permutation trials.

Table 5.15: Constant Homophily Models for ties within the cluster boundary (Female Networks)

	No. of actors	No. of missing	Intercept	p-values	In-group	p-values	R-square	p-values
Cluster B	125	0	0.006	1.000	0.363***	0.000	0.274***	0.000
Cluster C	134	0	0.003	1.000	0.172***	0.000	0.128***	0.000
Cluster D	131	0	0.002	1.000	0.296***	0.000	0.249***	0.000
Cluster E	95	0	0.002	1.000	0.241***	0.000	0.208***	0.000
Cluster F	95	0	0.002	1.000	0.310***	0.000	0.273***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

[91] It could possibly be that men purposely talk to peers who reside outside of the *bari* to avoid embarrassment associated with discussions of fertility issues. This aspect, however, was not investigated in this research.
[92] 82% of the ties amongst women are with others residing in the same *bari*, whereas 31% of the male ties are to actors in the same *bari*.

Table 5.16: Constant Homophily Models for ties within the cluster boundary (Male Networks)

	No. of actors	No. of missing	Intercept	p-values	In-group	p-values	R-square	p-values
Cluster B	106	7	0.013	1.000	0.171***	0.000	0.073***	0.000
Cluster C	67	1	0.012	1.000	0.037***	0.000	0.012***	0.000
Cluster D	63	1	0.014	1.000	0.064***	0.000	0.014***	0.000
Cluster E	58	0	0.014	1.000	0.063***	0.000	0.017***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

The results show that the probability of a tie between a pair of actors increases if they share the same *bari*. This result holds for both male and female networks. The coefficient estimates (in-group) and R-square results confirm that in-group tendencies are very strong for women in each cluster. In-group tendencies are weak in the male clusters (R-square is low) except in the case of Cluster B. Cluster B is, however, an exception because of the gender ratio in the male network. Despite this, women show a greater tendency to form ties with members of their own *bari* than men, even in Cluster B.

Although GIS coordinates are not available for actors residing outside the cluster boundaries, *bari* identifiers are available for nearly all of the respondents. Constant homophily models are re-estimated for each network without restricting the sample to actors within the cluster boundary. The results are listed in Tables 5.17 and 5.18. The figures for the entire sample reaffirm the strong in-group tendencies in the female networks and also show that the model provides a poor fit for the male networks.

Table 5.17: Constant Homophily Models (Female Networks)

	No. of actors	No. of missing	Intercept	p-values	In-group	p-values	R-square	p-values
Cluster B	153	0	0.006	1.000	0.363***	0.000	0.249***	0.000
Cluster C	151	0	0.003	1.000	0.172***	0.000	0.128***	0.000
Cluster D	146	0	0.002	1.000	0.296***	0.000	0.249***	0.000
Cluster E	104	0	0.002	1.000	0.239***	0.000	0.201***	0.000
Cluster F	106	0	0.003	1.000	0.296***	0.000	0.248***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

Table 5.18: Constant Homophily Models (Male Networks)

	No. of actors	No. of missing	Intercept	p-values	In-group	p-values	R-square	p-values
Cluster B	145	4	0.010	1.000	0.176***	0.000	0.063***	0.000
Cluster C	96	0	0.011	1.000	0.038***	0.000	0.009***	0.000
Cluster D	106	0	0.010	1.000	0.067***	0.000	0.010***	0.000
Cluster E	83	0	0.012	1.000	0.064***	0.000	0.012***	0.000

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

The visual and statistical results both confirm that gender norms play a strong role in the formation of ties.

Conclusion

This chapter set out to examine the networking processes which lead to the highly unequal social networks identified in Chapter 4 by exploring the role of transitivity, homophily and gender norms in tie formation. Transitivity and homophily tap into the micro processes of networking between triads and dyads, whereas gender norms bring the social context into the analysis, providing a comprehensive framework within which to explore the networking choices of individuals.

Consistent with earlier studies in network analysis (Karlberg 1999; Wasserman and Faust 1994), transitivity is found to be an important property of both male and female networks. This firmly rules out the notion that the observed network is random and suggests that actors try to achieve cognitive balance in relationships by forming transitive ties. However, a greater proportion of women than men form transitive relationships, implying that women are more concerned with achieving cognitive balance than simply seeking information from networks. The reasons behind these differing concerns for balance between male and female networks are beyond the scope of this research, but it is reasonable to speculate that since female networks are mainly confined to the *bari*, whose residents are also part of her husband's family networks, women feel pressured to

maintain cognitive balance. For men, maintaining cognitive balance in relationships may not be a pressing concern since their network partners are not confined to the *bari*, but instead are spread about the village and outside, and therefore not necessarily part of the familial network or strong ties. Women also show a modest but significant tendency to form ties with similar others (homophily) based on age, education and economic status.

Although transitivity and homophily are found to be important factors in the female networks, their explanatory power is limited to the confines of the *bari*. As shown by the GIS analysis, any ties outside the *bari* are rare due to the norms of purdah, which leads to the disconnected female network structures observed in Chapter 4. This, of course, does not hold for men whose networks are in no way restricted to the same *bari* or village; however, without information on men's socio-economic characteristics, it is difficult to conclusively identify the main factors behind the networking choices of men.

The results in this chapter show the limitations on the networking activities of women compared to those of men. Given that ties are formed within the constraints of gender norms, these networks are likely to reinforce the already existing inequalities rather than provide social capital. Furthermore, gender norms are far from being the only problem ignored by social capital theorists. As Chapter 4 has already established, social networks are embedded in issues of power and are divided into various factions. The results in this chapter show that female networks exhibit a tendency to form factions on the basis of age, education and wealth. In addition, transitivity predicts that the networks can be divided into several ranked clusters (Faust 2006; Wasserman and Faust 1994). These results therefore caution against the popular projection of networks in the social capital literature as 'benign and harmonious' (Rankin 2002, p. 7). Furthermore, these results show that even though women are confined to the *bari*, they form a

rich associational life within the confines of purdah, and behavioural analysis should not mistake all the women in a *bari* as being part of a homogenous group.

Lastly, it has been assumed that the analysis has not been compromised due to the snowball sampling technique followed during data collection. It is an undeniable fact that some ties will be missing in all the networks due to the sampling technique; nevertheless, the GIS results show that women belong to fairly closed networks within the confines of the *bari*. This suggests that snowballing can quickly identify the complete family planning network of women in any village with a few rounds of data collection in each *bari*, and it is highly likely that the female networks are reasonably good representations of the true family planning networks. By contrast, because male networks extend beyond the *bari* as well as the village, it is much more difficult to capture the complete family planning network of men in a village without imposing unrealistic boundaries. Despite this, the results in this and the previous chapter show that the identified patterns are consistently repeated in all the clusters, suggesting that the data has captured the true underlying network structure in the sampled villages and the results are not simply an artefact of the sampling methodology.

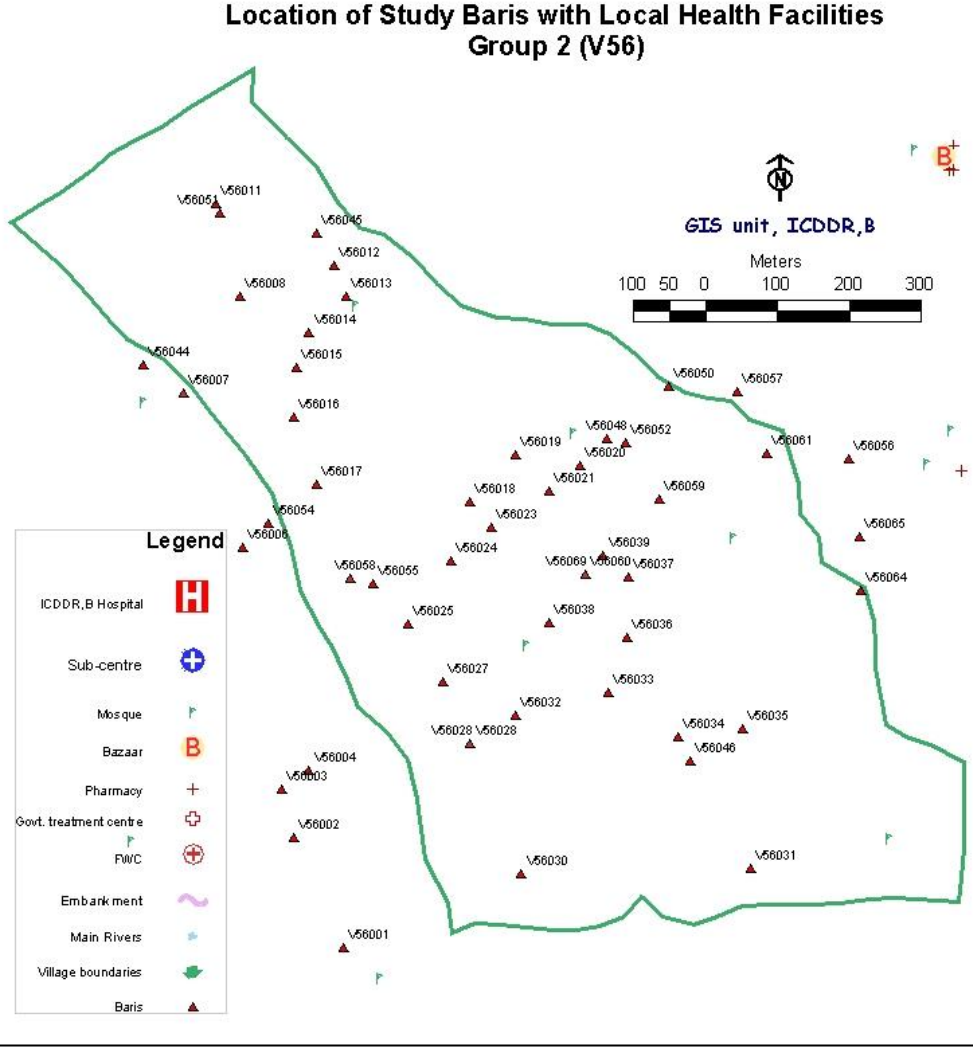
Although this research does not aim to generalise the results to all rural areas in Bangladesh or to more remote sections in the Matlab region, from the observed patterns it can be speculated that the seclusion of women in the *bari* is probably more acute in other rural areas. The choice of villages ensured all the selected communities were accessible and had access to market and health facilities. This implies that these communities have been exposed to greater modernising influences than more remote communities in Matlab as well as Bangladesh. Furthermore, the sheer presence of ICDDR,B in Matlab for over three decades suggests that family planning has been accepted by the wider community in both the treatment and government area, making it easier for women to muster support for travel outside of the household for family planning

services, which is likely to encourage the formation of wider female networks in the whole of Matlab region as compared to women's networks in other rural areas of Bangladesh. In recent years the provision of health services in the ICDDR,B area also requires travel to the health facility, which again encourages contact between women residing in different baris. All of this suggests that our results might have underestimated the true extent of gender subordination. On the other hand there is no reason to believe that male networks will be concentrated in the bari in remote areas of Matlab or in other rural areas of Bangladesh. It may be that in remote regions men do not network as extensively. The absence of a long standing intensive health program in the rest of rural Bangladesh may also discourage men from open discussions of family planning. These issues, however, can also be conclusively answered when more data is available from diverse communities in Bangladesh.

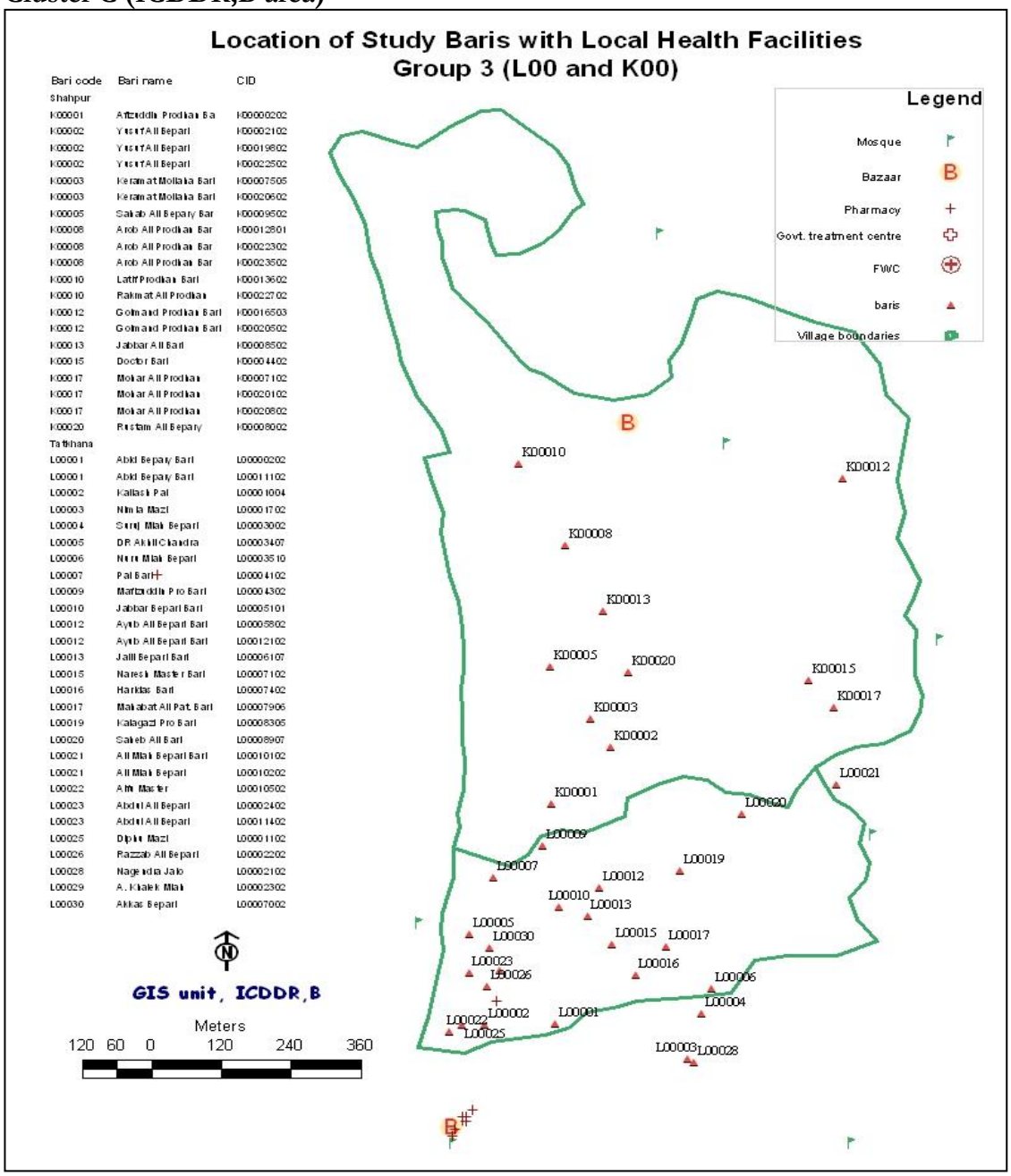
Appendix 5

Cluster B (ICDDR,B area)

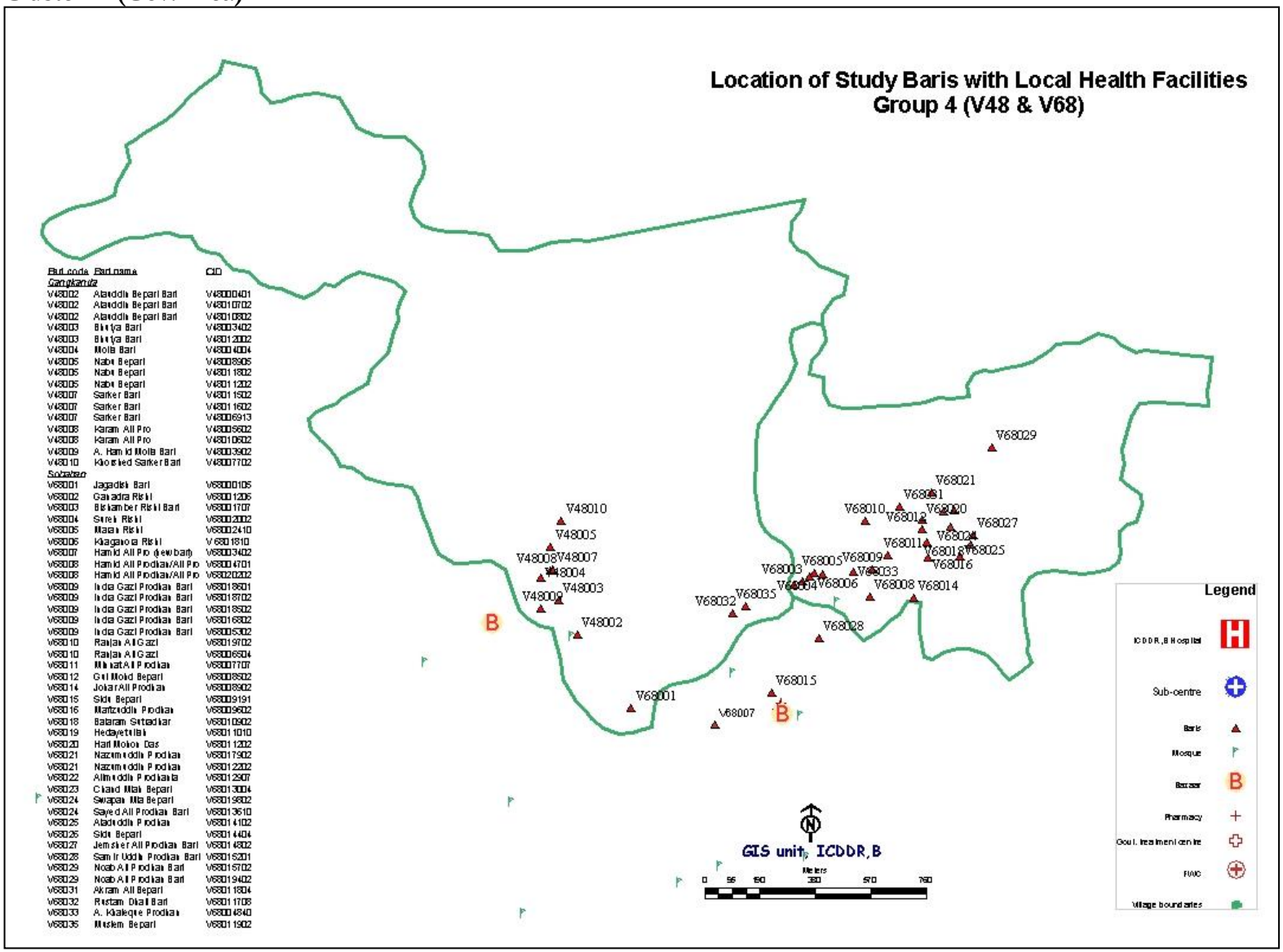
Bari code	Bari name	CID	Bari code	Bari name	CID	Bari code	Bari name	CID
Pailpara								
V56001	Sekander Ali	V56011102	V56023	Kashim Ali Bakaul	V56025502	V56046	Noor Mia Patwary	V56016605
V56002	Rustem Master	V56010002	V56024	Rahimuddin Meaji	V56024105	V56048	Ali Reza Bakaul	V56026604
V56003	Jabber Ali Pro	V56008904	V56025	Hazi Altajuddin Pro	V56023701	V56050	Muzaffer Dhali	V56027303
V56004	Rosha Gazi Pro	V56008001	V56025	Haji Altajuddin Pro	V56033401	V56051	Jalil Sayal	V56000908
V56006	Jabber Ali Bepary	V56007103	V56027	Hamid Ali Meaji	V56015503	V56052	Mia Raja Bakaul	V56030805
V56008	Rostam Mizi Bari	V56001502	V56028	Mansur Ali Meaji	V56016809	V56054	Amir Hossain Pro	V56007303
V56011	Wazuddin Saiyal	V56000106	V56030	Samid Kha	V56012304	V56055	Tipu Sultan	V56023801
V56012	Altafuddin Sail	V56003703	V56031	Manor Ali Bepari	V56013402	V56056	Nazrul Islam Bep	V56027202
V56013	Askor Ali Kabiraz	V56004303	V56032	Afsaruddin Sarker	V56018109	V56057	Abul Kalam Gazi	V56032902
V56014	Baksha Ali	V56005102	V56033	Mosharaf Hossain Patoary	V56018406	V56058	Billal Sarder	V56026002
V56015	Azimuddin Pro	V56005402	V56034	A. Jalil Patoary	V56019502	V56059	Nannu Darjee	V56027102
V56016	Saduruddin Pro	V56006002	V56035	Hazi Akbor Ali Patowary	V56020509	V56060	Harun Or Rashid	V56021903
V56017	Hazi Gofur Ali Sayal	V56006503	V56036	Jalaluddin Pro	V56021202	V56061	Salamat Bepari	V56030702
V56018	Mahabbat Ali Bakaul	V56030902	V56037	Jansgor Ali Pro	V56021502	V56064	Seraj Uddin Bakaul	V56033105
V56019	Mannan Bakaul	V56033702	V56038	Daula Gazi Pro	V56022802	V56065	Johor Ali Bepari	V56034002
V56019	Solimuddin Bakaul	V56027802	V56039	Johor Ali Pro	V56022202	V56069	Fazlul Haque Dhali	V56034702
V56020	Fazlur Rahman Bakaul	V56026402	V56044	Abul Khir Meazi	V56001402			
V56021	Sherazul Islam Bakaul	V56026102	V56045	Muklesur Rahman Sayal	V56003602			



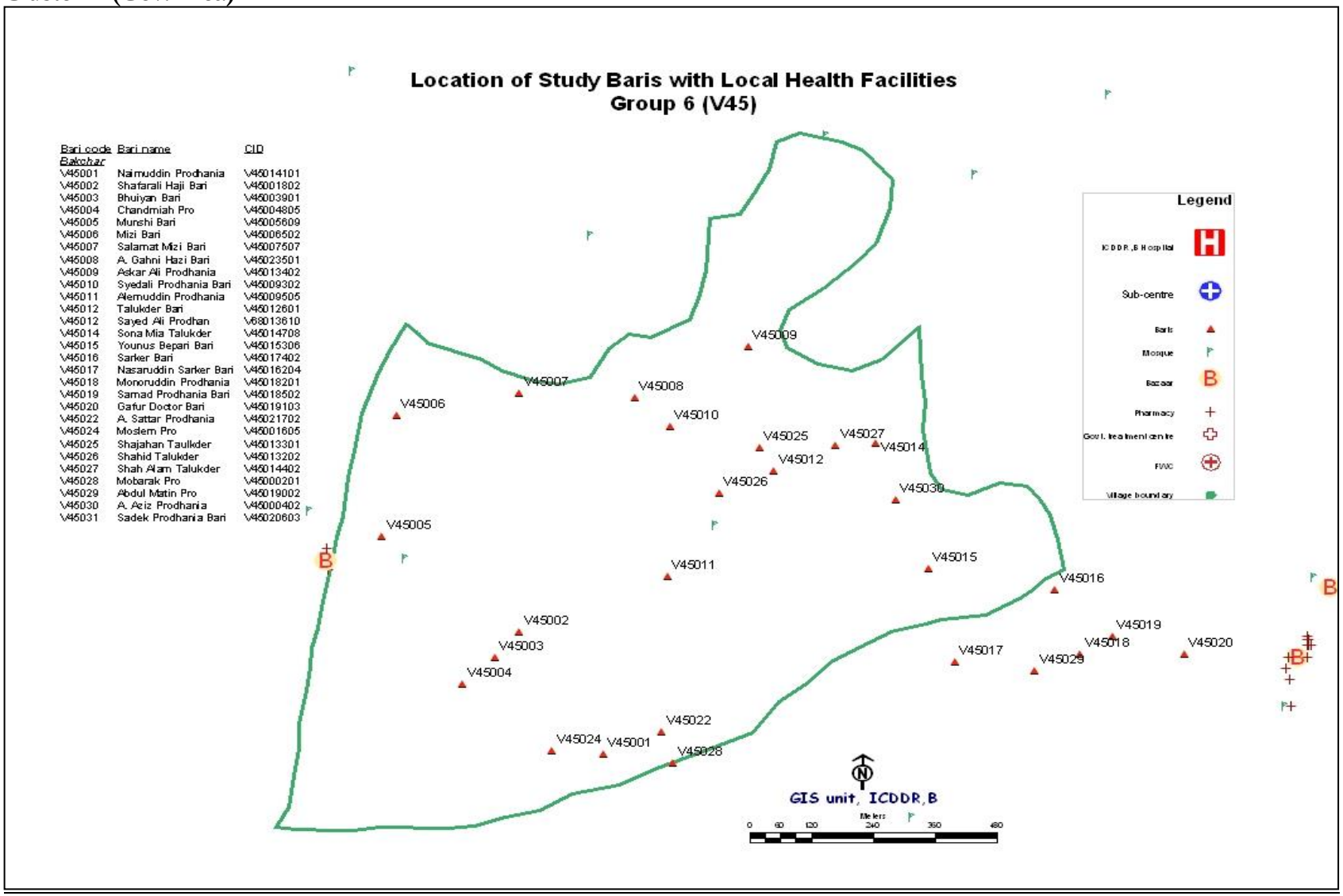
Cluster C (ICDDR,B area)



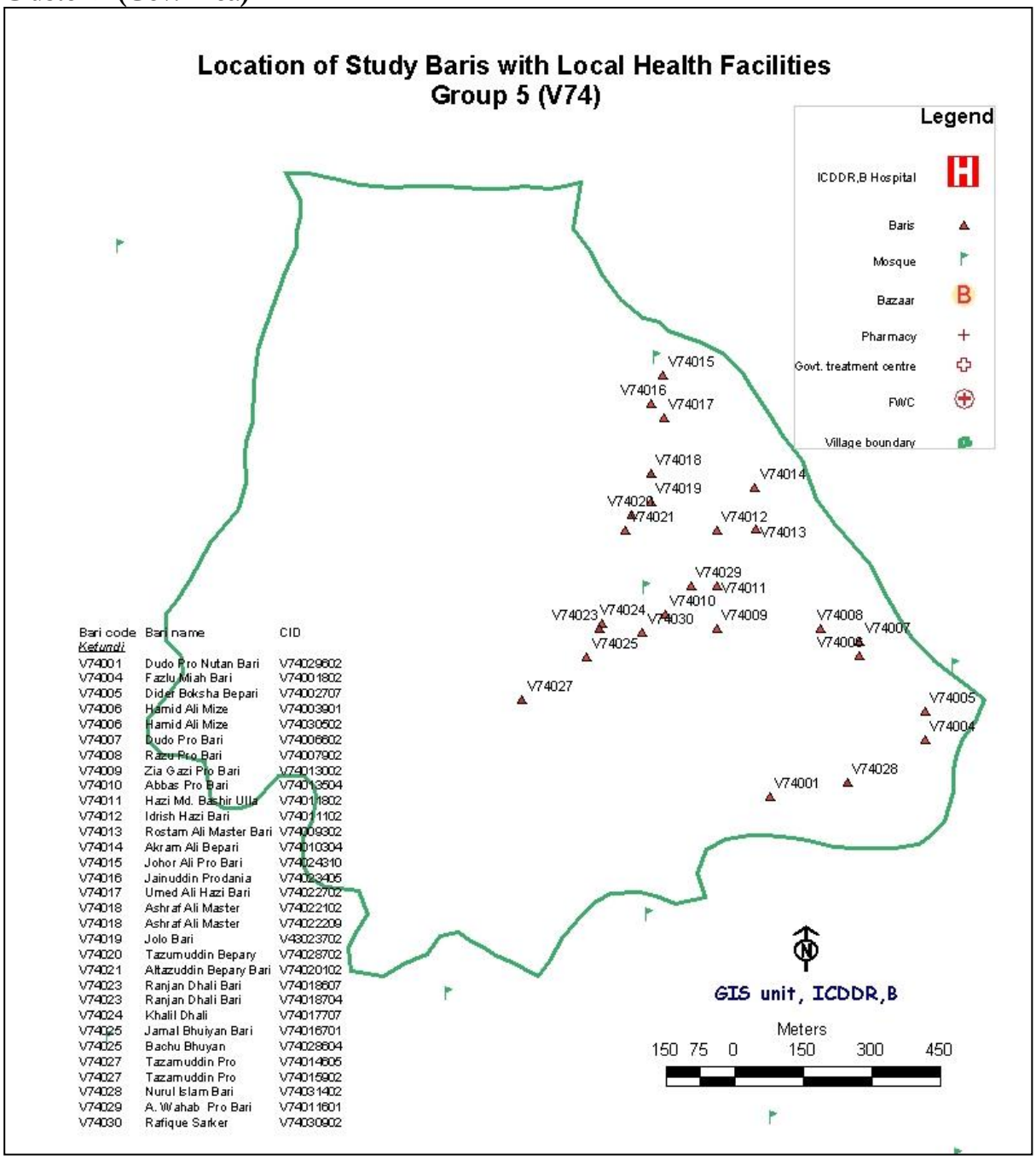
Cluster D (Gov. Area)



Cluster E (Gov. Area)



Cluster F (Gov. Area)



Bari code Ketumdi	Bari name	CID
V74001	Dudo Pro Nutan Bari	V74029602
V74004	Fazlu Miah Bari	V74001802
V74005	Didar Boksha Bepari	V74002707
V74006	Hamid Ali Mize	V74003901
V74006	Hamid Ali Mize	V74030502
V74007	Dudo Pro Bari	V74006602
V74008	Razu Pro Bari	V74007902
V74009	Zia Gazi Pro Bari	V74013002
V74010	Abbas Pro Bari	V74013504
V74011	Hazi Md. Bashir Ulla	V74011802
V74012	Idrish Hazi Bari	V74011102
V74013	Rostam Ali Master Bari	V74009302
V74014	Akram Ali Bepari	V74010304
V74015	Johor Ali Pro Bari	V74024310
V74016	Jainuddin Prodania	V74023405
V74017	Umed Ali Hazi Bari	V74022702
V74018	Ashraf Ali Master	V74022102
V74018	Ashraf Ali Master	V74022209
V74019	Jolo Bari	V43023702
V74020	Tazumuddin Bepary	V74028702
V74021	Altazuddin Bepary Bari	V74020102
V74023	Ranjan Dhali Bari	V74018607
V74023	Ranjan Dhali Bari	V74018704
V74024	Khalil Dhali	V74017707
V74025	Jamal Bhuiyan Bari	V74016701
V74025	Bachu Bhuyan	V74028604
V74027	Tazamuddin Pro	V74014605
V74027	Tazamuddin Pro	V74015902
V74028	Nurul Islam Bari	V74031402
V74029	A. Wahab Pro Bari	V74011601
V74030	Rafique Sarker	V74030902

6. Network Effects on Family Planning Decisions

The social capital literature offers a simplistic view of networks and links it with beneficial outcomes, while remaining silent on issues of power, conflict, exclusion and gender in networks. This research provides quantitative evidence that this position is at odds with the structural realities of networks in developing countries. The Bangladeshi data clearly establish gender differences in networks and show that women are more likely to face greater pressures, limited opportunity, and unequal power in these networks compared to men (Chapter 4). Furthermore, these networks follow the logic of discriminatory gender norms and are unlikely to prove a resource for women trying to break away from tradition in order act in their own self interest. These so called solidarity networks (Rankin 2002) of women are further divided into factions on the basis of age, education and wealth (Chapter 5). Thus the evidence presented so far hardly suggests networks 'as benign and harmonious', but rather 'as inherently conflictual and contradictory' (Rankin 2002, p. 7).

This chapter extends the analysis further to demonstrate the contradictory nature of social capital and shows its limits as a resource for women in the patriarchal society of Bangladesh with strong norms of female seclusion. The aim here is not to discredit the importance of networks but to expose the complexity of decision-making for actors embedded in networks which are formed in a discriminatory social space. These complexities are analysed by studying the role of networks on women's choices about practising family planning and the type of contraceptive method used in the Matlab area, together with the role of broader socio-economic realities of the region on fertility regulation. In the purdah-fettered society of Bangladesh, networks are expected to provide women with valuable information; however these networks are not likely to provide support for decisions that disturb the traditional norms of behaviour.

The literature on diffusion already shows that networks are important in shaping decisions about family planning. The diffusion perspective views family planning as an innovation which may spread through interpersonal communication (Valente et al. 1997), and such communication can accelerate the diffusion process by activating social learning and social influence in networks (Behrman, Kohler and Watkins 2002). Social learning arises when new information is obtained and assessed through networks; for example, networks can provide information on family planning as well as aid its evaluation through discussions of potential costs and benefits (Montgomery and Casterline 1996). Social influence, on the other hand, occurs when social networks reinforce or alter norms of behaviour (Behrman, Kohler and Watkins 2002). The desire to conform to other people's wishes is also classified as social influence (Montgomery and Casterline 1996). Thus social influence allows for changes in individual preferences as a result of interpersonal communication; for example, networks may alter views about desired family size as a result of communication with other users and hence affect contraceptive behaviour. By incorporating social influence into the analysis, diffusion literature clearly identifies the negative effects of social networks (Kohler, Behrman and Watkins 2001). According to social influence theory, if network partners do not support family planning then an individual is unlikely to adopt family planning even if he/she is in favour of contraceptive use.

Support for these network effects has been found in wide-ranging research, including studies on women's groups in Cameroon (Valente et al. 1997), ego networks in Kenya (Behrman, Kohler and Watkins 2002; Kohler, Behrman and Watkins 2001) and Ghana (Montgomery and Casterline 1998), kinship networks in Thailand (Godley 2001) and community-based programs in Madagascar (Stoebenau and Valente 2003).

Available evidence on Bangladesh also shows the importance of network effects on contraceptive behaviour. Kincaid (2000), in his research on the role of formally organised group discussions on family planning, found that women were five times more likely to use contraception if they engaged in family planning discussions at a group level. In a more general study conducted by Gayen and Raeside (2005) using a sociocentric approach[93], approval of contraceptive use by network members was found to be the most significant determinant of contraceptive use. This study thus showed that social influence was the most important factor in family planning decisions in Bangladesh. In the context of our discussions in Chapter 4, Gayen and Raeside's (2005) findings are not surprising. The results in Chapter 4 show that women in Bangladesh are embedded in dense networks and the cohesive nature of these ties implies that normative influences are likely to be strong in these networks. Women in Bangladeshi networks are therefore unlikely to use contraceptives without the support of their network partners.[94]

Investigation into the national family planning program of Bangladesh further supports the diffusion perspective. The family planning program of Bangladesh was launched by the government in the mid-1970s. The program focussed on a community-based distribution approach using female health workers, who provided supplies to clients' homes (mainly condoms and pills) as well as counselling and motivating couples to adopt family planning (Routh et al. 2001). Around the same time, ICDDR,B launched a more intensive program in nearly half of the Matlab area known as the 'treatment area'. The other half is served by the national program and is commonly referred to as the 'government area' or 'non-treatment area'. One of the main features distinguishing the ICDDR,B

[93] In a sociocentric approach, data is collected from everyone in a bounded community (Klovdahl 1985).
[94] Gayen and Raeside's (2005) study also found out-degree centrality to be important and attributed its significance to social learning; however, the reasons behind the importance of out-degree centrality in explaining contraceptive use remain unclear because the total number of ties was restricted to five. Furthermore, the significance of out-degree centrality can derive from greater autonomy rather than social learning.

program from the national program was the provision of greater personalised care to clients. The system of doorstep delivery of the national program was retained but the ICDDR,B program provided injectables along with condoms and pills at clients' homes (Bhatia et al. 1980). Most aspects of the program remain in place today, with the exception of home delivery of contraceptives in the treatment area which was permanently abandoned by ICCDR,B in 2001. The method of doorstep delivery was briefly abandoned by the government but was reinstated in 2003 (Directorate General of Family Planning, Ministry of Health & Family Welfare).[95]

The success of the national program is evident from the data on the contraceptive prevalence rate (CPR). The CPR for married women in Bangladesh has markedly increased from 8% in 1975 to 56% in 2007[96] (NIPORT et al. 2009). The CPR in the Matlab treatment area increased even more rapidly, reaching 57.1% in 1990 from 4.7% in 1975 (Fauveau and Chakraborty 1994). It increased to a high of 71.4% in 2005 but dropped again to 56.6% in 2007 (ICDDR,B 2010 HDSS-Matlab). In the Matlab government area, progress has been slower and the CPR increased from 4.7% in 1975 to 27.2% in 1990 (Fauveau and Chakraborty 1994), reaching 47.4% in 2005, but dropping to 43.6% in 2007 (ICDDR,B 2010 HDSS-Matlab).

Previous research confirms that the role of health workers has been central to these changes. Although all the channels through which the health workers have affected the CPR are still a matter of debate (Caldwell et al. 1999; Freedman 1997; Cleland et al. 1994), it is widely accepted that the programs have been successful in satisfying an 'unmet need' for birth control (Koenig et al. 1992; Phillips et al. 1996). Evidence also suggests that the health workers do not simply meet the existing

[95] Further details of the health services provided in the Matlab area are listed in Chapter 3.
[96] The CPR figures are based on current contraceptive use status of currently married women in the age range of 15-49 (NIPORT et al. 2009).

demand, but that the communication between the workers and clients is crucial in generating new demand (Simmons et al. 1988; Simmons 1996). Based on qualitative research, Simmons et al. (1988) summarise the role of the health worker as follows:

> her role transcends the boundaries of what is conventionally implied by the concept of supply. She acts as an agent of change…exposing women long secluded by the tradition of purdah to the modern notion of deliberate choice…The worker defends the practice of contraception as legitimate within the principles of Islamic law and attempts to alleviate child mortality fears by reference to new trends…Her credibility acts as guarantor for the safety of contraceptive technology and for an alien delivery system. She provides support in familial conflicts when the views of other family members and the woman's own interests concerning the practice of contraception clash (p. 36).

Thus the health worker is a source of both social learning and social influence not only for the targeted woman but also for the broader community. Statistical analysis also suggests that health workers in Bangladesh are not merely suppliers of contraceptives. Health workers were found to positively affect adoption amongst women not intending to use contraceptives (Phillips et al. 1993). In a rare study on fertility preferences using longitudinal data, Phillips et al. (1996) show that contact with health workers reduced the desire for additional children in Bangladesh. Although these effects were found to be statistically significant, the size of the estimated coefficients was modest.

Despite the evidence on diffusion, only a handful of studies employ the tools of social network analysis to model network structures in Bangladesh (Gayen and Raeside 2005; Kincaid 2000). These studies do not explicitly include health workers in the networks and hence very little is known about the health workers' position in these structures. Furthermore, the role of networks in contraceptive use in a high prevalence setting with an effective family planning program, such as the Matlab treatment area is still a mystery. It may be that the role of networks is diminished in such settings by

providing women with more options to exercise their preferences and because of greater knowledge of family planning techniques.

It has also been noted that one of the problems with controlling fertility has been ineffective use of contraceptives (Bairagi et al. 2000). Despite all efforts, the pill continues to be the most popular method in Bangladesh (NIPORT et al. 2009), yet also suffers from high failure (Bairagi et al. 2000) and discontinuation rates (NIPORT et al. 2009). No attention has been paid to modelling network effects on contraceptive method choices in Bangladesh, however, and only indirect evidence exists that confirms the importance of this approach (Paul 1990; Bhatia et al. 1980).

This study overcomes the omissions discussed above by analysing the effect of networks on contraceptive choices of women in both high and low prevalence settings.[97] The health workers are also included in these family planning networks and their influence on contraceptive choices is discussed in extensive detail. This study is the first ever in Bangladesh to measure network effects on contraceptive method choice.

We do not limit ourselves in this study to just the diffusion perspective. Opposite to diffusion perspective are the demand side theories. Broadly, the demand theories emphasise that contraceptive use is determined by preference for children, which is based on social and economic conditions (Phillips et al. 1993). Several socio-economic factors, including economic status (Kabeer 2001; Caldwell et al. 1999), women's schooling (Lam and Duryea 1999; Caldwell et al. 1999), fertility preferences (Gipson and Hindin 2009), women's status (Dyson and Moore 1983; Abadian 1996) and

[97] This analysis does not include the data obtained from male interviews because of questionable quality of information provided by men on contraceptive use by their wives. See Chapter 3 (field experience) for more details.

child mortality (Khan and Raeside 1997; Caldwell et al. 1999), are found to be important determinants of fertility. Compelling evidence also shows that son preference is strong in Bangladesh (Chowdhury and Bairagi 1990; Cleland et al. 1994). This research takes both the socio-economic and diffusion factors into account. The next section measures the network effects on contraceptive decisions, followed by a multivariate analysis of family planning choices which takes socio-economic characteristics into account.

It is important to note that the distinction between diffusion and demand side theories may not be clear cut. Even though networks may encourage contraceptive use, they may simultaneously discourage female mobility or reinforce the importance of sons by discriminating against the female child. In this way, networks can encourage behaviour that reinforces the structural constraints and hence leads to a high demand for children. Unfortunately this hypothesis cannot be tested directly due to data limitations;[98] however, the results in Chapter 5 show that female networks largely operate within norms of seclusion. Since these networks are embedded in a discriminatory space, they are likely to conform to the local social norms and reinforce rather than challenge prevalent practices; hence, the benefits of social networks will be regulated by the broader social structure. Our bivariate and multivariate analysis points in this direction, as it shows that despite high levels of social capital, women continue to make choices in accordance with social norms.

As has been the case in previous chapters, the network measures are based on symmetrised data.[99]

[98] The available data do not allow us to test this hypothesis. A possible survey question that could shed light on this aspect could be 'do your network partners currently support your use of family planning to delay or stop child birth?' At the time of the survey we collected information on 'whether the network partners approve of family planning?' This question is too general and does not take into account the respondents' individual circumstances. For example, the network partners may approve of family planning in general but may be against the respondent using a contraceptive method because she has not yet achieved the desired number of sons.

[99] The reasons behind this are discussed in Chapter 4.

Network Measures

The network effects are captured using degree centrality, personal network density[100] and network exposure. Degree centrality is simply the number of direct connections of each actor including both ties both sent and received (Hanneman and Riddle 2005). An actor with high degree centrality is expected to have greater autonomy because of a low degree of dependency on any one actor (Hanneman and Riddle 2005) and to have more opportunities for social learning and influence as compared to other actors (Kincaid 2000). It is assumed here that actors with many contacts will be better informed than respondents with lower degree centrality. Thus actors with high degree centrality can be expected to have high CPRs[101] and to show a greater likelihood of adopting new methods of contraceptives due to increased autonomy or access to superior information.

Density measures the level of interconnectedness between actors and can be measured at different levels. As in Chapter 4, we mainly focus here on personal network density. Actors in dense personal networks are likely to have access to less diverse information as compared to those in sparse networks (Ibarra 1993, Rogers and Kincaid 1981). Since dense networks minimise the opportunities for social learning they are likely to have a negative effect on contraceptive use (Kohler, Behrman and Watkins 2001). Actors in dense networks are also expected to choose the most popular contraceptive method as they are less likely to have information on newer techniques. However it may be that in the Bangladeshi networks the primary processes through which social networks affect family planning decisions is social influence rather than social learning. Dense networks are likely to be effective in exercising social influence since network partners can jointly exercise normative

[100] A detailed explanation of density and degree is provided in Chapter 4.
[101] Betweenness centrality was also tested in this research but was not found to be important in explaining contraceptive adoption.

pressures. If social influence is the main concern, the effect of density is going to be dependent on the content of interactions (Kohler, Behrman and Watkins 2001). Respondents in dense networks with many contraceptive users are more likely to use family planning methods, whereas respondents in a dense network with few contraceptive users are unlikely use contraceptives.[102] Actors in dense networks are also more likely to use the method chosen by the group if social influence is the primary motivator in these networks.

Network exposure is used to account for the content of these interactions (Kohler, Behrman and Watkins 2001), which is calculated by measuring the proportion of network partners that have adopted a particular innovation such as family planning. According to the diffusion perspective, family planning practices will spread through networks, because initial adopters are likely to persuade their network partners to adopt (Valente 2005). Network exposure has been defined by Valente (2005) as follows:

$$E_i = \frac{\sum w_i y_j}{\sum w_i}$$

w is commonly known as the weight matrix and captures the connections between actors. y is the vector of adoptions (Valente 2005). The weight matrix can be defined in numerous ways, depending on the influence processes assumed to be present (Leenders 2002). In this research, the weight matrix is used to capture personal contacts (both ties received and sent) in order to measure the influences transmitted through direct communication. Defined in this way, the exposure vector

[102] Thus if learning is the most important concern in the adoption of family planning then density should have a negative or insignificant effect on adoption; because sparse networks are more conducive to learning. On the other hand if social influence is important too then dense networks with many users, should have a positive and significant effect on adoption (Kohler, Behrman and Watkins 2001).

equals the proportion of people that have adopted in the actor's ego-network. Network exposure is expected to be both a source of social learning as well as social influence; for example, an ego with a high proportion of contraceptive users in the networks can be jointly or individually persuaded by her network partners to adopt family planning. At the same time, a large number of users in an ego's network creates more opportunities for social learning. Exposure is further multiplied by density to analyse the interaction between the structure and content of communication networks (Kohler, Behrman and Watkins 2001). Although personal network exposure is expected to be both a source of social learning and influence, normative influences are likely to be stronger in high density networks. Because most network partners in our case are formed between members of the same *bari* who are likely to be related through kinship (Chapter 5), normative influences cannot be ruled out altogether in the case of sparse networks.[103]

Lastly, it is possible that people are also influenced by members of their subgroup. Members of a cohesive subgroup[104] are likely to be aware of others' views in the group by comparison with non-members**.** They are also likely to come under interpersonal pressures that encourage reciprocity and compromise, leading to conformity in behaviour (Friedkin 1993).[105] In order to capture these influence processes, the weight matrix is operationalised using the definition of bi-components. A bi-component consists of more than two points, such that each node in a bi-component can reach the others through at least two paths and is not dependent on any one node to reach others (for details

[103] Kohler, Behrman and Watkins (2001) argue that normative influences will be minimal in sparse networks. Although we agree that normative influences are stronger in dense network, they are unlikely to be absent in sparse networks in the Bangladeshi context.

[104] Cohesive subgroups are "subsets of actors among whom there are relatively strong, direct, intense, frequent, or positive ties" (Wasserman and Faust 1994, p. 249)

[105] Or in other words members of cohesive subgroup are likely to influence each other. The cohesion model in network analysis is further backed by substantial empirical literature (Mizruchi 1994).

see Chapter 4). The exposure value measures the proportion of networks partners in bi-components who have adopted family planning or a certain method.

These measures are employed to test network effects on both 'whether or not the respondent or her husband currently use family planning' and 'the type of method used'.[106] Not everyone in the sample has been included in the analysis of contraceptive decisions. This is because when conducting the snowball methods, the network partners were deliberately not restricted by age or marital status, except in the first round. This method led to inclusion of many respondents who were post-menopausal or living separately from their spouse (mainly due to the migration of their husband to the city or overseas). Their contraceptive status is therefore not analysed and these respondents are excluded from the calculation of exposure values. Structural measures such as degree and density utilise information on the entire network structure, however, making the maximum use of the available data.[107]

Respondents with less than two ties are excluded as egos but not as alters, for two reasons. Firstly, actors who are less interested in family planning may not be actively involved in networks. On the other hand actors with a large number of ties may be predisposed to using family planning. Since we cannot control for these unobserved factors, network effects can be attributed to selectivity bias (Kohler, Behrman and Watkins 2001, Rutenberg and Watkins 1997). Secondly, it is likely that the

[106] The analysis is restricted to the use of modern methods.

[107] For example an actor may be adjacent to five actors out of which two are post menopausal and the other three are in child bearing age. In this case only the actors in child bearing age are included while calculating the exposure values since it is not clear what values should be assigned for contraceptive status to actors not in the child bearing age. To consider the post menopausal women as non-users is not deemed appropriate as these women are not making any contraceptive choices due to biological reason. However all the adjacent actors are considered while calculating measures of density and degree, since all five form the core network of the focal node. Density measures were also calculated after deleting all the actors who have not been included in the analysis of contraceptive choice due to reasons of age, marital status and so on. But this made little difference to the results presented in this chapter.

network ties of some respondents have not been adequately captured because the snowball method was terminated after three rounds. Although these weaknesses cannot be omitted altogether, they can be partially controlled by selecting egos with at least two ties.[108] Moreover, since networks are largely formed between women in the same *bari*, we expect that strategic selection of network partners is unlikely to play an important role in these networks and hence any further controls are not needed.

The analysis is conducted on the government and ICDDR,B areas separately due to the differences in the family planning services in the two areas.

Results (female)

Bivariate Analysis

Knowledge of contraceptives was found to be universal in both the government and ICCDR,B areas. 100% of respondents reported to be familiar with the pill; the knowledge of injectables, condoms and tubectomy was also found to be above 90%. Overall women in the ICCDR,B area were better informed about modern contraceptive methods.

Table 6.1: Knowledge of contraceptive methods

	Gov. Area	ICDDR,B area
	% of women who have heard about the method	% of women who have heard about the method
Pill	100	100
IUD	84.05	90.52
Injectable	99.14	99.53
Condom	92.24	94.34
Tubectomy	99.57	96.7
Vasectomy	61.64	82.94

[108] In an analysis of network effects on contraceptive use, Kohler, Behrman and Watkins (2001) control for selectivity bias by limiting the analysis to women with three or four network partners. Because of small sample size this approach is not tested here.

Women in the ICCDR,B area also regularly identified the designated health workers responsible for their village as their network partners. In the treatment area, 41% of women had a direct tie to the ICDDR,B health workers and nearly everyone was connected to the health worker through indirect ties. By contrast, the respondents in the comparison area did not identify any government health worker as their network partner. This difference in partner identification indicates the differences in the quality of services provided.

Higher use of modern contraceptives was found in the ICDDR,B area. 77% of respondents reported to be using a modern contraceptive method in the ICDDR,B area and 60% in the government area.[109] As discussed in Chapter 3, these figures are much higher than the CPRs available from ICCDR,B sources for the Matlab area. In 2007, CPR in the treatment area was 56.6% and 43.6% in the government area (ICDDR,B 2010 HDSS-Matlab). The official figures are based on the use of any method by married women in the age of range 15-49. Our sample figures differ from the official statistics for a few reasons. Firstly, we do not restrict the analysis to women in a certain age group. All the women who considered themselves fertile were included.[110] Secondly, the study is restricted to modern methods.[111] Thirdly, this study accounted for husband's residential status and women who were not residing with their husbands have not been included in the analysis.[112] Lastly, the data was collected in well-connected villages, which can be expected to have higher CPRs than the rest of the Matlab area.

[109] The entire sample has a CPR of 60.23% in the government area and 77.33% in ICDDR,B area. Thus excluding respondents with only one tie does not bias the results.
[110] 0.87% of the respondents in the government area and 1.9% of the respondents in the ICDDR,B area are above the age above the age of 49 in the sample analysed in this chapter.
[111] The restriction of this study to modern methods is likely to cause the CPRs in this study to be lower than the official figures.
[112] The prevalence of modern methods is 69.49% in ICDDR,B and 48.42% in government area for married women in the age range of 15-49. However this does not account for husband's residential status or other biological factors.

Table 6.2: Contraceptive Prevalence Rates

	Government Area		*ICDDR,B Area*	
	% of women who are users	N	% of women who are users	N
Any method	59.91	232	77	213
Pill	36.21	232	23.94	213
Injectable	12.07	232	38.5	213
Other method	11.64	232	14.55	213

Consistent with the literature, the pill was the most popular method in the government area and injectables in the ICCDR,B area. Currently, pills and condoms are the only methods delivered at home in the government area; all other methods require travel outside the household. None of the methods are delivered at home in the ICDDR,B area. Given that most methods require travel outside the *bari*, ease of availability of cannot be the only motivator in method selection. Furthermore the government provides pills and condoms at home, but the pill continues to dominate in the government area. The category 'other methods', which mainly includes condoms and tubectomy users, is the least popular in both the areas.

In order to ascertain the role of networks on contraceptive behaviour, correlation results for density, exposure and degree are presented in Table 6.3. Personal network exposure represents the proportion of direct ties currently using a method. Density measures are also based on the respondent's ego networks, and bi-component exposure captures both direct and short indirect ties.

The high awareness of contraceptive methods discussed earlier suggests that any identified networks effects operate through social influence rather than social learning. In addition to this, our study villages have been selected because they are close to a health a facility, which further lowers the cost of seeking information. Information on contraceptive methods can also be expected to have been

widely diffused between the government and ICDDR,B area through informal sources, but since the knowledge of contraceptive methods is based on the responses to 'heard about methods', social learning cannot be completely ruled out because possessing knowledge about the availability of certain methods may be insufficient to induce a respondent to adopt if she is ambivalent about its effectiveness and safety. In order to investigate social influence, measures of density and subgroup exposure have been incorporated into the analysis.

Although the results are based on women with at least two ties, some respondents' ego-networks and/or bi-component only included women who were not making family planning decisions for themselves for reasons such as age. These respondents were given an exposure value of zero.[113]

Table 6.3: Pearson Correlation between contraceptive use and network measures

	Gov. Area	ICDDR,B Area	ICDDR,B Area (no health worker)
	Whether the respondent is using any method	Whether the respondent is using any method	Whether the respondent is using any method
Degree	0.22***	0.08	0.05
Density	0.07	0.09	0.16*
Personal network exposure	0.24***	0.14*	0.14*
Den*personal net. exposure	0.15*	0.13	0.16*
Bi-component exposure	0.18**	0.15*	0.10

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

As Table 6.3 shows, the network effects are positive but modest in both the government and ICDDR,B areas; and are especially weak in the ICDDR,B area if the complete network with the

[113] Although everyone in the sample can be expected to receive advice about family from their direct connections, the exposure values are based on observed behaviour rather than on advice received. This, however, remains a weakness of this study because network partners who are not using any method for example due to biological reason are still expected to affect the decision-making process by advising about methods.

health workers is analysed. Degree is positively associated with contraceptive adoption in the government area but is insignificant in the ICDDR,B area. Deleting the health worker makes little difference to the results for degree in the ICDDR,B area.

The effect of density is insignificant in the government area but surprisingly it has a modest but positive association with contraceptive use in the ICDDR,B area after deleting the health worker.[114] The differences in the results for density in the two areas is probably due to the fact that the majority of network partners in the ICDRR,B area are likely to be contraceptive users and hence the normative pressure to use is likely to be greater in dense networks in the ICDDR,B area; hence, density is significantly correlated with contraceptive use. In the government area, however, the proportion of network partners who are users is more varied and the effect of density is likely to be subject to the content of discussions if social influence is important in these networks. Analysing the content of discussion clarifies this point. The effect of personal network exposure is positive in both areas, but stronger in the government villages. Interaction of personal network exposure and density weakens the results of personal network exposure in the government area but strengthens the results in the ICDDR,B area slightly in the network without the health worker. The interaction term is also significant in both these cases, and in both areas the actors with high density and a large number of contraceptive users are more likely to adopt family planning. But the effect of 'density*exposure' on contraceptive decisions in the government area is not as important as personal network exposure. This suggests that social influence is not necessarily the most important factor in the adoption of family planning in the government area, but neither can it be ignored.[115]

[114] The effect of density is not significant in the network with the health worker. This is probably because the health worker changes the structure of the personal network.

[115] Interaction between two variables is difficult to interpret because the results could be driven by any one of the two variables or by both the variables. Given that the effect of exposure (0.24) is substantially stronger than density*exposure (0.15) in the government area, it is likely that the results are primarily driven by exposure.

The results on density should be cautiously interpreted. It is possible that most women in our sample are embedded in dense personal networks but due to the snowball sampling techniques, personal network density has not been adequately captured for some women. In these cases, interaction between personal network density and exposure could provide misleading results. To explore this further, bi-component exposure is analysed. Accounting for indirect ties supports the view that normative influences are important in the government area. The effect of bi-component exposure is significant and positive in the government area but again not as important as personal network exposure.

The effect of group level exposure is significant but modest in the ICDDR,B area. Deleting the health workers shows that bi-component exposure is not significant in the ICDDR,B area. It is likely that health workers are instrumental in connecting groups of users and hence the bi-component exposure is significantly correlated with use when the health workers are included in the network. Nevertheless, the results again show that personal ties are important influences on contraceptive adoption in the ICDDR,B area if the health workers are excluded, although the effects are weaker than in the government area.

To analyse the network effects on method, all non-users were deleted. The results are presented in Table 6.4. Exposure values here represent the proportion of network members using a particular method.

Table 6.4: Pearson Correlation between the types of method adopted and network measures

Government Area			
	Whether the respondent is using the method		
	Pill	Inj	Other
Degree	-0.13	0.21*	-0.05
Density	0.17*	-0.05	-0.16
Personal network exposure	0.40***	0.69***	0.40***
Density*exposure	0.36***	0.66***	0.27**
Bi-comp exposure	0.40***	0.72***	0.13
ICDDR,B Area			
	Whether the respondent is using the method		
	Pill	Inj	Other
Degree	0.02	0.02	-0.06
Density	-0.04	0.01	0.04
Personal network exposure	0.23**	0.26**	0.09
Density*exposure	0.12	0.16*	0.09
Bi-comp exposure	0.17*	0.29***	0.02
ICDDR,B Area (No health Worker)			
	Whether the respondent is using the method		
	Pill	Inj	Other
Degree	-0.11	0.13	-0.04
Density	-0.09	0.09	-0.01
Personal network exposure	0.20*	0.28***	0.09
Density*exposure	0.04	0.23**	0.10
Bi-comp exposure	0.10	0.28***	0.07

*significant at p<0.05; **significant at p<0.01; ***significant at p<0.001

The results again confirm that network effects are stronger in the government area. In the government area, the variables personal network exposure and bi-component exposure are found to be strongly related to the adoption of injectables. Although these effects are weaker in the ICDDR,B area, they are significant. In both areas, the effect of exposure on injectables is stronger at the group level than at the level of personal network. This is probably due to the fact that in both areas women have to travel outside the *bari* in order to receive this medication and are thus likely to need greater network support in order to use this method.[116] After deleting the health worker, personal network

[116] Although all methods provided by ICDDR,B are distributed from fixed clinics, pills and condoms can be potentially bought by men from pharmacies if women's mobility is an issue.

exposure and group level exposure are found to be equally important to injectable use in the ICDDR,B area. Injectables are also found to be positively correlated with degree centrality, but only in the government area. Women with higher degree centrality are likely to be better informed and possibly more autonomous in their decision-making, making them likely to use this method, even without the support of network partners. The interaction between density and exposure is also significant in both the government and ICDDR,B area. Although density*exposure (0.66) has a smaller effect than exposure (0.69), the magnitude of the effect is not substantially weakened by including density. This, together with bi-component exposure, suggests that normative influences are important in method selection.

Network exposure is also found to be important for the pill and again, the network effects are more important in the government area. In the government area, both personal and group level exposures are equally important in explaining pill use. Both these variables also have the strongest effect on pill use; furthermore the effect of density is positive and significant in the government area. Since the pill is one of the oldest and the most popular method of contraception in the government area, dense networks are likely to encourage its use. The interaction of density*exposure confirms this, having a positive and significant effect on pill use. On the other hand, in the ICDDR,B area pill use is significantly correlated only with personal network exposure, with or without the health worker and bi-component exposure if the health worker is included. Moreover, these effects are weaker than in the government area.

Other methods, which mostly include condoms and tubectomy are only strongly correlated with personal network exposure in the government area. Density has a negative effect on other methods and was also found to be significant at 10% levels. Since 'other' methods are the least popular in

both areas, high density networks are likely to be less conducive to acquiring information about these methods as opposed to sparse networks. The interaction of density and exposure substantially weakens the network effects on the selection of other methods; the correlation coefficient for exposure and 'other methods' is 0.4 ($p<0.001$) whereas 'density*exposure' it is 0.27 ($p<0.01$). The substantial drop in the correlation coefficients suggests that the adoption of other methods is primarily driven by exposure. None of the network variables are found to be significant determinants of the use of other methods in the ICDDR,B area. It is likely that the health workers are the main motivators in the adoption of other methods in the ICDDR,B area and thus the network effects are not important.

The results in this section suggest that in the absence of health workers, women turn to their social networks for family planning advice. These networks have a positive but limited role in the adoption of family planning in a population which is well-informed about birth control techniques. The social context of purdah which discourages women's mobility and preference for sons suggests that lower CPRs in the government area are most likely caused by lack of support from official sources, fears of side-effects and anxieties over meeting the desired fertility rate rather than a lack of social capital. Side-effects were identified as a common concern during the course of the survey and women in the government area were more likely to drop the use of modern methods altogether if they experienced persistent side effects than those in the ICDDR,B area. Ten percent of respondents were not using any modern method due to health reasons and side effects in the government area. The presence of an effective family planning program, however, alters this situation by providing women with more information and the possibility of social influence through health workers. Only 5% of respondents in the ICDDR,B area were not using any method due to side effects or for other health reasons. The social obligation imposed on women to have children in order to achieve social value among their

husband's family suggests that women in both the ICDDR,B and government areas are likely to be anxious about meeting the desired fertility rate. However, the absence of regular counselling and motivation by the health workers in the government area is likely to increase women's anxieties over meeting the desired fertility to a greater extent than is likely in the ICDDR,B area. The role of 'fertility' is investigated in the next section using regression techniques.

Unlike contraceptive adoption, analysis on method mix suggests that women's choice of contraceptive method is strongly related to the network partners' choices, especially in the government area. However these network effects are weak in the ICDDR,B area. The results are not surprising given that these networks are formed between kin in isolated *baris* (Chapter 5). This implies that normative pressures are likely to be strong in these networks but information flow will be limited; in the absence of a strong family planning program, women are likely to be influenced into adopting the methods that are most popular in their kinship networks.

It is unlikely that social learning rather than social influence is the most important feature of networks, even though contraceptive decisions are mainly correlated with personal network exposure in both the areas, for several reasons. Firstly, most women were found to be well-informed about method mix (Table 6.1). Despite this knowledge women, especially in the government area, remained reluctant to use methods that were not adopted by their network partners, even when they experienced side effects, which were often reported as a cause of concern during the course of the survey in both the user and non-user group. Secondly, there is no reason to believe that personal network exposure is only capturing social learning. Personal contacts can also exercise social influence by encouraging the status quo. Thirdly, interaction between network exposure and density

are nearly as strong as personal network exposure in the case of injectables and pills,[117] suggesting that social influence is important in the selection of these methods. Density substantially weakens the network effects in the government area only in the case of 'other methods' and also has a negative effect on contraceptive use. This suggests that women in sparse networks, which are more conducive to acquisition of information from diverse sources and subject to fewer normative pressures, are more likely to adopt 'other methods'. Nevertheless, personal network exposure is also of paramount importance in the adoption of 'other methods' in the government area. Lastly, the group level measures also show that the adoption of pills and injectables is correlated across members in the same group, and that these effects are again especially strong in the government area. The networks thus encourage behavioural conformity in groups, which suggests that networks operate through social influence rather than social learning. These results show that networks are not 'capital' since they constrain women's choices rather than empower women to make independent decisions.

It may be argued that the differences in the CPR and network effects in the two areas are simply due to socio-economic conditions facing women in different villages and *baris*. In order to minimise these factors all villages were selected such that the health facility, pharmacy and market were in the close vicinity of each village. Moreover, all contraceptive methods are provided free of cost throughout Bangladesh which minimises the role of economic constraints. To further control for socio-economic factors, the next section analyses network effects using multivariate analyses. The model does not include network exposure as an independent variable because of the interdependence of observations, which is likely to bias the error terms (Valente 2005), but structural measures of density and degree are tested.

[117] Except in the ICDDR,B area where interaction between density and exposure is insignificant in the case of pills.

Multivariate Analysis

This section employs logit models to test the effect of network variables and socio-economic characteristics on 'whether or not the respondent or her husband uses family planning' followed by 'the type of method used'. Personal characteristics of the respondents are captured using age, education and work status. It is expected that women who are working will have greater autonomy as well as a higher opportunity cost of bearing children. Women's status is captured using variables 'whether or not the respondent has any cash saving', 'whether or not she owns any livestock' and 'whether or not any money she saved was forcefully taken by her husband'.[118] Women who own economic assets are expected to have more independence in decision-making, whereas women who have been forced into giving up their savings are expected to have a lower say in the household or lower status. Since educated women are likely to be married to educated men, the husband's education is included as an additional control (Kabeer 2001).

Household economic status is captured using variables that indicate possession of goods such as T.V and radio, household wall type and remittances from overseas. Due to the strong son preference noted in the literature, 'whether or not the respondent has a living son' is included as an explanatory variable, and the number of daughters is also included in the model. After controlling for a son, an increasing number of daughters are likely to have a positive effect on contraceptive use as daughters are generally considered an economic burden (Kabeer 2001). Network effects are modelled using the variables of density and degree. Lastly, dummies are included for each cluster to account for locational effects. Each cluster includes one or more villages based on the sampling technique discussed in Chapter 3. In some cases, clusters also include respondents from neighbouring villages;

[118] Information on these variables is only available for women who are involved in making contraceptive decisions for themselves. For this reason these variables could not be included in the homophily analysis undertaken in Chapter 5.

this is because the snowball technique led to respondents residing outside the sampled clusters. Including a dummy for each of the neighbouring villages is not deemed appropriate because only a handful of respondents are identified in this category. Religion has also not been included in the regression because of the lack of variation in this variable (more that 95% of the respondents are Muslim). Since health workers are source of supply of contraceptives, available information on meetings with the health worker is not included in the model. For example, the survey collected information on 'met with health worker in the last three months', but respondents could have met with a health worker to obtain supplies and hence this variable is potentially endogenous in the model.[119]

Table 6.5 reports the result of logistic regression on the decision to use family planning. The results are reported separately for the government and ICDDR,B areas. The results show the coefficient estimates as well as the marginal effects, which are calculated at sample means.[120] For dummy variables, marginal effects show the change in predicted probabilities for a discrete change in the dummy variables from 0 to 1, holding everything else constant.

[119] This variable also suffers from measurement errors as discussed in Chapter 3.

[120] Marginal effect for the kth independent variable is calculated as following (Powers and Xie 2000):

$$\frac{\partial P(y_i = 1 \mid x_i)}{\partial x_{ik}}$$

where X represent a matrix of k explanatory variables. The values of X for ith observation is denoted as a vector: $x_i = (x_{i0}, x_{i1}, ..., x_{ik})'$. Odds-ratio for the logistic regressions presented in Table 6.5 is attached in the appendix 6.

Table 6.5: Logistic regression on contraceptive use

	Gov Area (Model 1)		ICDDR,B Area (Model 2)		ICDDR,B Area (Model 3. No health worker)	
	Coef. estimates	Marginal effects	Coef. estimates	Marginal effects	Coef. estimates	Marginal effects
Age (years)	-0.0368	-0.00851	0.0170	0.00277	0.0200	0.00322
Education (years)	-0.0626	-0.0145	-0.0330	-0.00536	-0.0324	-0.00522
Total number of female child. alive	0.464**	0.107**	0.229	0.0372	0.189	0.0305
At least one male child alive (d)	1.353**	0.325**	0.215	0.0362	0.104	0.0169
Husband's Education (years)	0.0170	0.00392	0.000799	0.000130	-0.00219	-0.000352
Currently Employed (d)	0.130	0.0295	-0.205	-0.0351	-0.152	-0.0254
Owns productive assets (d)	-1.306**	-0.314**	-0.152	-0.0248	-0.0849	-0.0137
Has cash savings (d)	-0.259	-0.0604	-0.372	-0.0626	-0.341	-0.0567
Husband has taken savings against wishes (d)	1.903*	0.309***	-0.482	-0.0880	-0.445	-0.0797
Cluster B (d)			-0.188	-0.0304	-0.298	-0.0476
Cluster E (d)	-0.337	-0.0794				
Cluster F (d)	-0.168	-0.0392				
Degree Centrality	0.275**	0.0637**	0.102	0.0166	0.0862	0.0139
Density	0.678	0.157	0.845	0.137	1.156*	0.186*
Own T.V or Radio (d)	1.062**	0.243**	0.484	0.0772	0.528	0.0829
Received money from overseas in the last 12 months (d)	-0.984*	-0.236*	-0.452	-0.0797	-0.368	-0.0632
Main wall type is cement or tin (d)	0.452	0.107	-0.111	-0.0177	-0.0592	-0.00942
Have a direct connection to the health worker (d)					0.758	0.117
N	226	226	206	206	204	204
pseudo R^2	0.193	0.193	0.061	0.061	0.080	0.080
LR chi2	58.57	58.57	13.27	13.27	17.37	17.37
Prob > chi2	0.0000	0.0000	0.5813	0.5813	0.3621	0.3621

Marginal effects; (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The estimates for the government area show that age, education, husband's education, density, and locational effects are not significant predictors of contraceptive use. Degree centrality has a positive and significant effect on the decision to use family planning. The magnitude of this effect is small,

with increases in probability of adoption by 0.064 for a one unit change in degree near the mean of degree at 4.15. On the other hand, whether the respondent has a living son increases the probability of contraceptive use by 0.325. This variable is also significant at the 1% level and is the most important predictor of contraceptive use in the model.[121] Number of daughters along with possession of T.V or radio has a significant and positive effect on contraceptive use.

The variable 'household wall type' is not found to be significant but women residing in households that receive remittances from overseas are less likely to be contraceptive users. The households that received remittances were observed to be more conservative during the field work, which is probably why this variable has a negative effect on the adoption of family planning.[122] More puzzling, however, is the finding that women who own livestock are less likely to use contraceptives whereas women who experienced forceful appropriation of their savings by their husband are more likely to use family planning. Women's work status has an insignificant effect on the likelihood of adoption. A possible explanation for these findings could be that these variables are capturing the economic status of the household rather than women's status. It has been previously noted in the literature that generally women from poorer households tend to be involved in income-generating activities (Kabeer 2001). Poorer women also tend not to adopt family planning. The logit models were also estimated with the husband's occupation to further control for economic status (results not reported), but this made little difference to the findings.

[121] Even if personal network exposure, which was found to be most strongly associated with contraceptive adoption in the bivariate analysis in the government area, is included in model one, the variable 'at least one male child alive' is still the most important predictor of family planning.

[122] All the women who were not using contraceptives because their husband was not residing with them were excluded from the analysis.

The results for the ICDDR,B area are reported in Model 2 of Table 6.5. Not a single explanatory variable is found to have a significant effect on contraceptive use in the ICDDR,B area. Moreover, the likelihood-ratio test shows that the model is not significant. The model was re-estimated after deleting the health worker, with a dummy indicating a direct connection to the health worker.[123] The results are reported in Model 3 in Table 6.5. Model 3 shows an improvement in model fit compared to Model 2, although the likelihood ratio test indicate this model is not significant. The new variable that emerges as significant is density, which has a positive effect on the probability of adopting family planning. In particular, for the average household, a one percentage point increase in density, increases the probability of adoption by 0.186 ($p<0.05$). A direct connection to the health worker increases the probability of adoption, but this variable is only significant at the 10% levels.[124] From this finding and the previous bivariate analysis, it appears that contraceptive use in the ICDDR,B area is hardly influenced by socio-economic or network characteristics, apart from density. In the government area, by contrast, both network characteristics and socio-economic variables play an important role, but the network effects are not as important as variables such 'having a son' in the government area.[125]

Examining the factors behind method selection presents a slightly different picture. The choice of methods is modelled after deleting everyone who is not using a method. The logistic regressions are run separately for pill, injectable and other users. The category 'other users' is mainly composed of women who rely on condoms and tubectomy for contraception. The results in Table 6.6 show the

[123] In Model 2, degree centrality includes ties to the health worker. However in Model 3, degree centrality is calculated after deleting the health worker. Adjacency to the health worker in the third model is, however, captured by using a dummy variable.
[124] Everyone in the ICDDR,B area is found to be connected to the health worker, either directly or through several steps.
[125] Also as noted earlier, density can possibly provide misleading results. Omitting density from the analysis does not change the basic findings.

regression results for the government area. As evidenced in the results presented, most of the socio-economic characteristics are not important determinants of method selection in the government area. Coefficients for age, work status, women's status, and fertility and household characteristics are all insignificant.

Table 6.6: Logistic regression on type of method adopted in the government area

	Model 4		Model 5		Model 6	
	Coef. estimates ego_pill	Marginal effects ego_pill	Coef. estimates ego_inj	Marginal effects ego_inj	Coef. estimates ego_other	Marginal effects ego_other
Age (years)	-0.0312	-0.00733	-0.0211	-0.00167	0.0718	0.00940
Education (years)	0.170	0.0401	-0.306*	-0.0242*	0.0107	0.00141
Total number of female child. alive	-0.120	-0.0281	0.196	0.0155	-0.0523	-0.00685
At least one male child alive (d)	-0.0447	-0.0105	-0.524	-0.0493	0.445	0.0516
Husband's Education (years)	-0.0503	-0.0118	0.146	0.0116	-0.0467	-0.00612
Currently Employed (d)	0.789	0.165	-1.757	-0.0784	0.0821	0.0110
Owns productive assets (d)	-0.00207	-0.000487	0.239	0.0204	-0.150	-0.0189
Has cash savings (d)	0.565	0.129	-0.569	-0.0421	-0.346	-0.0437
Husband has taken savings against wishes (d)	-1.074	-0.262	0.983	0.107	0.880	0.144
Cluster E (d)	-1.061*	-0.256*	3.469***	0.529***	-1.322	-0.139*
Cluster F (d)	-1.256*	-0.300*	3.481***	0.493***	-0.462	-0.0567
Degree Centrality	-0.0880	-0.0207	0.360*	0.0286*	-0.126	-0.0165
Density	1.241	0.292	-0.0271	-0.00215	-1.462	-0.191*
Own T.V or Radio (d)	0.0582	0.0137	-0.0140	-0.00111	0.0740	0.00965
Received money from overseas in the last 12 months (d)	0.716	0.157	-0.611	-0.0417	-0.582	-0.0673
Main wall type is cement or tin (d)	0.869	0.211	-0.827	-0.0800	-0.458	-0.0655
N	136	136	136	136	136	136
pseudo R^2	0.175	0.175	0.363	0.363	0.141	0.141
LR chi2	32.14	32.14	50.22	50.22	19.13	19.13
Prob > chi2	0.0096	0.0096	0.0000	0.0000	0.2620	0.2620

Marginal effects; (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Education is significant in explaining injectable use and has a negative impact. Education reduces the probability of using injectables by -0.0242 for an additional year of schooling from the mean of education of 3.6 years. Apart from this, education does not have a significant effect on method selection. However, locational effects are found to be extremely important in method selection. Respondents in Cluster E and Cluster F are more likely to use injectables but less likely to use the pill than Cluster D. Women in Cluster E are also less likely to use other methods. The model for other methods is, however, not significant as shown by the likelihood ratio test statistics. Amongst the network measures, degree has a significant and positive effect on injectable use but the marginal effect is small in magnitude, indicating this effect is only 0.0286 ($p<0.05$). Findings for density, however, differ from degree. Density has a negative effect on the adoption of other methods and the marginal effect is -0.191 ($p<0.05$); but has insignificant effect on pill and injectable use. The result for density and degree also coincide with the earlier finding on network effects undertaken as part of the bivariate analysis.

It could be that our regression results are biased because the sample consists of a pool of types of women: those who are using temporary methods but may not want to cease childbearing completely, and those who are using permanent methods like tubectomy and therefore clearly want to eliminate all possibility of having another child. To control for this, the women who were using permanent methods were deleted from the sample and pill and injectable use was re-modelled. This did not change the core conclusion. It was not possible to model 'other methods' after deleting the tubectomy users because the number of remaining women in this category was insufficient to provide meaningful results.

Like the government area, most of the demographic and socio-economic characteristics do not have a significant impact on method selection in the ICDDR,B area, as is evident from the results reported in Table 6.7. Not even a single explanatory variable is found to be significant in explaining pill use in the ICDDR,B area. Strangely, 'having at least one male child' has a negative effect on the use of other methods. It could be that women who have had at least one son are less likely to use a permanent method due to desire for more children or condoms due to ambivalence about their dependability.[126] None of the other variables were found to be significant in the ICDDR,B area and the model fits were poor for each of the methods. All the women who were relying on permanent methods of contraception were deleted and pill and injectable use was re-modelled. This made little difference to the results.

[126] The marginal effect of 'having at least one male child', evaluated at means is not significant for the reference household.

Table 6.7: Logistic regression on type of method adopted in the ICDDR,B area

	Model 7		Model 8		Model 9	
	Coef. estimates ego_pill	Marginal effects ego_pill	Coef. estimates ego_inj	Marginal effects ego_inj	Coef. estimates ego_other	Marginal effects ego_other
Age (years)	-0.0274	-0.00572	-0.0153	-0.00383	0.0678	0.00919
Education (years)	0.000547	0.000114	0.0696	0.0174	-0.0935	-0.0127
Total number of female child. alive	0.0355	0.00739	0.240	0.0599	-0.468	-0.0635
At least one male child alive (d)	-0.140	-0.0298	0.980	0.235*	-1.395*	-0.243
Husband's Education (years)	0.0474	0.00989	-0.0884	-0.0221	0.0657	0.00891
Currently Employed (d)	0.421	0.0937	-0.566	-0.138	0.216	0.0312
Currently Employed (d)	-0.177	-0.0361	-0.500	-0.123	0.921	0.151
Owns productive assets (d)	0.163	0.0344	-0.257	-0.0642	0.0710	0.00970
Has cash savings (d)	0.180	0.0388	-0.855	-0.203	0.781	0.132
Cluster B (d)	-0.0134	-0.00279	-0.338	-0.0843	0.472	0.0632
Density	0.0761	0.0159	-0.267	-0.0668	0.322	0.0436
Degree centrality	-0.0118	-0.00247	0.0447	0.0112	-0.104	-0.0142
Own T.V or Radio (d)	0.656	0.138	-0.628	-0.156	0.0601	0.00815
Received money from overseas in the last 12 months (d)	0.223	0.0479	-0.268	-0.0666	0.0284	0.00387
Main wall type is cement or tin (d)	-0.394	-0.0858	-0.190	-0.0474	0.782	0.0908
N	160	160	160	160	160	160
pseudo R^2	0.044	0.044	0.074	0.074	0.108	0.108
LR chi2	8.685	8.685	16.40	16.40	16.91	16.91
Prob > chi2	0.8934	0.8934	0.3563	0.3563	0.3241	0.3241

Marginal effects; *t* statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To probe further the role of networks in contraceptive method choice in the ICDDR,B area, the health workers were excluded and the parameters were re-estimated. The results obtained are reported in Table 6.8. The estimates provide an equally poor fit, but degree centrality is found to have a significant effect on injectable use.

Table 6.8: Logistic regression on type of method adopted in the ICDDR,B area (no health worker)

	Model 10		Model 11		Model 12	
	Coef. estimates ego_pill	Marginal effects ego_pill	Coef. estimates ego_inj	Marginal effects ego_inj	Coef. estimates ego_other	Marginal effects ego_other
Age (years)	-0.0156	-0.00320	-0.0329	-0.00823	0.0705	0.00981
Education (years)	0.00111	0.000228	0.0712	0.0178	-0.0916	-0.0127
Total number of female child. alive	0.0291	0.00597	0.274	0.0686	-0.478	-0.0665
At least one male child alive (d)	-0.0828	-0.0172	0.962	0.231	-1.417*	-0.254
hus_educ	0.0413	0.00849	-0.0851	-0.0213	0.0651	0.00907
Husband's Education (years)	0.0822	0.0172	-0.365	-0.0903	0.286	0.0432
Currently Employed (d)	-0.177	-0.0354	-0.445	-0.110	0.876	0.146
Currently Employed (d)	0.0955	0.0198	-0.227	-0.0565	0.102	0.0144
Owns productive assets (d)	0.0399	0.00826	-0.632	-0.154	0.726	0.123
Cluster B (d)	0.238	0.0487	-0.592	-0.147	0.483	0.0665
Degree centrality	-0.212	-0.0435	0.253*	0.0632*	-0.0927	-0.0129
Density	-0.360	-0.0740	0.410	0.102	0.104	0.0145
Own T.V or Radio (d)	0.677	0.141	-0.661	-0.164	0.0443	0.00618
Received money from overseas in the last 12 months (d)	0.152	0.0320	-0.187	-0.0468	0.0134	0.00188
Main wall type is cement or tin (d)	-0.419	-0.0902	-0.155	-0.0388	0.760	0.0913
Have a direct connection to the health worker (d)	-0.650	-0.131	0.612	0.152	-0.118	-0.0164
N	158	158	158	158	158	158
pseudo R^2	0.063	0.063	0.102	0.102	0.104	0.104
LR chi2	12.26	12.26	22.37	22.37	16.26	16.26
Prob > chi2	0.7259	0.7259	0.1318	0.1318	0.4352	0.4352

Marginal effects; (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In summary, socio-economic and demographic characteristics are found to have only a marginal effect on method selection in both the government and the ICDDR,B area, but they are found to be important in explaining family planning adoption in the government area.

Conclusion

This chapter has aimed to demonstrate the effect of networks on the contraceptive choices of women in Matlab. As demonstrated in Chapter 4, women have plenty of 'solidarity' networks or 'bonding social capital' in both the 'treatment' and 'non-treatment' areas. According to the social capital literature, the holders of this 'bonding capital' can employ it to achieve positive outcomes (Putnam 2000); since dense networks are essential to gaining social support (Putnam 2000). However, we have argued in Chapter 4 that these 'solidarity' networks are also likely to constrain women, while providing them with informational benefits. Furthermore, Chapter 5 argues that in the face of existing inequalities, networks are likely to reinforce norms of subordination rather than challenge existing inequalities. Any benefits deriving from networks are thus going to be limited for women.

To provide an empirical basis to the argument, network effects are tested on behaviour in this chapter. The network measures employed in this chapter are again adopted from social network analysis. The complexity of women's social world is captured using measures of degree, density, personal and group level exposure. Although this study bases the interpretation of these variables on the diffusion theory and social network analysis, the measures of density and subgroup can be interpreted as 'bonding social capital'.

The analysis shows that, consistent with social capital theory, networks have a positive effect on family planning adoption in both the 'treatment' and 'non-treatment' areas, as shown by the bi-variate analysis. Amongst all measures used in this research, personal network exposure is found to be the most important in the government area and density in the ICDDR,B area. But these effects

are modest, especially in the ICDDR,B area. This, thus, shows that social capital in itself cannot improve outcomes for women since network measures are weakly correlated with contraceptive adoption. The most probable explanation of higher contraceptive use in the ICDDR,B area than government area is the continual support of health workers and possibly superior services in access to contraceptive methods[127]; however in both areas the methods are supplied free of costs.

To further explore the possible causes of lower contraceptive use in the government area, regression techniques are employed. Some selected network indicators along with standard socio-economic and demographic variables are tested. The results again confirm that network effects are positive but limited in the government area. More important in the 'government area' are fertility and economic characteristics; thus, despite high levels of social capital, women continue to be concerned about meeting the desired fertility rate. It is likely that the networks further reinforce the prevalent norms of son preference; however this hypothesis could not be tested due to inadequacy of the data. In the ICDDR,B area the personal characteristics are not found to be strong predictors of contraceptive use, but network measure of density is found to be significant. The insignificance of socio-economic and demographic characteristics is not meant to imply that women in the ICDDR,B are emancipated from the cultural expectations in the region. But the findings do suggest that women in the ICDDR,B area are more willing to use modern methods to manage their fertility goals and are less affected by social and economic constraints.

[127] Even though the regression analysis shows that a direct connection to health worker is only marginally significant, this does not rule out the importance of the health workers in the ICDDR,B area. The analysis undertaken in Chapter 4 demonstrates that everyone in the ICDDR,B area is connected to the health worker either directly or indirectly. Also the health workers regularly visit women in their *baris* in the treatment area. As a result, most women in the ICDDR,B come into contact with the health workers.

Unlike the results on the adoption of family planning, the bivariate results show that women's choice of contraceptive method is strongly related to the network partners' choices, especially in the government area. Correlation of the 'type of method adopted' and personal network exposure confirms this for all methods in the government area. Significant association is found between exposure and pill and injectable use in the ICDDR,B area; but the size of the estimates is modest. In the government area group level exposure is also highly important for pill and injectable use coupled with interaction of personal network exposure and density. Although these effects are weaker in the ICDDR,B area, they are significant particularly for injectables. The results on density and group level exposure suggest that the networks effects operate through social influence rather than social learning. If social learning was an important motivator the interaction between density*exposure would not have been important in method selection and exposure would be the only significant variable. The significance of group level measures also suggests that social influences are transmitted from both direct and short indirect connections. Thus, the results suggest that the networks encourage behavioural conformity in method selection, especially if the health workers are absent from the network. Yet again, the group level and density effects can be interpreted as 'bonding social capital'. These results, therefore, suggest that social capital induces women to stick to the popular choices in the group rather than seek information on methods that are most suitable to their needs.

It may be argued that the results of network effects on contraceptive method choice are spurious because of homophily. Women are likely to select network partners that are similar to themselves, who are also likely to select similar methods of contraception. However, the regression analysis provides hardly any basis for making this argument because the personal attributes of the respondents are not an important predictor of contraceptive method choice.

The results presented in this chapter confirm the implications on behaviour derived from the earlier analysis of networks structure in Chapters 4 and 5. In the absence of support from health workers, women are likely to turn to their network partners. However the network effects are limited and are unable to compensate for an effective family planning program. Moreover, networks are unlikely to be a resource for change but are likely to be constraining by encouraging conformist choices. Lastly, this analysis demonstrates that providing women with institutional support can induce decision making that is less dependent on the group behaviour and possibly in women's own best interest.

Appendix 6

Logistic regression on contraceptive use (Odd-ratio Table 6.5)

	Gov Area (Model 1)	ICDDR,B Area (Model 2)	ICDDR,B Area (Model 3) No health worker
	Odds Ratio	Odds Ratio	Odds Ratio
Age (years)	0.964	1.017	1.02
Education (years)	0.939	0.968	0.968
Total number of female child. alive	1.591**	1.257	1.209
At least one male child alive (d)	3.869**	1.24	1.109
Husband's Education (years)	1.017	1.001	0.998
Currently Employed (d)	1.139	0.815	0.859
Owns productive assets	0.271**	0.859	0.919
Has cash savings (d)	0.772	0.689	0.711
Husband has taken savings against wishes (d)	6.703*	0.617	0.641
Cluster B (d)		0.829	0.742
Cluster E (d)	0.714		
Cluster F (d)	0.845		
Degree Centrality	1.317**	1.108	1.09
Density	1.969	2.329	3.176*
Own T.V or Radio (d)	2.892**	1.623	1.695
Received money from overseas in the last 12 months (d)	0.374*	0.636	0.692
Main wall type is cement or tin (d)	1.572	0.895	0.943
Have a direct connection to the health worker (d)			2.135
N	226	206	204
pseudo R^2	0.193	0.061	0.08
LR chi2	58.57	13.27	17.37
Prob > chi2	0.0000	0.5813	0.3621

Exponentiated coefficients; *t* statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7. Conclusion

Social capital takes a positive view of social relationships and associates networks with solidarity, norms of reciprocity, trust and civic virtues (Putnam, Leonardi and Nanetti 1993; Putnam 2000). The very use of the term 'capital' in social capital implies that the concept is associated with enhancing productivity. In view of its most prominent contemporary theorist, Robert D. Putnam, networks can be employed to achieve mutually beneficial outcomes for interacting parties as well as generate positive externalities (Putnam, Leonardi and Nanetti 1993; Putnam 2000). The benefits of social capital networks can be unlimited. Networks can enhance productivity by providing information, social insurance, and social support; by inculcating norms of generalised reciprocity; by generating social trust and reducing the possibilities of free riding and so forth (Putnam, Leonardi and Nanetti 1993; Putnam 2000; Coleman 1988). Furthermore there is a built in assumption that social capital investment opportunities are available to all and can be freely employed to derive returns (Arniel 2006).

This thesis has argued that social capital evades issues of power, race, gender, exclusion, peer pressures in networks to reach a plain view of the social world, where networks are associated with positive outcomes. In light of such criticisms made previously in the literature (Cleaver 2005; Molyneux 2002; Fine 2001; Fine 2003; Silvey and Elmhirst 2003; Mayoux 2001), the view of social capital has been slightly modified by Putnam by incorporating bonding and bridging social capital; however, it is not clear under what circumstances individuals or societies come into possessing or dispossessing these different types of 'capital' and the distribution of these 'capital' generating networks is still a mystery. Nor has the social capital literature addressed the 'downside' (Portes 1998) of social networks and the perception of social networks as 'capital' remains unaltered.

This thesis has argued that the uncomplicated perception of networks adopted by most social capital scholars is not only dissatisfying from a theoretical standpoint but runs the risk of exacerbating social inequalities. By incorporating gender into the analysis we have shown that networks are embedded in structural inequalities. The comparison of men's and women's family planning networks in the Matlab region of Bangladesh reveals the gendered pattern of ties. Women are embedded in dense networks that are likely to provide information and possibly social support but at the same time subject actors to social pressures. Men, on the other hand, are embedded in sparse networks which are likely to provide them with resources without facing similar structural constraints as women. Thus, for women, networks are both a resource and a constraint. Our analysis has also shown that positional advantage is unequally distributed in networks and issues of power within the 'social capital' providing networks cannot be dismissed. Who gets what is dependent not only on gender but also on actor's structural positions in these networks. The GIS analysis further reveals that the alleged bonding social capital of women is formed within the norms of seclusion. This implies that networks are likely to reinforce rather than challenge structural inequalities.

The gendered patterns of ties have been found to be impervious to change even in the face of a long standing health intervention undertaken by ICDDR,B, which has introduced the region to many outside influences. The presence of ICDDR,B has brought in additional employment, better roads and transport facilities. Employment of health workers has introduced the communities to female mobility in the public sphere. Despite these changes and regular contact with health workers in the intervention area, the patterns of ties have been found to be similar across all of the sampled clusters. It may be that the networks in other rural areas of Bangladesh are even more unequal and this research has underestimated the structural inequalities in networks. Nevertheless, the structural

analysis implies that women derive little opportunity and face stronger normative pressures in networks compared to men.

Our test of networks effects on contraceptive use has shown that in a context such as Matlab, where information on contraception has widely diffused, networks have a minimal role to play in family planning adoption. The comparison between the intervention and non-intervention area imply that continual support by health workers and possibly easy access to services is the key to contraceptive use by women in the Matlab region. Women's solidarity networks are unable to compensate for the institutional support provided by health workers. Networks are, however, instrumental in method selection, particularly in the non-intervention area. The analysis of contraceptive method choice in the non-intervention area has shown that women's choice of contraceptive method is strongly correlated with network partners' choices; but, such associations are much weaker in the intervention area. The results, thus, suggest that in the absence of a strong family planning program women are likely to imitate choices of their network partners. The results propose a degree of behavioural conformity in networks since it is highly unlikely that the method chosen by the network partner is appropriate for each individual's needs.

Based on these findings this thesis challenges the assumption that social capital will be empowering for women in developing countries and cautions that a gender blind view of social capital is likely to contribute to already existing inequalities. The analysis undertaken in this research also shows that women are unlikely to be exposed to new information in the absence of contact with health workers. Due to the rising costs of field visits, efforts are being made to scale back on field activities. Such efforts are likely to result in a drop in contraceptive use; however, engaging the men in family planning issues can provide a resource for encouraging further reductions in fertility. This research

shows that men do talk about family planning matters and the diffusion benefits are greater in the male networks than the female networks. Thus, a family planning program that targets men is likely to be more cost-effective than one that is singularly focussed on women. Involving men also frees women of bearing the sole responsibilities of fertility regulation in a situation where they have little opportunity and power. Male involvement is not only going to be cost-effective but is also likely to contribute to women's well-being. Another possible channel to lower costs of field services is to encourage the uptake of permanent methods of contraception. This research shows that this policy can only gain momentum if women's immediate networks and community attitudes are positive towards permanent methods.

A few omissions remain in this research. The results in this thesis are based on snowball sampling techniques and cannot be generalised to the whole population. Moreover the degree of bias associated with the snowball method is not clear. In examining the limited range of female ties and the similarity of patterns across clusters, this research argues that the methodology adopted in this study is most likely providing an accurate view of the pattern of ties in the region. This aspect will be explored in future research using data from a cluster where the snowball was conducted for a total of four rounds (the data from this particular cluster is yet to be analysed and has not been included in this thesis or published elsewhere). The *round one* respondents will be examined in further detail as they were selected at random and are unlikely to suffer from biases that can be associated with respondents identified in subsequent rounds. Lastly, the analysis in Chapter 6 is suggestive of network effect on contraceptive decisions. These effects cannot be conclusively established unless the network variables are explored in a multivariate framework. This, unfortunately, is only possible using longitudinal data which is beyond the means of this research.

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