# The Social Side of Service Accessibility

**Barbara Entwisle, Amy Weinberg,
Ronald R. Rindfuss, Katherine Faust**

**November 2002**

Carolina Population Center
University of North Carolina
at Chapel Hill
123 W. Franklin Street
Chapel Hill, NC 27516
Phone: 919-966-7482
Fax: 919-966-2391
measure@unc.edu
www.cpc.unc.edu/measure

Collaborating Partners:

Macro International Inc.
11785 Beltsville Drive
Suite 300
Calverton, MD 20705-3119
Phone: 301-572-0200
Fax: 301-572-0999
measure@macroint.com

John Snow Research and Training
Institute
1616 N. Ft. Myer Drive
11th Floor
Arlington, VA 22209
Phone: 703-528-7474
Fax: 703-528-7480
measure_project@jsi.com

Tulane University
1440 Canal Street
Suite 2200
New Orleans, LA 70112
Phone: 504-584-3655
Fax: 504-584-3653
measure2@tulane.edu

Funding Agency:

Center for Population, Health
and Nutrition
U.S. Agency for
International Development
Washington, DC 20523-3600
Phone: 202-712-4959

**WP-03-65**

The research upon which this paper is based was sponsored by the MEASURE *Evaluation* Project with support from the United States Agency for International Development (USAID) under Contract No. HRN-A-00-97-00018-00.



The working paper series is made possible by support from USAID under the terms of Cooperative Agreement HRN-A-00-97-00018-00. The opinions expressed are those of the authors, and do not necessarily reflect the views of USAID.

The working papers in this series are produced by the MEASURE *Evaluation* Project in order to speed the dissemination of information from research studies. Most working papers currently are under review or are awaiting journal publication at a later date. Reprints of published papers are substituted for preliminary versions as they become available. The working papers are distributed as received from the authors. Adjustments are made to a standard format with no further editing.

A listing and copies of working papers published to date may be obtained from the MEASURE *Evaluation* Project at the address listed on the back cover.

## Other MEASURE *Evaluation* Working Papers

**WP-03-64** Comparative Analysis of Program Effort for Family Planning, Maternal Health, and HIV/AIDS, 30 Developing Countries (J.A. Ross)

**WP-03-63** Assessment of a Capture-Recapture Method for Estimating the Size of the Female Sex Worker Population in Bulawayo, Zimbabwe (S.S. Weir, D. Wilson, P.J. Smith, V.J. Schoenbach, J.C. Thomas, P.R. Lamptey, and J.T Boerma)

**WP-02-62** Socioeconomic Status, Permanent Income, and Fertility: A Latent Variable Approach (K.A. Bollen, J.L. Glanville, and G. Stecklov)

**WP-02-61** The Effect of Facility Characteristics on Choice of Family Planning Facility in Rural Tanzania (S. Chen, D. K. Guilkey)

**WP-02-60** Health Program Effects on Individual Use of Services (Amy O. Tsui, Festus Ukwuani, David Guilkey, and Gustavo Angeles)

**WP-02-59** Health Facility Characteristics and the Decision to Seek Care (E. Jensen, J. Stewart)

**WP-02-58** HIV impact on mother and child mortality in rural Tanzania (Japheth Ng'weshemi, Mark Urassa, Raphael Isingo, Gabriel Mwaluko, Ngalula J, J Ties Boerma, Marston M, Basia Zaba)

**WP-02-57** Secretive females or swaggering males? An assessment of the quality of sexual partnership reporting in rural Tanzania (Soori Nnko, J Ties Boerma, Mark Urassa, Gabriel Mwaluko, Basia Zaba)

**WP-02-56** Understanding the Uneven Spread of HIV within Africa: Comparative Study of Biological, Behavioral and Contextual Factors in Rural Populations in Tanzania and Zimbabwe (J Ties Boerma, Constance Nyamukapa, Mark Urassa, Simon Gregson)

**WP-02-55** Assessment of the Roll Back Malaria Monitoring and Evaluation System (Kate Macintyre, Erin Eckert, Amara Robinson)

**WP-02-54** Measuring Family Planning Sustainability at the Outcome and Program Levels (Rob Stephenson, Amy Ong Tsui, Rodney Knight)

**WP-02-53** An Assessment of the Quality of National Child Immunization Coverage Estimates in Population-based Surveys (Jennifer Brown, Roeland Monasch, George Bicego, Anthony Burton, and J. Ties Boerma)

**WP-02-52** Determinants of Contraceptive Method Choice in Rural Tanzania between 1991 and 1999 (Susan Chen and David K. Guilkey)

**WP-02-51** Estimation of levels and trends in age at first sex from surveys using survival analysis (Basia Zaba, Ties Boerma, Elizabeth Pisani, Nahum Baptiste)

**WP-02-50** The Impact of Community Level Variables on Individual Level Outcomes: Theoretical Results and Demographic Applications (Gustavo Angeles, David K. Guilkey, Thomas A. Mroz)

**WP-02-49** The Impact of a Reproductive Health Project Interventions on Contraceptive Use in Uganda (Katende C, Gupta N, Bessinger )

**WP-02-48** Decentralization in Tanzania: the View of District Health Management Teams (Paul Hutchinson)

**WP-02-47** Community effects on the risk of HIV infection in rural Tanzania (Shelah S. Bloom, Mark Urassa, Raphael Isingo, Japheth Ng'weshemi, J. Ties Boerma)

**WP-02-46** The Determinants of Fertility in Rural Peru: Program Effects in the Early Years of the National Family Planning Program (Gustavo Angeles, David K. Guilkey and Thomas A. Mroz)

**WP-02-45** Cost and Efficiency of Reproductive Health Service Provision at the Facility Level in Paraguay (Gustavo Angeles, Ruben Gaete and John F. Stewart)

**WP-02-44** Decentralization, Allocative Efficiency and Health Service Outcomes in the Philippines (J. Brad Schwartz , David K. Guilkey and Rachel Racelis)

**WP-01-43** Changes in Use of Health Services During Indonesia's Economic Crisis (Elizabeth Frankenberg, Bondan Sikoki, Wayan Suriastini, Duncan Thomas)

**WP-01-42** Contraceptive Use in a Changing Service Environment: Evidence from the First Year of Indonesia's Economic Crisis (Elizabeth Frankenberg, Bondan Sikoki, Wayan Suriastini, Duncan Thomas)

**WP-01-41** Access as a Factor in Differential Contraceptive Use between Mayans and Ladinos in Guatemala (Eric Seiber and Jane T. Bertrand)

**WP-01-40** Dimensions of Ratings of Maternal and Neonatal Health Services: A Factor Analysis (Rodolfo A. Bulatao and John A. Ross)

**WP-01-39** Do Health Services Reduce Maternal Mortality? Evidence from Ratings of Maternal Health Programs (Rudolfo A. Bulatao and John A. Ross)

**WP-01-38** Economic Status Proxies in Studies of Fertility in Developing Countries: Does the Measure Matter? (Kenneth A. Bollen, Jennifer L. Glanville, and Guy Stecklov)

**WP-01-37** A Pilot Study of a Rapid Assessment Method to Identify Areas for AIDS Prevention in Cape Town, South Africa (Sharon S. Weir, Chelsea Morroni, Nicol Coetzee, John Spencer, and J. Ties Boerma)

**WP-01-36** Decentralization and Local Government Health Expenditures in the Phillippines (J. Brad Schwartz, Rachel Racelis, and David K. Guilkey)

**WP-01-35** Decentralization and Government Provision of Public Goods: The Public Health Sector in Uganda (John Akin, Paul Hutchinson and Koleman Strumpf)

**WP-01-34** Appropriate Methods for Analyzing the Effect of Method Choice on Contraceptive Discontinuation (Fiona Steele and Siân L. Curtis)

**WP-01-33** A Simple Guide to Using Multilevel Models for the Evaluation of Program Impacts (Gustavo Angeles and Thomas A.Mroz)

**WP-01-32** The Effect of Structural Characteristics on Family Planning Program Performance in Côte d'Ivoire and Nigeria (Dominic Mancini, Guy Stecklov and John F. Stewart)

**WP-01-31** Socio-Demographic Context of the AIDS Epidemic in a Rural Area in Tanzania with a Focus on People's Mobility and Marriage (J. Ties Boerma, Mark Urassa, Soori Nnko, Japheth Ng'weshemi, Raphael Isingo, Basia Zaba, and Gabriel Mwaluko)

**WP-01-30** A Meta-Analysis of the Impact of Family Planning Programs on Fertility Preferences, Contraceptive Method Choice and Fertility (Gustavo Angeles, Jason Dietrich, David Guilkey, Dominic Mancini, Thomas Mroz, Amy Tsui and Feng Yu Zhang)

**WP-01-29** Evaluation of Midwifery Care: A Case Study of Rural Guatemala (Noreen Goldman and Dana A. Glei)

**WP-01-28** Effort Scores for Family Planning Programs: An Alternative Approach (John A. Ross and Katharine Cooper-Arnold)

**WP-00-27** Monitoring Quality of Care in Family Planning Programs: A Comparison of Observation and Client Exit Interviews (Ruth E. Bessinger and Jane T. Bertrand)

**WP-00-26** Rating Maternal and Neonatal Health Programs in Developing Countries (Rodolfo A. Bulatao and John A. Ross)

**WP-00-25** Abortion and Contraceptive Use in Turkey (Pinar Senlet, Jill Mathis, Siân L. Curtis, and Han Raggers)

**WP-00-24** Contraceptive Dynamics among the Mayan Population of Guatemala: 1978-1998 (Jane T. Bertrand, Eric Seiber and Gabriela Escudero)

**WP-00-23** Skewed Method Mix: a Measure of Quality in Family Planning Programs (Jane T. Bertrand, Janet Rice, Tara M. Sullivan & James Shelton)

**WP-00-21** The Impact of Health Facilities on Child Health (Eric R. Jensen and John F. Stewart)

**WP-00-20** Effort Indices for National Family Planning Programs, 1999 Cycle (John Ross and John Stover)

**WP-00-19** Evaluating Malaria Interventions in Africa: A Review and Assessment of Recent Research (Thom Eisele, Kate Macintyre, Erin Eckert, John Beier, and Gerard Killeen)

**WP-00-18** Monitoring the AIDS epidemic using HIV prevalence data among young women attending antenatal clinics: prospects and problems (Basia Zaba, Ties Boerma and Richard White)

**WP-99-17** Framework for the Evaluation of National AIDS Programmes (Ties Boerma, Elizabeth Pisani, Bernhard Schwartländer, Thierry Mertens)

**WP-99-16** National trends in AIDS knowledge and sexual behaviour in Zambia 1996-98 (Charles Banda, Shelah S. Bloom, Gloria Songolo, Samantha Mulendema, Amy E. Cunningham, J. Ties Boerma)

**WP-99-15** The Determinants of Contraceptive Discontinuation in Northern India: A Multilevel Analysis of Calendar Data (Fengyu Zhang, Amy O. Tsui, C. M. Suchindran)

**WP-99-14** Does Contraceptive Discontinuation Matter?: Quality of Care and Fertility Consequences (Ann Blanc, Siân Curtis, Trevor Croft)

**WP-99-13** Socioeconomic Status and Class in Studies of Fertility and Health in Developing Countries (Kenneth A. Bollen, Jennifer L. Glanville, Guy Stecklov)

**WP-99-12** Monitoring and Evaluation Indicators Reported by Cooperating Agencies in the Family Planning Services and Communication, Management and Training Divisions of the USAID Office of Population (Catherine Elkins)

**WP-98-11** Household Health Expenditures in Morocco: Implications for Health Care Reform (David R. Hotchkiss, Zine Eddine el Idriss, Jilali Hazim, and Amparo Gordillo)

**WP-98-10** Report of a Technical Meeting on the Use of Lot Quality Assurance Sampling (LQAS) in Polio Eradication Programs

**WP-98-09** How Well Do Perceptions of Family Planning Service Quality Correspond to Objective Measures? Evidence from Tanzania (Ilene S. Speizer)

**WP-98-08** Family Planning Program Effects on Contraceptive Use in Morocco, 1992-1995 (David R. Hotchkiss)

**WP-98-07** Do Family Planning Service Providers in Tanzania Unnecessarily Restrict Access to Contraceptive Methods? (Ilene S. Speizer)

**WP-98-06** Contraceptive Intentions and Subsequent Use: Family Planning Program Effects in Morocco (Robert J. Magnani)

**WP-98-05** Estimating the Health Impact of Industry Infant Food Marketing Practices in the Philippines (John F. Stewart)

**WP-98-03** Testing Indicators for Use in Monitoring Interventions to Improve Women's Nutritional Status (Linda Adair)

**WP-98-02** Obstacles to Quality of Care in Family Planning and Reproductive Health Services in Tanzania (Lisa Richey)

**WP-98-01** Family Planning, Maternal/Child Health, and Sexually-Transmitted Diseases in Tanzania: Multivariate Results using Data from the 1996 Demographic and Health Survey and Service Availability Survey (Jason Dietrich)

# THE SOCIAL SIDE OF SERVICE ACCESSIBILITY

**Barbara Entwisle**
**Amy Weinberg**
**Ronald R. Rindfuss**
**University of North Carolina at Chapel Hill**

**Katherine Faust**
**University of California-Irvine**

**November, 2002**

**Abstract:**

This methodological project relates both to the conceptualization and measurement of potential program effects. The starting point is the hypothesis that the social side of service accessibility--i.e., social network characteristics that affect access to information and redundancy in the information obtained--is important to an understanding of accessibility and its effects. Our results suggest that this is true. Using a unique survey data set for Nang Rong, Thailand, we formalize social network concepts at the individual and village level, and then examine effects on contraceptive choice--method and source--in the context of models that also take into account physical proximity. To quickly summarize our results: Proximity to family planning outlets affected contraceptive choices, especially source choices. Women living further away from a local health center were less likely to choose a local health center, and women living further away from a hospital were less likely to choose a hospital. Proximity mattered less, however, for women living in households directly linked by sibling ties to other households in the village and to siblings living in other places. Results inform the design and interpretation of evaluation efforts in a variety of settings, and the potential role of social networks in bringing about program effects. While the specific focus is the provision of family planning services, the idea extends to the provision of STD or maternal and child health services as well.

## THE SOCIAL SIDE OF SERVICE ACCESSIBILITY

Family planning accessibility refers to the supply of contraceptive methods and services in a community. Its components include the proximity, variety, cost, and quality of contraceptive services (Hermalin and Entwisle 1987). It may seem obvious that accessibility would have a positive effect on use of services. However, the effects of service proximity vary from one study to the next, and often are quite weak. There are problems of data availability and measurement (Chayovan et al. 1984) as well as disagreements about modeling and estimation (Gertler and Molyneaux 1994; Hermalin 1979; Herandez 1984). Progress is needed because family planning accessibility effects lie at the heart of program assessment.

This methodological project relates both to the conceptualization and measurement of potential program effects. Its starting point is the hypothesis that the social side of service accessibility--i.e., social network characteristics that affect access to information and redundancy in the information obtained--is as important as physical and spatial dimensions. The data needed to formalize and test this hypothesis are rarely available. Most studies of social interaction in relation to fertility are indirect, inferring effects through geographic proximity, shared language, or behavioral conformity (e.g., Coale and Watkins 1986; Leasure 1963; Leastheghe 1977; Montgomery and Casterline 1993; Rosero-Bixby and Casterline 1993; Watkins 1991). Most studies of social interaction in relation to use of family planning services and contraceptive choice are based on observation and qualitative interviews (e.g., Entwisle et al. 1996; Mita and Simmons 1995; Rutenberg and Watkins 1996). We have a unique survey data set for Nang Rong, Thailand that allows us to formalize social network concepts at the individual and village level, and then examine effects on choice of method and source in the context of models that already take into account physical proximity. We assess the extent to which the functioning of social networks affects and possibly conditions the effects of service proximity. Further, even though our investigation is limited to contraceptive choice, both method and source, the application of our methodological approach would straightforwardly extend to the provision of STD services or the provision of maternal and child health services.

### Significance

Social network concepts, measurement, and explanations have long been part of the population field, but have not yet been fully tested. In the 1960s, a number of researchers looking at fertility and its proximate determinants followed a network approach. Lee (1969) used a snowball sampling to examine the search processes used by young women who wanted an abortion at a time when it was illegal in the U.S. Among her findings was how easy it was to find an abortionist when motivated to do so despite the illegality involved. Palmore (1967) examined the flow of information about contraceptives in Chicago. Freedman and Takeshita's (1969) classic family planning experiment in Taiwan involved network components, and in Korea in the 1960s there was a formal data

collection strategy to link social networks and fertility behavior (Rogers and Kincaid 1981).

Despite this activity in the 1960s, the application of social network concepts, data, and techniques to study fertility all but stopped in the 1970s and 1980s. Indeed, only recently has the unique nature of the Korean data caught the attention of analysts with considerably broader research agendas and access to more sophisticated analytical techniques (Chung 1994; Kohler 1997; Valente 1995). During the intervening decades, fertility surveys emphasizing national representation tended to dominate the fertility research area, with such mega projects as the World Fertility Survey (WFS) and the Demographic and Health Surveys (DHS).

Yet, a number of influential examples suggest that social networks are important. The massive study by Coale and his colleagues of the historical fertility decline in Europe pointed to the limited explanatory power of traditional socioeconomic indicators and suggested that social networks influenced fertility decline (Coale and Watkins 1986; Lesthaeghe 1977; Watkins 1989). Recent work on family planning evaluation (e.g., Jato et al. 1995; Kincaid et al. 1993; Mita and Simmons 1995; Valente et al. 1998) and on diffusion processes in fertility declines (e.g., Montgomery and Casterline 1993; Rosero-Bixby and Casterline 1994; Watkins 1991) have made explicit reference to the role of social networks, but this has typically been inferential rather than through the direct measurement and modeling of social network variables. Indeed, in our earlier work in Thailand, we found what we termed the "footprints" of social networks, but direct network measures were not available (Entwisle et al. 1996).

**Study Setting: Nang Rong as a Case**

Nang Rong, our research site, is located in Northeast Thailand. The district is approximately 1,300 sq. kilometers and includes approximately 300 villages. Villages averaged just under 100 households in 1994. Typically they consist of a compact cluster of dwelling units surrounded by agricultural fields. The climate is exceptionally hot. Social life takes place outside in shaded areas, in front of and underneath the dwelling units (which often are raised up on stilts). Interpersonal contact can be assumed. Until recently, Nang Rong was a frontier area--similar in this respect to recently settled areas in Latin America as well as some parts of Southeast Asia. A few villages date back several hundred years to when the district was part of Cambodia, but primary waves of recent settlement occurred at the turn of the century and then again especially after the second world war. Linguistically, the region is diverse, reflecting the origins of the settlers. Villagers may speak Korat Thai (a dialect of the national language), Khmer, Lao, and/or Suai. In contrast to this linguistic diversity, the region is homogeneous religiously (Buddhist).

The district is relatively poor. Most villagers are farmers, growing rice and upland crops such as cassava, sugar cane, kenaf, and corn. Soil quality is generally poor. Most agriculture is rain-fed, dependent on the timing and amount of the annual monsoon. "Walking tractors" (roughly similar to rototillers in the U.S.) are used to prepare the

ground for planting at the beginning of the season, and mechanized mills are used to separate the edible portion of the grain from its husk, but otherwise rice cultivation in Nang Rong involves intensive handwork to plant, transplant, weed, and harvest the crop.

As is true for the country as a whole, Nang Rong is in the final phase of the demographic transition. In 1994, 72 percent of married women of reproductive age (15-49) used modern forms of contraception, up from 54 percent in 1984. Mortality has been low for some time, the decline having preceded data collection in the district. Migration, both permanent moves to Bangkok and other urban areas and temporary movement, is common. Demographically speaking, Nang Rong has little in common with the African settings featured in some of the more innovative projects on social networks and fertility (e.g., Rutenberg and Watkins 1996). It resembles more closely source areas for urban migrants found elsewhere in Asia and Latin America, including source areas in Mexico for international migrants to the U.S. (Massey et al. 1987). From a demographic perspective, then, Nang Rong differs from the settings where The MEASURE Evaluation Project's results are likely to be used. It is still important for the MEASURE Evaluation Project because, to the best of our knowledge, it is the only place where data exist to investigate the effects of social networks in a setting where longitudinal data already exists on a variety of relevant factors including geographical aspects of accessibility. The social side of accessibility should be as important in settings of high fertility and low contraceptive prevalence as in Nang Rong, Thailand.

**Data Sources: The Nang Rong Surveys**

The longitudinal data set used for the analyses began as an evaluation. In 1984, the Population and Community Development Association (PDA) began a Community Based Integrated Rural Development (CBIRD) project in selected villages in Nang Rong district. The CBIRD project was designed to (1) improve skills and productive capacity in agriculture, animal husbandry, and various cottage industries, such as raising silk worms, and (2) upgrade waste disposal facilities, increase year-round availability of drinking water, and promote health practices. PDA arranged for the Institute for Population and Social Research (IPSR) to evaluate the success of the CBIRD project. IPSR designed and conducted a multilevel baseline survey in 1984. First, 51 villages were chosen and community surveys were conducted in these villages. Then a complete household census was conducted in all 51 villages, with the census obtaining information on all household members. Initial interest in these data by IPSR and Carolina Population Center (CPC) collaborators focused on contraceptive use in the context of community change, but it subsequently broadened to include social networks, migration, and the environment. An expanded data collection took place in 1994/95, building on the earlier surveys and also reflecting these new interests.

There are three components to the 1994/95 data collection: a community profile, household survey, and migrant follow-up. The proposed research draws on the first two. The 1994 Community Survey was done in all villages in Nang Rong (310), including but not limited to the original 51. Interviews were conducted between March and June 1994. All villages participated. The 1994 Household Survey was a complete census of all

households in each of the 51 villages in the 1984 survey. It also followed up all individuals and households in the 1984 wave. Data were collected between April and July 1994 from 7,337 households. Information was obtained on 42,219 current and former members of these households. Response rates were excellent. See http://www.cpc.unc.edu/projects/nangrong/nangrong_home.html for additional information on the surveys.

**Methodology**

The question guiding the proposed analyses can be put simply: to what extent does the social side of accessibility, as captured by social network structure and position at the household and village levels, contribute to the explanation of source and method choice? Does it condition the effect of physical accessibility? If social accessibility acts to reinforce physical accessibility, then the effect of physical accessibility would be stronger in a tightly knit village. But it is also possible that access to more distant sources is easier for people with more social ties, meaning that the effect of physical accessibility would be weaker in a tightly knit village. Because formal concepts and measures of social network structure and position are not well known in the population field, we discuss them in detail in the next subsection. Following that, we describe the information available on method and source choice and our approach to modeling their determinants.

**Social Network Data and Measures**

Social networks are used to represent and model relationships (ties or linkages) between social entities (called actors). The actors may be individuals or they may be collective units, such as households or villages. The relationships linking actors can be any social interaction, transfer of resources, transaction, kinship relationship, formal role relationship, or other sort of tie between the actors. The two elements, a set of actors and one or more relationships between pairs of actors, define a social network.

Social network properties are used to study both potential information availability and social pressures to conform. We have calculated network measures for a household's position in a network of households in a village and the overall network of ties among households in a village. Household network properties are calculated from information on how households are linked to one another within villages and outside villages. The Nang Rong survey collected ties between siblings, equipment renting/sharing, help with the annual rice harvest, and using the same rice mill. Of these, preliminary analysis indicated that only sibling ties affects contraceptive choice. Sibling ties are counted as the number of siblings that 18 to 35 year old members of one household report residing in other households within the village or in other villages, districts, or provinces. We are interested in both kinds of ties, those inside the village and those reaching outside of it. Village network properties are calculated by aggregating household level information from the household surveys to village level network properties.

There are four general kinds of network properties that we have measured: the centrality of actors within networks, the knittedness or density of networks, the permeability of

network boundaries, and the degree of overlap (or multiplexity) of different social relations. Of these, preliminary analysis indicated that centrality and permeability of network boundaries have some effect on contraceptive choice. We introduce and explain the concepts and measures below.

**Centrality.** Actor centrality measures the importance, prominence, or level of activity of an actor in a network based on the actor's ties to other members of the network (Freeman 1979; Friedkin 1991). We are interested in the centrality of households within villages. There are numerous specific indices of centrality. We focus on two: actor degree centrality and a version of closeness centrality based on the path distances between pairs of actors. We also explored other measures. Choice of a specific centrality index is a theoretical concern and depends on what network properties are relevant in a given application. It is also limited by features of the social network data, including its sparsity. Some centrality measures (for example, closeness centrality) cannot be calculated if the network is not connected.

The degree centrality of an actor is the number of other actors in the network to which the actor is directly tied or adjacent. Degree centrality can be further differentiated by looking at the direction of the links, distinguishing between indegree centrality, counting the number of ties coming to an actor, and outdegree centrality, counting the number of ties going from an actor. Degree centrality d(i) for a nondirectional relation is equal to the sum of ties to (or from) each actor. The degree centrality is the row or column sum in the sociomatrix. For a nondirectional relation X ij =X ji the row and column totals are equal.

$$d_1(i) = \sum_{j=1}^{n} X_{ij}$$

Degree centrality measures are calculated ignoring the tie from an actor to itself (X ii is ignored). Actors who have no ties in the network are isolates; their degree centrality is equal to zero. An actor may be an isolate in one network, but nevertheless have ties in another network.

Degree centrality measures the immediate ties to or from an actor, and thus is limited when we are interested in information which might come from more distant channels (i.e., through intermediaries). In this case we need a measure based on indirect paths to and from actors. Graph theoretic distance (or simply distance) is the number of network links in a path between a pair of actors. A path between two actors is a sequence of pairwise actor-to-actor links and the length of the path is the number of links in it. Actors who are directly tied (adjacent) are distance one from each other, actors joined by a path with a single intermediary between them are distance two from each other, and so on. Pairs of actors with a path between them are reachable from each other. The distance between two actors can be measured as the length of the shortest path between them. Some pairs of actors may not be reachable via any path in a given network, in which case the distance between them is infinite.

The extent to which an actor is tied into a network, and thus potentially has access to information flowing through the network, can be measured by looking at the distances that the actor is from other actors in the network and counting the number of other actors accessible via indirect paths of different lengths. Closeness centrality is an index that is often used to measure centrality based on distances between actors in a network (Freeman 1979; Valente 1995, 1998). It is the inverse of the average distance that an actor is from all other actors in the network. However, closeness centrality can only be calculated in networks where there are paths between all pairs of actors (since it cannot include infinite distances that occur between actors with no paths between them). Thus, it is not useful for our purposes since the household sibling, equipment, and rice harvest networks are sparse (many pairs of actors have no paths between them). Instead we use a measure based on a count of the number of other actors who are reachable in paths of length one, two, three, and so on up to the maximum path length. Actors with access to many others through relatively short paths are better positioned to obtain information circulating through informal network ties than are actors to whom few others are accessible. This can also be summarized as a network level variable by calculating the average number of others reachable via paths of a given length.

How tightly knit a network is affects the potential for coordinated activity of network actors and, we argue, the extent to which the network exerts pressure for members' conformity. Network knittedness can be measured by the extent to which ties in the network are present between pairs of actors and the extent to which actors can reach others via short paths. The knittedness of a network is also related to the average distance between pairs of actors. We will use a measure based on the path length statistics, described above. For a network we will calculate the average number (or percent) of other actors reachable to each actor via paths of a given length. We expect that paths of length three or four will be most useful, but will explore other path lengths.

A distinctive feature of our network data is that we have measured ties not only within villages, but also to other villages, districts, and provinces. Thus, we can distinguish between local and distant ties. For households, local ties are those within the village and distant ties are beyond the village.

**Method and Source Choice in Nang Rong**

Couples in Nang Rong choose among five methods of contraception: pill, IUD, injection, vasectomy, and female sterilization. Table 1 shows method-specific prevalence rates for married women aged 15-49 and for women married less than 10 years. Prevalence is high: 72 percent overall, 64 percent among recently married women. Pill, injection, and female sterilization are the most popular methods.

**Table 1**
**Contraceptive Prevalence, Nang Rong 1994**

| | Women Married Less Than 10 Years | All Married Women Aged 15-49 |
|---|---|---|
| **Overall Prevalence** | 64.1% | 72.2% |
| **Method-Specific Prevalence** | | |
| Injection | 30.1% | 20.2% |
| IUD | 2.4 | 4.1 |
| Pill | 25.8 | 21.6 |
| Female Sterilization | 5.5 | 20.1 |
| Vasectomy | 0.3 | 6.2 |
| **N** | 2207 | 5773 |

Couples also choose among sources of methods. Table 2 shows the distribution of sources for users of each method in the overall sample. Pills and injection are generally obtained from local health centers, although a significant minority go to the district hospital. Drug stores are also an option for pill users, especially for recently married users (data not shown). IUDs, vasectomies, and female sterilization are obtained at district or provincial hospitals. Government sources dominate.

**Table 2**
**Method Sources for Current Users, Married Women Aged 15-49 (N=4139)**

| | Total | Injection | IUD | Pill | Sterilization | Vasectomy |
|---|---|---|---|---|---|---|
| Local Health Center | 51.0% | 85.2% | 16.4% | 84.0% | 0.9% | 9.3% |
| District Hospital | 40.8 | 12.3 | 75.6 | 8.5 | 84.2 | 83.3 |
| Provincial Hospital | 5.0 | 0.3 | 7.1 | 0.2 | 14.3 | 5.7 |
| Drug Store | 0.8 | 0.1 | 0.0 | 2.6 | 0.1 | 0.0 |
| Other Source | 2.3 | 2.1 | 0.8 | 4.7 | 0.5 | 1.7 |

Clearly, there is substantial overlap of method and source. This is probably true in many settings. We have no way of knowing which choice comes first, method or source, or whether the choice is a joint one. Interestingly, research on contraceptive choice is dominated by studies of method choice, with relatively few considering source choice. In the analysis below, we consider both. In preliminary analysis, we tried to estimate method and source choice equations jointly, following Akin et al. (1997), but that modeling effort failed. Hence, we follow a seemingly unrelated regression approach.

## Social Networks and Choice

We test hypotheses about the impact of social networks on contraceptive choice, method, and source, and attempt to shed light on social side of accessibility. We focus on the choices made by women married in the past ten years who have not (yet) been sterilized. These women are "at risk" of a contraceptive choice as of the survey. They may choose to use injection, the IUD, pill, or no method at all. Sources of interest are the local health center and hospital. Because of small numbers of cases, we group the district and provincial hospitals into a single category, and we drop women obtaining their temporary method from the drug store or some other source. The analyses of method and source choice are based on data for 1957 nonsterilized women married for the first time in the ten years preceding the 1994 survey. Whether the outcome of interest is temporary method choice or source choice, our analytic approach is the same: we specify a multilevel multinomial logistic response model that corrects for unmeasured heterogeneity at the village level (see Entwisle et al. 1996; Rindfuss et al. 1996).

The effects of accessibility are the focus of our analyses, and we consider both the physical and social sides of accessibility. We include two measures of physical accessibility, one indicating distance (in km.) to the nearest local health center and the other indicating distance (in km.) to the nearest hospital. These measures come from an accessibility analysis conducted within a Geographic Information System (GIS) created for Nang Rong (see Entwisle et al. 1997). They refer to the shortest road distances between the village center to the nearest family planning outlet of each type existing in 1993, the year before the survey. Table 3 shows the means and standard deviations for the distance measures. In our sample, the average woman lives just under 4 kilometers from a local health center and just over 13 kilometers from a hospital. Especially considering the rural context, family planning is widely accessible in Nang Rong.

We use measures of sibling ties within and outside of villages to capture the social side of accessibility. Ties within villages provide a conduit of potential information about contraceptive methods and sources. If social networks affect contraceptive choices by acting as social arenas for the expression of norms and pressures toward conformity, then embeddedness in kin networks should affect these choices. At the household level, we consider the number of ties to other households by virtue of sibling relationships, i.e., sibling ties of path length one. As shown in Table 3, the average woman in our sample lives in a household that is connected to two other households in the village by virtue of sibling relationships (her own siblings or those of someone else aged 18-35 in her household). Also at the household level, we look at ties outside the village, especially to urban places such as Bangkok, the Eastern Seaboard, Korat, and Buriram. The average woman lives in a household with connections to 2.5 siblings (hers or someone else aged 18-35 in her household) living outside the village but somewhere in Buriram province and almost 3 siblings outside of Buriram household. These ties are likely more important as sources of information than normative pressure.

To make valid inferences about the impact of the social network variables, proper controls for other determinants of contraceptive choice that might be related to social

network position are critical. We considered a wide variety of control variables, including the age, age at first marriage, education, and occupation of the woman; whether her spouse was located in the village; the land owned by and assets (e.g., agricultural equipment, vehicle ownership) held by the household; and village wealth (as inferred from crop composition and productivity). Since our focus was on accessibility, we retained only those control variables with statistically significant effects in our sample. The models shown here include the woman's age and occupation and whether her spouse lives outside the village as control variables.

Tables 4 and 6 show the estimated effects of distance to family planning sources, sibling ties, and the control variables on temporary method choice and source choice, respectively.

Of particular interest in the method choice analysis are contrasts involving injection. Whereas the pill, and especially the IUD, had been available as a contraceptive method in Nang Rong as part of the national family planning program, dating back to the early 1970s, injection was a newer method. We might wonder whether ties to siblings inside and outside the village helped to spread the word about this relatively new method. Not only was injection the newer of the methods, there was a change in its availability. In 1984, injection was not available through local health centers to potential users in Nang Rong; this had changed by 1994. As shown in Table 4, however, the distance to the local health center did not have an effect on the choice of this method in 1994. Sibling ties did have a modest effect on the use of injection. Women living in households with more ties, inside as well as outside the village, were more likely to use injection rather than no method.

Turning to choice of source, we show contrasts with the local health center. The effects of accessibility on choice of source are strong. The further away villages are from the local health center, the more likely the women living in these villages are to choose the hospital over the local health center. They are also more likely to choose no source. Similarly, the further away villages are from the hospital, the more likely they are to use a local health center. In the analysis of source choice, a greater number of sibling ties encourages the use of local health centers but not hospitals.

We now consider interactions between measures of network structure at the village level and measures of network position at the household level. The question is whether the effects of physical proximity might depend on social ties. A family planning outlet might be located close by, but if no one knows about it, then it is effectively far away. In preliminary analysis, we considered interactions between the network measures and distance to the nearest local health center, and between network measures and distance to the nearest hospital. Only the latter interactions were statistically significant. Tables 5 and 7 show the results for these interactions in models of temporary method choice and source choice, respectively. For method choice, there is no evidence of interaction between sibling ties and distance to the hospital. For source choice, however, there is an interaction. Social ties inside the village and outside the village moderate the negative effect of increasing distance to the nearest hospital on the use of this source as opposed to

the local health center. It may be that conversation and related experience with the hospital increases the information that women have about this source, and hence their willingness to choose it. It is also possible that women living in households with more ties to urban areas are more likely to travel to these areas themselves; for them, going to a hospital for a temporary contraceptive method may be more convenient.

**Outcomes and Programmatic Relevance**

We began this project with the hypothesis that the social side of service accessibility–i.e., social network characteristics that affect access to information and redundancy in the information obtained–is important to an understanding of accessibility and its effects. Results based on a unique data set from Nang Rong, Thailand suggest that this is true. Proximity to family planning outlets affected contraceptive choices, especially source choices. Women living further away from a local health center were less likely to choose a local health center, and women living further away from a hospital were less likely to choose a hospital. Proximity mattered less, however, for women living in households directly linked by sibling ties to other households in the village and to siblings living in other places. It is important to consider social network characteristics in evaluating the effects of accessibility on contraceptive choice.

Going further, our results suggest that social network variables are related to method choice and source choice in Nang Rong. At the most general level, if social networks matter, that is if they influence method and source choice, then programs will be well served by taking the structure of social networks into account. Social networks might help in the recruitment of clients, identifying individuals targeted by a program or encouraging continued participation. Conversely, social networks might hinder the program if they act as a conservative force in a low prevalence country.

Finally, the kinds of social network data that we have used are expensive to collect and cannot be easily incorporated in the standard DHS study. While constructing complete social networks for individuals and communities might not be feasible, given our results, it is probably worth considering proxy social network measures that could be incorporated within a DHS or other similar survey.

Table 3. Means and Standard Deviations of Independent Variables

| Variable | Mean | S.D. |
|---|---|---|
| *Individual Characteristics* | | |
| Primary education | 0.767 | 0.423 |
| Age | 26.509 | 5.089 |
| Age at first marriage | 21.785 | 4.394 |
| Non-agricultural occupation | 0.280 | 0.449 |
| Spouse located outside village | 0.130 | 0.337 |
| *Household Characteristics* | | |
| Number of households reached at Sibling path length 1 | 1.976 | 1.993 |
| Number of siblings outside of village and within province | 2.545 | 2.646 |
| Number of siblings outside of province | 2.744 | 2.588 |
| Vehicle ownership | 0.331 | 0.471 |
| *Village Characteristics* | | |
| Distance to the closest local health center (kin) | 3.914 | 2.334 |
| Distance to the closest hospital (kin) | 13.129 | 4.895 |
| Average proportion of siblings reachable | 0.135 | 0.143 |

Table 4. Multinomial Logit Regression, Final Method Model (N = 1957)

| Independent Variables | Pill vs. injection | IUD vs. injection | None vs. injection |
|---|---|---|---|
| Age | -0.003 | 0.049* | 0.017 |
| | *0.012* | *0.023* | *0.013* |
| Non-agricultural occupation | 0.334* | -0.120 | 0.137 |
| | *0.137* | *0.394* | *0.117* |
| Spouse resides outside village | 0.015 | -0.988 | 0.488** |
| | *0.215* | *0.774* | *0.182* |
| Households reached at Sibling PL 1 | -0.024 | 0.101 | -0.076** |
| | *0.027* | *0.061* | *0.024* |
| Siblings within province | 0.006 | 0.043 | -0.007 |
| | *0.022* | *0.059* | *0.024* |
| Siblings outside of province | 0.003 | -0.053 | -0.059** |
| | *0.022* | *0.038* | *0.022* |
| Distance to local health center | -0.037 | 0.102 | 0.039 |
| | *0.026* | *0.072* | *0.027* |
| Distance to hospital | -0.005 | 0.030 | 0.012 |
| | *0.013* | *0.041* | *0.013* |
| Constant | 0.012 | -4.803*** | -0.656 |
| | *0.431* | *0.926* | *0.435* |

Table 5. Multinomial Logit Regression, Final Method Model w/ interactions (N = 1957)

| Independent Variables | Pill vs. injection | IUD vs. injection | None vs. injection |
|---|---|---|---|
| Age | -0.004 | 0.046* | 0.017 |
| | *0.012* | *0.022* | *0.013* |
| Non-agricultural occupation | 0.334* | -0.116 | 0.136 |
| | *0.138* | *0.383* | *0.117* |
| Spouse resides outside village | 0.015 | -0.940 | 0.486** |
| | *0.216* | *0.793* | *0.178* |
| Households reached at Sibling PL 1 | -0.047 | 0.021 | 0.008 |
| | *0.087* | *0.177* | *0.058* |
| Siblings within province | 0.005 | 0.105 | 0.033 |
| | *0.051* | *0.130* | *0.071* |
| Siblings outside of province | 0.004 | -0.311** | -0.105 |
| | *0.061* | *0.110* | *0.063* |
| Distance to local health center | -0.037 | 0.094 | 0.039 |
| | *0.026* | *0.072* | *0.026* |
| Distance to hospital | -0.008 | -0.022 | 0.021 |
| | *0.017* | *0.066* | *0.022* |
| Households reached at Sibling PL1 *distance to hospital | 0.002 | 0.005 | -0.006 |
| | *0.006* | *0.010* | *0.004* |
| Siblings within province *distance to hospital | 0.000 | -0.004 | -0.003 |
| | *0.004* | *0.009* | *0.005* |
| Siblings outside province *distance to hospital | 0.000 | 0.018* | 0.003 |
| | *0.004* | *0.008* | *0.004* |
| Constant | 0.050 | -4.000*** | -0.765 |
| | *0.464* | *1.134* | *0.528* |

Table 6. Multinomial Logit Regression, Final Source Model (N = 1957)

| Independent Variables | Hospital vs. Local HC | No Source vs. Local HC |
|---|---|---|
| Age | 0.020 | 0.020 |
| | *0.016* | *0.012* |
| Non-agricultural occupation | 0.026 | -0.010 |
| | *0.194* | *0.109* |
| Spouse resides outside village | 0.086 | 0.512** |
| | *0.277* | *0.164* |
| Households reached at Sibling PL 1 | -0.092 | -0.085*** |
| | *0.058* | *0.023* |
| Siblings within province | -0.025 | -0.016 |
| | *0.040* | *0.021* |
| Siblings outside of province | -0.062 | -0.069** |
| | *0.032* | *0.023* |
| Distance to local health center | 0.191** | 0.086* |
| | *0.069* | *0.039* |
| Distance to hospital | -0.093* | -0.003 |
| | *0.045* | *0.015* |
| Constant | -1.536 | -1.081** |
| | *0.911* | *0.363* |

Table 7. Multinomial Logit Regression, Final Source Model w/ int (N = 1957)

| Independent Variables | Hospital vs. Local HC | No Source vs. Local HC |
|---|---|---|
| Age | 0.017 | 0.019 |
| | *0.016* | *0.012* |
| Non-agricultural occupation | 0.039 | -0.009 |
| | *0.194* | *0.109* |
| Spouse resides outside village | 0.146 | 0.520** |
| | *0.285* | *0.160* |
| Households reached at Sibling PL 1 | -0.417*** | -0.051 |
| | *0.097* | *0.063* |
| Siblings within province | -0.093 | 0.001 |
| | *0.097* | *0.063* |
| Siblings outside of province | -0.251** | -0.149* |
| | *0.093* | *0.075* |
| Distance to local health center | 0.189** | 0.086* |
| | *0.066* | *0.038* |
| Distance to hospital | -0.201** | -0.013 |
| | *0.059* | *0.025* |
| Households reached at Sibling PL 1 *distance to hospital | 0.026*** | -0.002 |
| | *0.006* | *0.004* |
| Siblings within province *distance to hospital | 0.007 | -0.001 |
| | *0.008* | *0.004* |
| Siblings outside province *distance to hospital | 0.016* | 0.006 |
| | *0.007* | *0.005* |
| Constant | -0.271 | -0.931* |
| | *0.986* | *0.465* |

**References**

Chayovan, Napaporn, Albert I. Hermalin, and John Knodel. 1984. "Measuring Accessibility to Family Planning Services in Rural Thailand." Studies in Family Planning 15: 201-211.

Chung, Woojin. 1994. The Diffusion of Fertility Control in Korea: Multilevel Models for Social Network Data. Ph.D. Dissertation, State University of New York at Stony Brook.

Coale, Ansley and Susan Watkins, eds. 1986. The Decline of Fertility in Europe. Princeton, N.J.: Princeton University Press.

Entwisle, Barbara. 1989. "Measuring Components of Family Planning Program Effort." Demography 26:53-76.

Entwisle, Barbara, Ronald R. Rindfuss, David K. Guilkey, Aphichat Chamratrithirong, Sara R. Curran, and Yothin Sawangdee. 1996. "Community and Contraceptive Choice in Rural Thailand: A Case Study of Nang Rong." Demography 33:1-11.

Entwisle, Barbara, Ronald Rindfuss, Stephen J. Walsh, Tom P. Evans, and Sara R. Curran. 1997. "Geographic Information Systems, Spatial Network Analysis, and Contraceptive Choice." Demography 34:171-88.

Entwisle, Barbara and Jenny Godley. 1998. "Village Networks and Patterns of Contraceptive Choice." Under review.

Faust, Katherine, Barbara Entwisle, Ronald Rindfuss, Stephen Walsh, and Yothin Sawangdee. Forthcoming. "Spatial Arrangement of Social and Economic Networks Among Villages in Nang Rong, Thailand." Social Networks.

Freedman, Ronald and John Y. Takeshita. 1969. Family Planning in Taiwan: An Experiment in Social Change. Princeton, N. J.: Princeton University Press.

Freeman, Linton C. (1979). "Centrality in social networks: I. Conceptual clarification." Social Networks, 1:215-239.

Friedkin, Noah E. (1991). "Theoretical foundations for centrality measures." American Journal of Sociology. 96:1478-1504.

Godley, Jenny. 1998. "The Influence of Sibling Ties on Women's Contraceptive Method Choice in Nang Rong, Thailand." Unpublished MA Thesis. Department of Sociology, University of North Carolina at Chapel Hill.

Hermalin, Albert I. 1979. "Multivariate Areal Analysis." Pp. 97-111 in United Nations, The Methodology of Measuring the Impact of Family Planning Programmes on Fertility.

Population Studies No. 66. New York: United Nations, Department of International Economic and Social Affairs.

Hermalin, Albert I. and Barbara Entwisle. 1987. "The Availability and Accessibility of Contraceptive Services." Pp. 583-596 in Robert J. Lapham and George B. Simmons (eds.), Organizing for Effective Family Planning Programs. Washington, DC: National Academy of Sciences Press.

Hermalin, Albert I., Barbara Entwisle, and Zeinab Khadr. 1996. "Whose Accessibility" Reweighting DHS Data to Serve Multiple Perspectives." Studies in Family Planning 27: 88-97.

Hernandez, Donald J. 1984. Success or Failure? Family Planning Programs in the Third World. Westport, CT: Greenwood Press.

Hubert, Lawrence J. (1987). Assignment Methods in Combinatorial Data Analysis. New York: Marcel Dekker.

Jato, M., A. van der Straten, O. M. Kumah, C. Vondrasek, O. P. Tsitson-Mede, R. Seukap, and C. Efiom. 1995. "Women's Tontines in Yaounde, Cameroon: Using Social Networks for Family Planning Communication." The Johns Hopkins School of Public Health, Project Report No. 6.

Kincaid, D. L., E. Massiah, A. DasGupta, and N. S. Mitra. 1993. "Communication Networks, Ideation, and Family Planning in Trishal, Bangladesh." Paper presented at the Annual Meetings of the Population Association of America, Cincinatti, OH.

Kohler, Hans-Peter. 1997. Fertility and Social Interaction: An Economic Approach. Ph.D. Dissertation, University of California at Berkeley.

Lee, Nancy Howell. 1969. The Search for an Abortionist. Chicago: University of Chicago Press.

Leasure, William J. 1963. "Factors Involved in the Decline of Fertility in Spain, 1900-1950." Population Studies 16:271-285.

Lesthaeghe, Ron J. 1977. The Decline of Belgian Fertility, 1800-1970. Princeton, N.J.: Princeton University Press.

Marsden, Peter V. 1990. "Network data and measurement." Annual Review of Sociology. 16:435-463.

Massey, D., R. Alarcon, J. Durand, and H. Gonzalez. 1987. Return to Aztlan: The Social Process of International Migration from Western Mexico. Berkeley, CA: University of California Press.

Mita, Rezina and Ruth Simmons. 1995. "Diffusion of the Culture of Contraception: Program Effects on Young Women in Rural Bangladesh." Studies in Family Planning 26:1-13.

Montgomery, M. R. and J. B. Casterline. 1993. "The Diffusion of Fertility Control in Taiwan: Evidence from Pooled Cross-Section Time-Series Models." Population Studies 47:457-79.

Palmore, James A. 1967. "The Chicago Snowball: A Study of the Flow and Diffusion of Family Planning Information." Pp. 272-363 in Donald Bogue, ed. Sociological Contributions to Family Planning Research. Chicago: Community and Family Study Center, University of Chicago.

Rindfuss, Ronald R., David K. Guilkey, Barbara Entwisle, Aphichat Chamratrithirong and Yothin Sawangdee. 1996. "The Family Building Life Course and Contraceptive Use: Nang Rong, Thailand." Population Research and Policy Review 15:341-368.

Rogers, E. M. and D. L. Kincaid. 1981. Communication Networks: Toward a New Paradigm for Research. New York: Free Press.

Rosero-Bixby, Luis and John B. Casterline. 1994. "Modeling Diffusion Effects in Fertility Transition." Population Studies 47:147-67.

Rutenberg, Naomi and Susan Cotts Watkins. 1996. "The Buzz Outside the Clinics: Conversations and Contraception in Nyanza Province, Kenya." Studies in Family Planning 28:290-307.

Valente, Thomas W. (1995). Network Models of the Diffusion of Innovations. Cresskill, NJ: Hampton Press.

Valente, Thomas W. and Robert K. Foreman (1998). "Integration and radiality: measuring the extent of an individual's connectedness and reachability in a network." Social Networks 20:89-105.

Valente, Thomas W., Susan Cotts Watkins, Miriam N. Jato, Ariane van der Straten and Lous-Philippe M. Tsitsol. 1997. "Social Network Associations with Contraceptive Use among Cameroonian Women in Voluntary Associations." Social Science and Medicine 45:677-687.

Wasserman, Stanley and Katherine Faust (1994). Social Network Analysis: Methods and Applications. Cambridge, ENG: Cambridge University Press.

Watkins, Susan Cotts. 1991. From Provinces Into Nations: Demographic Integration in Western Europe, 1870-1960. Princeton, NJ: Princeton University Press.