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Residential Mobility and Contraceptive Use in Northeastern Brazil

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Abstract

Several aspects of the relationship between residential mobility and contraceptive choice and use in northeastern Brazil, based on the 1991 Demographic and Health Survey (DHS), are investigated in this paper. The DHS collected detailed information on pregnancies, contraceptive use, marriage, employment, and residential mobility, based on a six-year monthly calendar of events.

The document examines three main issues: (1) whether the contraceptive practices of women who change their residence to more urbanized centers are selective at origin, (2) whether a change in residence is associated with a modification in contraceptive use, and (3) whether migrants adapt to the contraceptive regime of their destination. These issues are important to researchers and policymakers because, to the extent that fertility behavior may be influenced by the characteristics of the place of residence, public policy interventions can be designed to account for the residential experience of women served by family planning and maternal child health programs.

The data lend some support to the selection hypothesis, although the adaptation and disruption hypotheses also seem to help explain the relationship between migration and contraceptive use among Brazilian women. The results of the research suggest that, in northeastern Brazil, migrants adopt more innovative practices in regulating their fertility than do nonmigrants, and will seek family planning services in their new place of residence.

The Study: Its Background, Objectives and Significance

Since the 1950s, most Latin American countries have experienced a massive growth in the number of urban dwellers and an increased concentration of their population in large metropolises, and thus a rising level of urbanization overall. For instance, the two largest cities in the world—Mexico City, Mexico, and São Paulo, Brazil—are now in Latin America. The main impetus behind the rising tide of urbanization has been the influx of migration from rural to urban areas. Along with this trend, fertility differentials between urban and rural areas have widened over time as the use of contraceptive methods has increased dramatically in urban areas, thus leading to a rapid decline in urban fertility levels (United Nations, 1987 and 1989). Clearly, the relationship between these changing rates of urbanization and the fertility levels and contraceptive practices of migrant and nonmigrant women in urban and rural areas deserves more in-depth research.

Though many studies have documented the large urban-rural differentials in both fertility and contraceptive use in Latin America (see, respectively, Rodríguez and Aravena, 1991, and United Nations, 1989), little is known about the actual mechanisms that cause these differences. Moreover, none of the studies of fertility or contraceptive practices in this region has assessed either the extent to which migration—the single most important determinant of urbanization in Latin America—is a selective process or the extent to which migrants adopt the fertility behavior of their urban destination.

Among the studies that have addressed some aspects of the relationship between migration and fertility are investigations in Asia (Goldstein and Goldstein, 1981) and in Latin America (Ribe and Schultz, 1980; Hutchison, 1961; Iutaka et al., 1971), as well as a review of international-level studies of migrant-nonmigrant fertility differentials in urban areas (Zárate and Zárate, 1975). Only Goldstein and Goldstein (1983) have studied the relationship specifically between migration and contraceptive use—and that based on Malaysian data.

Undoubtedly, the paucity of analyses of the relationship between residential mobility and fertility and, more specifically, contraceptive use is due largely to the limitations with and the inadequacy of available data. The national fertility and family planning surveys most frequently used to track fertility and contraceptive behavior since the 1960s—particularly the Contraceptive Prevalence Survey (CPS) and the World Fertility Survey (WFS)—sought information primarily on (1) a complete history of live births within a fixed period of time or as of the interview date, (2) knowledge and the availability and accessibility of contraceptive methods, and (3) current and previous use of a contraceptive method. Occasionally, each of these surveys has collected additional data on contraceptive use in the respondents' most recent birth interval or intervals, but rarely have they elicited more detailed information—such as the timing and duration of use, or whether and why women choose to discontinue their contraceptive use.[1] Compounding this dearth of detailed data on timing and use, the information collected by the WFS questionnaire on the length of time the respondent had resided in the place of the interview and her place of

residence during childhood is insufficient to support a detailed analysis of the contraceptive behavior of migrants and nonmigrants.[2] Census-type questions on the place of birth and length of current residence have also been used in other fertility surveys to ascertain the migration experience of the respondents.

However, data from the Demographic and Health Survey (DHS) Program are now available to make a detailed analysis of contraceptive practice and residential mobility feasible. As will be described later in this paper, the 1991 DHS data offer several advantages over information collected from other studies: (1) they will support analyses of the adoption, use, and discontinuation of both traditional and modern contraceptive methods; (2) they will make it feasible to link contraceptive practices to the timing and planning status of each of the pregnancies during a fixed study period as well as to a place-of-residence history; (3) they will support using a national or regional sample not characterized by the selection biases frequently associated with other types of samples, such as follow-up studies of contraceptive acceptance; and (4) they will not be affected by the attrition of select members of the sample at follow-up.

Previous Research

Researchers generally agree that the effect of place of residence—and residential mobility—on reproductive behavior and, more specifically, on fertility is not well understood. Yet they also recognize that three distinct processes may be responsible for the large differentials in fertility and contraceptive practice between urban and rural areas: (1) ***selection effects***, whereby women with lower fertility migrate to urban areas, and thus leave among the rural residents a large pool of women with a high rate of fertility; (2) ***adaptation effects***, whereby migrants to urban areas adopt the fertility regime of their destination (where fertility is lower because family planning services are more readily available, because employment opportunities make it more difficult to raise children, or because individual preferences or aspirations dictate against childbearing), and (3) ***disruption effects***, whereby migration itself may interrupt childbearing due to the separation of spouses. These effects are not mutually exclusive because each or all of them may explain the relationship between migration and fertility (Goldberg, 1959; Duncan, 1965; Ribe and Schultz, 1980; Goldstein and Goldstein, 1981).

Several past studies provide some evidence to support the selection and adaptation hypotheses, for example, the study by Goldstein and Goldstein (1981) in Thailand based on census data and one based on the 1980 census in the United States (Kahn, 1988). Yet, despite this evidence to support selectivity and adaptation in the fertility outcomes of migrants from less developed and less urbanized sending countries, the census data that supported these studies lacked information on the timing of events, were cross-sectional in nature, and yielded estimates of fertility levels that were derived from limited indirect-estimation techniques, for example, the own-children method (Cho et al. 1981), which yield only limited information on the timing of fertility. Indeed, in examining the application of census data or survey data modelled on censuses, Goldstein and Goldstein (1983) found five definitional and methodological limitations:

- Because census-based measures of fertility are usually based on children ever born, pre- and postmigration fertility cannot be ascertained.
- Because censuses usually do not provide information on intervals between births, the spacing of childbearing around the move cannot be assessed.
- Census data on social and economic characteristics, including the marital status of respondents, refer to the year in which data are collected, making it difficult to separate selection effects from adaptation effects.
- Because censuses do not provide a detailed residential history, fertility can be related to repeat or return moves only in a restricted manner.
- Censuses rarely collect information on attitudes towards or the use of contraceptives.

In an attempt to overcome these limitations, Goldstein and Goldstein (1983) used longitudinal data from the Malaysian Family Life Survey (MFLS) (Butz and DaVanzo, 1978) to test the three hypothesized effects. The data strongly supported the existence of selectivity and adaptation effects. For example, (1) migration is more likely among women whose fertility levels are lower than among women whose fertility levels are higher; (2) the adaptation of migrants to the "fertility norms" at destination may occur rapidly; and (3) migration is associated with disruptions in child-spacing patterns, although this effect does not appear to extend beyond the immediate migration period.

Because the MFLS also recorded a history of contraceptive use, Goldstein and Goldstein could also relate these data sequentially to pregnancies and changes in residence. Because migrants who were former nonusers adopted modern contraceptive methods, they adapt to their movement by restricting their childbearing. However, in the absence of enough cases, Goldstein and Goldstein could not test whether movement between specific types of locations (and specifically from urban to rural locations) causes changes in contraceptive behavior nor could they assess formally whether the fertility behavior of migrants is selective at origin.

Objectives and Significance

Data from the 1991 Demographic and Health Survey (DHS) are used to investigate three specific issues associated with the relationship between residential mobility and contraceptive choice and use in northeastern Brazil: (1) whether the contraceptive behavior of women who migrate to more urbanized centers is selective at origin, (2) whether a change in residence is associated with a modification in contraceptive use, and (3) whether migrants adapt to the contraceptive regime of their urban destination. Several advantages underscore the unique setting of northeastern Brazil (comprising the states of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia) for testing specific hypotheses about the mechanisms underlying demographic transition. First, the demographic and socioeconomic differentials between urban and rural areas are considerable, and rural poverty is pervasive. Moreover, the Northeast is the second most populous region in Brazil, and remains the poorest region in this country, with a per-capita income of less than half the national average (Wood and Carvalho, 1988).

Second, the Northeast has the second largest concentration of metropolitan centers in the country, and rural-to-urban migration has contributed significantly to the rapid growth of such urban areas as Fortaleza, Salvador, and Recife (Merrick and Graham, 1979). Moreover, the pattern of urbanization in northeastern Brazil has followed the pattern that occurred in the southern states of São Paulo and Rio de Janeiro two decades earlier. Third, maternal child health services in urban and rural areas proliferated beginning in the early 1980s, and efforts have continued to be made by state and private organizations to expand these services further. Of primary concern are the implications of this study for the family planning and health services available to those who have recently migrated to urban centers in the Northeast and to those who remained behind in the impoverished rural areas of this region.

The data to support this study come from Brazil's *Pesquisa sobre Saúde Familiar no Nordeste Brasil 1991* (PSFNE) (Ferraz et al., 1992), conducted as part of Phase II of the DHS Program. This is the only available dataset that contains a detailed account of contraceptive use, reasons for discontinuation, and residential mobility from a representative sample in a region that is so amenable for study. Hence, it is possible to examine how changes in contraceptive practice are associated with residential mobility, and to consider the concomitant influence of other events, such as changes in marital status or employment.

The subsequent sections of this paper cover the following topics: the hypotheses that are tested in this investigation; a description of the Brazilian dataset and its limitations and a presentation of a strategy for testing these hypotheses, particularly with a focus on the best approach for drawing inferences from cross-sectional data; the results of this inquiry; and a discussion and concluding remarks.

Selection, Adaptation, and Disruption Hypotheses

The three hypotheses that have been posited as the determinants of the differentials in the reproductive behavior of migrants and nonmigrants are examined in this study (Zárate and Zárate, 1975; Ribe and Schultz, 1980; Goldstein and Goldstein, 1983). These hypotheses constitute the *theory of determination*, which postulates that migration is a vehicle of social change and, in turn, a regulator of fertility (Goldscheider, 1980). As stated earlier, any or all of these premises would help explain the relationship between reproductive behavior and migration. However, they differ according to the nature and timing of the relationship:

- The ***selectivity model*** views differentials in contraceptive practices as having existed before the migration occurred.
- The ***adaptation model*** postulates that differentials arise in the place of destination in response to the fertility norms of the host population and to the availability of family planning services in the area of destination.
- The ***disruption model*** argues that the contribution of the migration process to changes in contraceptive behavior (and ultimately to whatever differentials exist in the fertility of migrants and natives at origin or

destination) is due to concurrent linking events, such as the separation of spouses or entry into an informal union.[3]

The main supposition of the ***selectivity model*** is that migration is not a random event at origin. This premise is consistent with the general evidence that migration tends to depend on such variables as age, marital status, or education. Hence, even after other relevant characteristics are controlled for, the fertility behavior of migrants would continue to differ from the behavior of nonmigrants. Among the explanations of why this distinction occurs, researchers have suggested that the same behavior that causes individuals to move may also prompt them to restrict the size of their families (for example, see Katz and Stark, 1985; Stark, 1981; and Lee, 1989). The applicability of the selectivity model to explaining the differential behavior of migrants and nonmigrants may change with varying degrees of development or modernization. For instance, the early rural migrants to the southeastern urban centers of Brazil (for example, Rio de Janeiro and São Paulo) may have been more innovative and willing to adopt new behavior than the migrants who followed them later, an assertion that is impossible to verify.

The main assumption of the ***adaptation model*** is that, because migrants do not differ significantly from the population at origin, they assume the reproductive norms and behavior that characterize the population at their destination. For example, for rural-to-urban migrants, the adaptation model suggests that the interaction with the urban population will in time prompt them to adopt contraception or to use more efficient methods. The reason that they adopt lower fertility patterns in urban settings could stem from either economic motivation (Ribe and Schultz, 1980; Stark, 1981) or noneconomic factors, such as family or peer pressures, or the accessibility of health and family planning services (Boulier, 1984). The model predicts that the contraceptive behavior (and, more generally, the fertility) of migrants will converge toward the behavior of the destination. Note, however, that the model does not specify how long it takes for adaptation to occur. Moreover, adaptation will depend on the extent of differences between the place of origin and the place of destination. Presumably, the more different these places are, the longer the adaptation process will take.

The main premise of the ***disruption model*** is based on the consequences of migration itself, and not on the characteristics of the place of origin or the place of destination. It assumes that migration will affect reproductive behavior at the time of the change in residence, but that, as time elapses, migrants will tend to follow the same behavior they exhibited before the move. For example, migration may lead to the temporary separation of spouses, which could in turn lead to the discontinuation of specific methods or of contraception use at all. Conversely, migrants may temporarily adopt more effective methods when they arrive at their new place of residence to avoid the risk of mistimed or unintended pregnancies that would conflict with employment or other social or economic exigencies in their place of destination.

Data and Methods

Data on Migration and Contraceptive Use

The core questionnaire of the Demographic and Health Surveys (Phase II) for countries with a high prevalence of contraceptive use includes a *monthly* calendar of events for all women of reproductive age in the sample. This calendar records the women's pregnancies and their family planning status, contraceptive use, reasons for discontinuing contraceptive practice, breastfeeding, postpartum amenorrhea, postpartum abstinence, marriage, employment, and place of residence for up to 72 months prior to the interview date (IRD, 1990).

In a DHS-based evaluation of an experimental version of this calendar in Peru, Goldman et al. (1989) concluded that the calendar appears to improve the resulting data in two ways: (1) it provides more complete and accurate reports of contraceptive use, failure rates, and discontinuation rates (relative to estimates derived from a tabular format that records partial information on contraceptive use in each birth interval); and (2) it collects a residential history (in addition to marriage and employment histories), yielding useful and reasonably accurate information on rates of mobility and the level of urbanization.

1. Sample Characteristics

The PSFNE consists of a sample of dwellings in the northeastern states of Brazil, extracted from a subsample of the *Pesquisa Nacional por Amostra de Domicílio* (PNAD) of the *Instituto Brasileiro de Geografía e Estadística* (IBGE),[4] selected according to a two-stage cluster sampling design. The PSFNE yields representative results for the northeastern region, its urban and rural areas, and each of the nine constituent states. In each selected dwelling, all women 15 to 49 years of age were interviewed, and information was collected from these women, from a subsample of their husbands (1,666 cases), and for all the women's children born in the five years preceding the interview (3,750 cases). The PSFNE yielded 6,222 complete interviews with eligible women. Two-thirds of them live in urban areas, and 42 percent have five or more years of education. Almost 57 percent of all women were married or in union as of the interview. (Additional information on the characteristics of the sample are available in Ferraz et al. 1992.)

2. Advantages and Limitations

A calendar of events addresses many of the shortcomings of traditional census-type information because it distinguishes between events occurring before and after moves.[5] Still, the data from the Brazil DHS-II may suffer from the limitation common to all retrospective studies—that current survey data from respondents on their previous characteristics may not be representative of the population in the past. In particular, the selective out-migration of

out-origin populations to other regions in Brazil between a given point in the past and the time of the interview will make it impossible to ascertain the true characteristics of the population at the place of origin within that time period, thus affecting the comparisons between migrants and nonmigrants. This latter problem will particularly affect the attempt in this study to test the selectivity hypothesis. Other specific limitations of the data on residential mobility and contraceptive use collected in the Brazil DHS-II survey are described below.

a. Mobility Data

As mentioned before, the calendar determines information on the place of residence from the individual on a monthly basis for up to 72 months prior to the interview date. The respondent reports the length of current residence, the month of the change in residence, and the perceived urbanization level of the place of residence. In many respects, the residential history closely parallels the other demographic histories taken in the calendar, but, because a change in residence encompasses time and space dimensions, several measurement features deserve special attention.

First, the definition of migration should be refined and geographic boundaries established. The United Nations (1970) treated migration as a change in place of abode or "usual" place of residence. Yet the notion of usual place of residence can itself be difficult to determine for some respondents; long visits, job-search sojourns, and return migration all serve to muddle the event. Thus, a geographic threshold is necessary to separate *local* mobility from migration. This threshold should distinguish longer-distance moves between labor markets and social settings.[6] Because the PSFNE (and, more generally, the components of the DHS) found it desirable to focus on migration (ignoring local mobility), a migration-defining boundary or a threshold was necessary. Change of "community" serves this need. Thus, women are asked when they changed community, not merely their residence within the community.

Second, more accurate geographic concepts are required to develop adequate territorial breakdowns for place of residence. The questionnaire uses the trichotomy of rural area (in Portuguese: *zona rural*), town (*cidade/vila*), and capital city (*capital*), and records the respondent's *perception* of the level of urbanization in the present and previous places of residence. For current place of residence, the perceived level of urbanization can be compared with an assignment based on the geographic code from the survey sampling design.[7] Not only does the geographic classification affect how migration events are recorded, but it also influences how other demographic events (such as the pregnancies recorded in the calendar) are allocated to places.

Third, timing issues must be addressed. While monthly intervals for fertility and contraceptive-use data are generally considered adequate, there is no "natural" interval for the events of residential mobility and migration. Extremely short durations of "usual place of residence" might go unrecorded, and long intervals of residence may exceed the six-year window of the calendar.[8] Thus, the analyst has no reliable measure against which the accuracy of the

reported duration of residence in a given community can be compared.[9] Still, monthly recording generates much more detailed data than do most migration surveys. For instance, the Malaysian survey recorded only the *year* when a change of residence occurred (Goldstein and Goldstein, 1983). This feature of the calendar enables the analyst to assess the relationship between mobility and other types of demographic events.

b. Contraceptive-Use Data

Data were first collected in the PSFNE on knowledge, ever-use, and the availability and acceptability of contraceptives. Information on current use was obtained next and, after it was entered into the calendar, the interviewers used it to probe for all previous segments of use between 1986 and the interview date.[10] Interviewers were trained to use information already coded in the calendar (that is, months of pregnancy and birth) to facilitate the respondent's recall. All months of contraceptive use (including a code for nonuse) were entered into the first column of the calendar, and each month of this column contained one and only one code, i.e., a code for pregnancy, birth, nonuse, or the use of a particular method.

The reason that the respondent stopped using a contraceptive for each use segment, i.e., whether the woman became pregnant, whether she wanted to become pregnant, or whether she discontinued for another reason (for example, costs, health side-effects, or spousal separation), was also collected. This information was coded in another column of the calendar alongside the last month of use for the relevant episode.

Finally, if the woman reported having used a method in January 1986, the interviewer recorded the date of first use. But if the woman was not using a method in January 1986 but had used one before that date (for example, after the birth of the child born just before January 1986), the interviewer recorded the date when the woman stopped using the method.

Although the calendar seems to improve the internal consistency of the data on contraceptive use over other approaches (Goldman et al., 1989), there is no practical or economical way to validate these data.

Using Comparisons of Migrants and Nonmigrants to Assess the Three Hypothesized Effects

In this section the analytical strategy for assessing the three hypotheses about the relationship between migration and contraceptive use, i.e., comparing the contraceptive practice of migrants and nonmigrants at selected points in time, is discussed.

One straightforward way to examine whether the contraceptive use of migrants is *selective* at origin would simply be to compare contraceptive use among migrants before the actual month of the change in residence with the

contraceptive use before a randomly assigned reference month among those women who remained in the same place of residence (Goldstein and Goldstein, 1982; Bumpass and Rindfuss, 1984).

Similarly, whether women *adapt* to the pattern of contraceptive use at the place of destination can be examined by comparing differences in the contraceptive behavior of nonmigrants and migrants after the latter have changed their place of residence.

To explore whether migration itself *disrupts* contraceptive practice, researchers can examine changes in the contraceptive status of migrants within a period before and after their change in residence with the changes in contraceptive use among nonmigrants before and after an arbitrary reference month.

One problem that complicates using these comparisons is that, as noted earlier, the monthly account of contraceptive use (or other history reported in the calendar) is left- and rightcensored. Thus, information on the contraceptive status of a woman n months before or after migration (or a random reference month for those who did not migrate within the calendar period) may not be available if it corresponds to a date located either prior to January 1986 or after the date of interview, or both. Thus, in such comparative analyses, either (1) the censored cases must be excluded from the analysis or (2) statistical methods must be used to control for the censored experience of women.

Another, more relevant problem that jeopardizes inferences about the relationship between migration and contraceptive use is ***selection bias*** (Hausman and Weiss, 1985; Heckman and Robb, 1986; Heckman and Hotz, 1989). Specifically, selection bias arises when differences in the observed or unobserved characteristics of migrant and nonmigrants are not accounted for when the influence of a change in residence on contraceptive use is assessed. This omission might induce a spurious association between migration and reproductive behavior and, hence, distort comparisons of contraceptive use by migrants and nonmigrants. For instance, the degree of innovation and risk avoidance that prompts certain groups of rural women to have low fertility levels probably also contributes to their decision to migrate to urban centers. The degree of innovation and risk avoidance is usually an unobserved (and unobservable) characteristic of the individual. In the next section, a statistical procedure to control for selection bias (that is, to test the selectivity hypothesis) is discussed in the context of assessing the three hypotheses about the relationship between migration and contraceptive use.

Controlling for Selection Bias

In observational studies in which individuals are assigned or assign themselves to a treatment or course of action without the benefit of randomization, the relevant characteristics of the treatment groups may differ systematically,

and the groups may not be directly comparable (Cochran, 1965). Thus, the researcher must invoke mathematical or statistical methods to eliminate or isolate spurious channels of causation between treatments and the outcome variable.

Several techniques have been proposed to avoid drawing biased inferences from nonexperimental, cross-sectional data. One of the most suitable techniques for the problem addressed in this research is ***propensity score*** analysis, in which the impact of treatments on an outcome variable is compared within allegedly homogenous classes or strata (Rosenbaum and Rubin, 1983 and 1984). This method seems to be more adequate than model-based solutions for correcting for selection bias in cross-sectional studies where individuals are not assigned randomly to their treatment status (Heckman and Robb, 1986; Heckman and Hotz, 1989). In particular, when the outcome is a discrete polytomous dependent variable (that is, the choice of a contraceptive method), and when the distributional assumptions are difficult to identify or justify, propensity score analysis can be applied more readily than can a switching-regression model with endogenous switching (Maddala and Nelson, 1975). Although a switching-regression model with endogenous switching is the natural choice in studies of wage differentials between migrants and nonmigrants (for example, the Mover-Stayer or two-populations model), its application to this research seems to be far from straightforward. The main reason is that, in the process of estimating the parameters of a two-populations model when the dependent variable is polytomous, neither maximum-likelihood nor two-stage methods are sophisticated enough to control for selection according to unobservable characteristics. Thus, the standard econometric approaches for comparing the experience of migrants and nonmigrants directly are not available for the type of problem addressed in this paper.

The propensity score—a scalar function (for example, a logit model) of all covariates related to the outcomes and the treatment assignment—summarizes the information required to make the distribution of observed covariates for migrants and nonmigrants identical within subclasses of covariates. In the parlance of Heckman and Hotz (1989), the propensity score is a semi-parametric matching procedure. In other words, subclasses created from the scalar propensity score will balance all covariates, thus providing estimates of treatment effects within each subclass. In fact, four or five subclasses constructed from the distribution of the propensity score (that is, at the quartiles or the quintiles) will often suffice to remove more than 80 to 90 percent of the bias due to each of the observed covariates (Rosenbaum and Rubin, 1984). However, one drawback with the propensity score approach is that it can control bias due to imbalances only in *observed* covariates or for unmeasured covariates that are correlated with those considered in the propensity function. In other words, selection according to unobserved characteristics cannot be ascertained. This limitation has led econometricians to argue that the propensity score method does not resolve the general problem of selection bias (Heckman and Robb, 1986; Heckman and Hotz, 1989). However, as stated earlier, propensity score analysis seems to be the only practical solution available for comparing the fertility-regulation experience of migrants and nonmigrants directly. In brief, under the assumption that all variables related to *both* outcomes *and* treatments are included in the propensity score function—or a "strongly ignorable treatment

assignment" assumption, in the parlance of Rosenbaum and Rubin (1983)—estimates of the impact of a treatment on the outcome variable would be approximately unbiased.[11]

In the following section the results of an analysis of the impact of migration on contraceptive use within an observation interval, based on the propensity score technique to control for selection bias, are presented. Pre-interview study periods of one or five years define the observation intervals. These two reference periods represent a compromise between the length of the calendar period used in the questionnaire (data reported for up to 72 months) and conventions used to analyze rates of migration. Under this approach, the experience of migrants and nonmigrants is compared at the same point in time and for comparable follow-up periods, and, consequently, the exclusion of censored cases is not a consideration. A multinomial logit model (see, for example, Hoffman and Duncan, 1988) is used to ascertain the importance of a change in residence within the observation interval (controlling for the other individual characteristics of the respondent) to the type of contraceptive method used as of the interview. Although this research could have relied on a discrete choice model that treats the categories of the response as ordered for example, a continuation-ratio model (Fienberg, 1980) the study regards the contraceptive options of women as four competing alternatives: no use, the use of a coitus-dependent method, the use of a coitus-independent method, and the use of sterilization.[12] The reason behind this decision is that, since women did not report their choice of contraceptive methods in terms of the categories used for the outcome variable in this analysis (that is, groups of methods whose clinical effectiveness is similar), their responses should be regarded as nominal data.

Observed Levels of Migration, Fertility, and Contraceptive Use

This section offers an overview of the levels of migration, fertility, and contraceptive use among women in northeastern Brazil as background for testing the three hypotheses of concern for this research.

1. Residential Mobility and Type of Place of Residence

In the five years preceding the survey, a small proportion of Brazilian women 15 to 49 years of age opted for a change in their community of residence, i.e., *migration*. As of the interview, more than half of all women reported never having changed their place of residence (see Table 1). Among those who had ever migrated, about 35 percent (16.3/(100.0 - 54.0)) changed their community of residence between January 1986 (that is, the onset of the calendar period under consideration) and the date of the interview. Compared with other demographic events—for example, about 40 percent of women became pregnant at least once within the calendar period—migration is a social event restricted to a small proportion of the female population. About 15 percent had migrated in the five-year interval before the interview, and 5 percent in the one-year interval before the interview.

Among women who had moved in the recent past, most of them changed residence only once (Table 1). For instance, less than 10 percent of the women who migrated within the year prior to the interview reported having changed their community two or more times within that period. Some of these cases probably include reporting errors attributable to the vagueness of the questions used to ascertain whether a woman changed residence; it is possible that women reported temporary trips or visits as a more permanent change in the community of residence. Finally, among those who had migrated in the one-year interval before the interview, the last change in residence occurred an average of about five months before the interview; among those who had migrated in the five-year interval before the interview, the last change in residence occurred about two years prior to the survey.

Table 1. Selected Measures of Migration or Change in Place of Residence

Distribution of Women by Migration Status		
Has never changed residence	54.0 %	(n = 3,360)
Changed residence before January 1986	29.7 %	(n = 1,845)
Changed residence within a calendar period but not before January 1986	16.3 %	(n = 1,017)
	100.0 %	(n = 6,222)
Proportion of Women Who Changed Residence within an Observation Interval Prior to the Interview		
One-year interval		5.1 %
Five-year interval		15.4 %
Distribution of the Number of Changes in Residence within an Observation Interval Prior to the Interview Among Those Who Moved	One-Year Interval	Five-Year Interval
1	91.1 %	79.6 %
2	8.5 %	17.1 %
3	0.4 %	2.4 %
4+	0.0 %	0.9 %
	100.0 %	100.0 %
Mean Number of Months Since the Last Change in Residence Among Those Who Moved within an Observation Interval Prior to the Interview		
One-year interval		5.0 months
Five-year interval		24.1 months

Although information is available on the timing, origin, and destination of *all* changes in residence within a reference period, this study examines only the last of those moves, i.e., the one closest to the time of the interview. Because the analysis is based not on demographic or social events occurring as of the change in residence, but at the onset of an interval prior to the interview or as of the interview, the previous convention simplifies and refines the analysis. Note, however, that this convention is based on the assumption that the behavior of migrants is *homogenous*, regardless of the number of times they had moved within the pre-interview study period.

Another way to describe the intensity of the residential mobility of the female population in northeastern Brazil is to examine the distribution of women by their place of residence as of the interview according to their place of residence at some point prior to the interview. The results of these cross-tabulations are reported in Table 2. In the first panel, women are classified by their interview reports of their place of residence one or five years prior to the survey and by their place of residence as of the interview based on the community's size (or geo-code) as defined by the primary sampling unit where the woman was interviewed, derived from information from the 1984 Master Sample of the PNAD. In contrast, in the second panel, the more objective measure of the level of urbanization in the place of residence as of the interview is replaced by the *perceived* level of urbanization of the place of residence as of the interview. Although the reports of the perceived level of urbanization in the place of residence as of the interview seem to be fairly accurate—almost 82 percent of women correctly classified their place of residence at the interview, according to the site's geographic classification of its size (results not shown)—the self-reported level of urbanization in the place of residence is not reliable for drawing inferences about the importance of *site-specific flows.*

Indeed, using the self-reported place of residence rather than the geo-classification implies that a much smaller proportion of women changed residence within a fixed period prior to the survey. For example, among women who were living in a capital city as of the interview (according to the geo-code), about 19.5 percent were living in a city/village and 4.1 percent in a rural area five years ago. If the self-reported place of residence had been used (the lower panel), only 6.7 percent of the residents in a capital city as of the interview would have come from a city/village and only 3.1 percent from a rural center. Using the geo-code rather than the perceived level of urbanization in the place of residence as of the interview yields a difference of almost 16 percentage points in the proportion of residents in a capital city as of the interview who had moved from another place of residence.

In brief, most of the female migrants in northeastern Brazil left cities or villages to move to a capital city (that is, a large city) or to another city/village. For example, almost 97 percent of women who were living in a city/village five years prior to the interview were living in a capital city or in a city/village as of the interview (see the column percentages in the lower panel of the right-hand side of Table 2). In addition, mobility from rural centers to cities or villages was not an uncommon event in the late 1980s (for example, about 11.5 percent of women who reported having lived in a rural area five years prior to the interview reported living in an urban center five years later.) Still,

Table 2. Percentage Distribution of Women According to Place of Residence at the Interview, by Place of Residence at the Beginning of an Observation Interval

	Self-Reported Place of Residence									
	Observation Interval									
	One Year Prior to Interview					Five Years Prior to Interview				
	Capital	City/ Village	Rural	Change[a]	Total	Capital	City/ Village	Rural	Change[a]	Total
Place of Residence at Interview (Based on Geo-Code)										
Capital	80.5	17.4	1.8	0.3	100.0	76.1	19.5	4.1	0.3	100.0
	60.9[b]	**11.2**	**1.4**	**18.5**	**24.1**	**59.9**	**12.8**	**3.1**	**33.3**	**24.1**
City/Village	26.4	70.2	2.9	0.5	100.0	25.8	66.4	7.6	0.2	100.0
	38.0	**85.9**	**4.4**	**48.2**	**45.2**	**38.6**	**82.5**	**10.8**	**40.0**	**45.8**
Rural	1.2	3.6	94.7	0.5	100.0	1.6	5.8	92.4	0.2	100.0
	1.2	**2.9**	**94.2**	**33.3**	**30.0**	**1.5**	**4.7**	**86.2**	**26.7**	**30.0**
Total	31.9	37.5	30.2	0.4	100.0	30.7	36.9	32.2	0.2	100.0
	100.0	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	
Self-Reported Place of Residence at Interview										
Capital	96.3	2.7	0.8	0.2	100.0	89.9	6.7	3.1	0.3	100.0
	97.6	**2.3**	**0.9**	**11.1**	**32.3**	**94.9**	**5.9**	**3.0**	**40.0**	**32.3**
City/Village	1.3	96.2	1.8	0.7	100.0	3.2	89.3	7.3	0.2	100.0
	1.6	**96.2**	**2.2**	**59.3**	**37.6**	**3.9**	**90.6**	**8.5**	**40.0**	**37.5**
Rural	0.9	1.6	97.1	0.4	100.0	1.2	4.1	94.5	0.2	100.0
	0.8	**1.3**	**96.6**	**29.6**	**30.0**	**1.2**	**3.4**	**88.2**	**20.0**	**30.0**
Change	0.0	50.0	50.0	0.0	100.0	0.0	37.5	62.5	0.0	100.0
	0.0	**0.2**	**0.2**	**0.0**	**0.1**	**0.0**	**0.1**	**0.3**	**0.0**	**0.2**
Total	31.9	37.5	30.2	0.4	100.0	30.7	36.9	32.2	0.2	100.0
	100.0	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	

NOTES: Totals may not add up to 100.0 due to rounding.
[a] Refers to the woman's report of a change of residence in that month.
[b] Figures in bold represent column percentages.

it is not possible to generate an accurate estimate of the importance of site-specific flows because the validity of the reports of the previous place of residence, if any, is not known.

2. Fertility

Fertility in northeastern Brazil declined by nearly 30 percent between 1986 and 1991 (Ferraz et al., 1992). For instance, in 1991, the total fertility rate was 3.7 children per woman, compared with 5.2 in 1986. Although the reductions in fertility were equally impressive in urban and rural areas, the fertility level in rural areas in 1991 declined only to the fertility level of women in northeastern Brazil five years earlier. In contrast, the fertility rate in urban areas fell to 2.8 children per woman at the beginning of the 1990s.

3. Contraceptive Use

The fertility decline in northeastern Brazil in the late 1980s was accompanied by an increase in the prevalence of contraceptive use of about 11 percent between 1986 and 1991, from 53 to 59 percent of all married women age 15 to 49 years at the interview (Ferraz et al., 1992). At the time of the interview, about 60 percent of all women living in urban areas were using a method, compared with about 44 percent of women living in rural areas. The most important change in the pattern of contraceptive use during this five-year period was a significant increase in the proportion of women opting for sterilization. The prevalence of this method rose from 25 percent in 1986 to almost 38 percent in 1991. The pill and sterilization accounted for more than 85 percent of all methods used in northeastern Brazil in 1991. Because almost 50 percent of users of the pill abandoned this method within the first year after adopting it, contraceptive practice in northeastern Brazil essentially consists of sterilization.

Is Residential Mobility Associated with Contraceptive Use?

This section includes an examination of the determinants of migration within the one-year and five-year intervals prior to the interview, a discussion of how the groups of migrants and nonmigrants were constructed so as to balance their demographic and socioeconomic characteristics, and an assessment of the importance of the selection, adaptation, and disruption hypotheses in explaining contraceptive choice in northeastern Brazil.

Sociodemographic Differences Between Migrants and Nonmigrants

With few exceptions, the distribution of the characteristics of migrants and nonmigrants is substantively and statistically different for the two groups.[13] For instance, nearly 70 percent of women who changed residence within the one-year interval prior to the survey were 15 to 24 years of age at the beginning of this period, compared with only 43 percent of the nonmigrants of similar age (see Table 3).

Table 3. Percentage Distribution of Women According to Selected Characteristics and Migration Status within an Observation Interval Prior to the Interview

Characteristics	Observation Interval: Migration Status: One Year Prior to Interview: Migrated	Did Not Migrate	Total	Five Years Prior to Interview: Migrated	Did Not Migrate	Total
Age (in Years)[a]						
15 - 24	68.0	43.1	44.4	70.9	53.8	56.4
25 - 34	18.7	27.5	27.0	17.4	25.5	24.2
35 - 49	13.3	29.4	28.6	11.7	20.7	19.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (2) = 77.86; p = 0.000			χ^2 (2) = 97.22; p = 0.000		
Residence at Age 12						
Capital	11.4	21.8	21.3	9.8	23.4	21.3
City/Village	42.7	35.2	35.6	38.2	35.1	35.6
Rural	45.9	42.9	43.0	51.8	41.4	43.0
Missing	0.0	0.1	0.1	0.2	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (3) = 21.15; p = 0.000			χ^2 (3) = 91.96; p = 0.000		
Woman's Years of Education						
None	12.3	16.9	16.6	16.1	16.7	16.6
1 - 3	25.3	22.7	22.8	23.7	22.7	22.8
4	16.5	13.7	13.9	15.9	13.5	13.9
5 - 8	28.8	25.5	25.7	28.2	25.2	25.7
9 or more	17.1	21.2	21.0	16.1	21.9	21.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (4) = 9.94; p = 0.041			χ^2 (3) = 19.58; p = 0.000		
Whether in Union[a]						
Yes	42.4	54.7	54.1	50.2	54.8	54.1
No	57.6	45.3	45.9	49.8	45.2	46.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (1) = 18.38; p = 0.000			χ^2 (1) = 7.11; p = 0.008		
Children Ever Born[a]						
None	56.7	40.3	41.1	63.6	49.6	51.7
1 - 2	24.4	23.2	23.2	17.0	18.7	18.4
3 - 5	16.5	25.4	24.9	14.1	22.2	21.0
6+	2.5	11.2	10.8	5.3	9.6	8.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (3) = 50.22; p = 0.000			χ^2 (3) = 73.11; p = 0.000		

TABLE 3 *(continued)*

Characteristics	Observation Interval: Migration Status: One Year Prior to Interview: Migrated	Did Not Migrate	Total	Five Years Prior to Interview: Migrated	Did Not Migrate	Total
Who Should Decide about the Number of Children?						
Woman	40.6	34.9	35.2	36.1	35.0	35.2
Man	11.7	9.3	9.4	12.8	8.8	9.4
Both	43.0	49.1	48.8	45.5	49.4	48.8
Other/doesn't matter	0.0	0.3	0.3	0.1	0.3	0.3
God	2.2	1.5	1.6	1.6	1.6	1.6
Do not know	2.5	4.9	4.7	3.9	4.9	4.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (5) = 12.06; p = 0.034			χ^2 (5) = 19.33; p = 0.002		
Who Should Decide about the Use of Contraceptives?						
Woman	64.9	58.2	58.6	60.9	58.1	58.6
Man	10.8	15.3	15.1	13.0	15.6	15.1
The one who has the fewest problems	3.5	3.1	3.1	3.8	2.9	3.1
Does not matter	10.1	11.6	11.5	10.8	11.6	11.5
Other	7.6	6.8	6.9	6.7	6.9	6.9
Do not know	3.2	5.0	4.8	4.8	4.9	4.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (5) = 9.47; p = 0.092			χ^2 (5) = 6.76; p = 0.239		
Method Used at the Beginning of the Interval[a,b]						
No method	67.1	54.9	55.1	74.1	64.1	65.7
Coitus-independent	8.9	9.7	9.7	8.3	8.8	8.7
Sterilization	11.1	22.8	22.2	6.6	14.7	13.5
Coitus-dependent	4.7	4.7	4.7	3.1	3.8	3.7
Pregnant	8.2	7.9	7.9	7.9	8.5	8.4
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (4) = 26.92; p = 0.000			χ^2 (4) = 53.44; p = 0.000		
Whether Woman Ever Moved Prior to Interval[a]						
Yes	53.5	43.2	43.8	34.8	36.5	36.2
No	46.5	56.8	56.2	65.2	65.5	63.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (1) = 12.77; p = 0.000			χ^2 (1) = 1.02; p = 0.312		

TABLE 3 *(continued)*

Characteristics	Observation Interval: Migration Status: One Year Prior to Interview: Migrated	Did Not Migrate	Total	Five Years Prior to Interview: Migrated	Did Not Migrate	Total
Place of Residence[a]						
Capital	19.9	32.5	31.9	15.7	33.4	30.7
City/village	45.9	37.1	37.5	41.4	36.1	36.9
Rural	34.2	30.0	30.2	42.5	30.3	32.2
Change of residence	0.0	0.4	0.4	0.4	0.2	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (3) = 24.41; p = 0.000			χ^2 (3) = 127.12; p = 0.000		
Employment Status[a]						
Unemployed	65.5	54.0	54.6	68.9	61.3	62.5
Paid employment	34.2	44.2	43.7	29.5	36.9	35.8
Unpaid employment	0.3	1.6	1.5	1.6	1.7	1.7
Employer	0.0	0.2	0.2	0.0	0.1	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
	χ^2 (3) = 17.96; p = 0.000			χ^2 (3) = 20.34; p = 0.000		
Total	94.9	5.1	100.0	84.6	15.4	100.0
Sample Size	5,906	316	6,222	5,267	955	6,222

NOTE: The Pearson Chi-square statistic assesses whether the distribution of the characteristics of women who migrated differs from the distribution of the characteristics of those who did not migrate.

[a] Measured at the beginning of the observation interval.

[b] Coitus-independent methods are the pill, IUD, injections, and implants; coitus-dependent methods are condoms, rhythm, coitus interruptus, and vaginal methods; and sterilization includes male and female operations.

Migrants were younger than their counterparts who did not move from the place of residence where they were living at the beginning of the observation interval. More migrants who changed residence at least once in the five-year interval prior to the survey had lived in a rural area at age 12 (51.8 percent) versus 41.4 percent of nonmigrants, a difference that is statistically significant. Similarly, the distribution of the number of years of education among migrants and nonmigrants differed at the interview; a lower percentage of nonmigrants had less than 9 years of education (79 percent versus 83 percent of migrants). In addition, more migrants did not have children, were not in union, and were not using a contraceptive method. Note that nearly one-quarter (22.8 percent) of the nonmigrants had been sterilized at the onset of the one-year observation interval, whereas only about 11.1 percent of the migrants had used this method by the onset of the one-year interval. More migrants were unemployed at the onset of the one-year interval: 65.5 percent versus 54 percent. The distribution of female migrants and nonmigrants according to their belief about who should decide the contraceptive methods to be used is similar; around 60 percent of both groups (58.6 percent for both intervals) reported that they should decide who uses a contraceptive method. In

contrast, nearly half of the women reported that the decision about the number of children should be a joint decision between them and their spouses, but the responses of migrants and nonmigrants differed.

In summary, it is clear that the contraceptive experience of migrants and nonmigrants is not directly comparable, due to the imbalance of most of the demographic and social characteristics of these two groups and, equally probable, due to differences in the unmeasured factors associated with the decision to migrate and regulate fertility. Thus, as stated in the Data and Methods section, achieving unbiased inferences about the possible influence of residential mobility on contraceptive use necessitates constructing groups of comparable individuals based on their propensity to migrate.

The Propensity to Migrate

The method proposed by Rosenbaum and Rubin (1984) calls for constructing propensity-to-migrate groups from the predicted probabilities of changing residence within a period prior to the interview, estimated with a logit model.

Separate models were fitted for each study period. They included several socioeconomic and demographic factors that are considered to be important predictors of the change in residence within the observation interval. Information on the childhood place of residence attempts to capture the characteristics of the environment where the early socialization of women occurred. The place of residence at the beginning of the observation interval is included as an important predictor of mobility, because women probably moved elsewhere if they lived in a rural area or a small village. The woman's ethnicity is a control for differences in aspirations and cultural values, as well as social standing. The educational level of the woman and her husband (if married at the time of interview) is expected to be positively correlated with the likelihood of migration. A dummy variable for whether the woman changed residence before the observation interval is expected to be strongly related to her propensity to migrate within the study period. Because migration is negatively related to the ages and number of children ever born, as has previously been shown in many studies, these variables are also included in the logit model. Similarly, employment and marriage status at the onset of the study period are incorporated in the analysis because it has been postulated that married and employed women are less likely to migrate than their unemployed and unmarried counterparts (Mincer, 1978). Several variables related to attitudes toward fertility control are also considered, e.g., the contraceptive method used at the beginning of the observation interval and the woman's opinion about who should decide the number of children and whether to use contraceptive methods, because migration decisions are expected to be closely related to the "modernity" of women's views toward controlling their reproduction. The distributions of most of these variables for the one-year and five-year intervals were reported previously in Table 3.

The multivariate analysis of migration within the study period suggests that women who spent their childhood in rural areas were more likely to move within the observation interval, as were those who changed residence prior to the study period (results not shown). Similarly, mobility is positively correlated with more years of education. In

contrast, women are less likely to migrate if they are age 35 or older, had given birth to at least one child by the beginning of the observation interval, were living in union, or were employed at that time. Residents of areas other than capital cities are more likely to migrate than their counterparts. Whereas the likelihood of migration is higher among users of coitus-independent methods (that is, the pill, IUD, injections, and implants), women who had been sterilized by the beginning of the observation interval seemed to be less likely to migrate than those who were not using a method (net of other factors, including age). Finally, information on who decides the number of children or which of the couple's members should use a contraceptive method has a small impact on the likelihood of migration. As explained earlier, these two variables were included in an attempt to measure the attitudes of women and their spouses towards regulating their fertility behavior.

Box-plots of the distribution of the estimated probability of changing the place of residence within the pre-interview intervals—or the *propensity to migrate*—are shown in Figure 1. The figures for the one-year interval are seen in the upper panel; the corresponding distributions for the five-year interval are seen in the lower panel. The median of the propensity score is the line that bisects the boxes; by construction, the median for migrants is higher than that for nonmigrants. Despite some outliers among nonmigrants—women whose predicted probability of migration was high but who did not move (shown by the circles at the top of the vertical line emerging from the box, or the "whisker")—almost each migrant has a comparable nonmigrant in the sense that their estimated probability of migration is similar, thus supporting the contention that the propensity score technique *balances migrants and nonmigrants according to the factors that affect the likelihood of pre-interview migration.*

Classifying women successfully into groups whose characteristics are comparable depends on how well the propensity score model fits the data. If the model effectively predicts whether a woman changed residence within an observation interval prior to the interview, then the propensity groups will contain individuals whose observable characteristics are more akin to each other.

The logit model gives a fairly good fit to the data. For example, the overall predictive power of the propensity score function ranges between 37 percent for the five-year study interval to 45 percent for the one-year study interval (see Table 4).[14] The sensitivity and specificity of the models are also fairly high, despite a large false positive rate, which is expected when uncommon events are modelled.[15] Even the pseudo-R^2 indicates a high value for a model of a binary response (Cox and Wermuth, 1992). Chi-square tests of the goodness of fit of grouped data (four groups based on the quartiles of the distribution of the propensity score) reveal no statistically significant difference between the number of predicted migrants and the number of observed migrants within each of the four groups, confirming that the models fit the data well for both pre-interview intervals.

Figure 1. Propensity score box plots for 1-year and 5-year intervals prior to interview by migration status

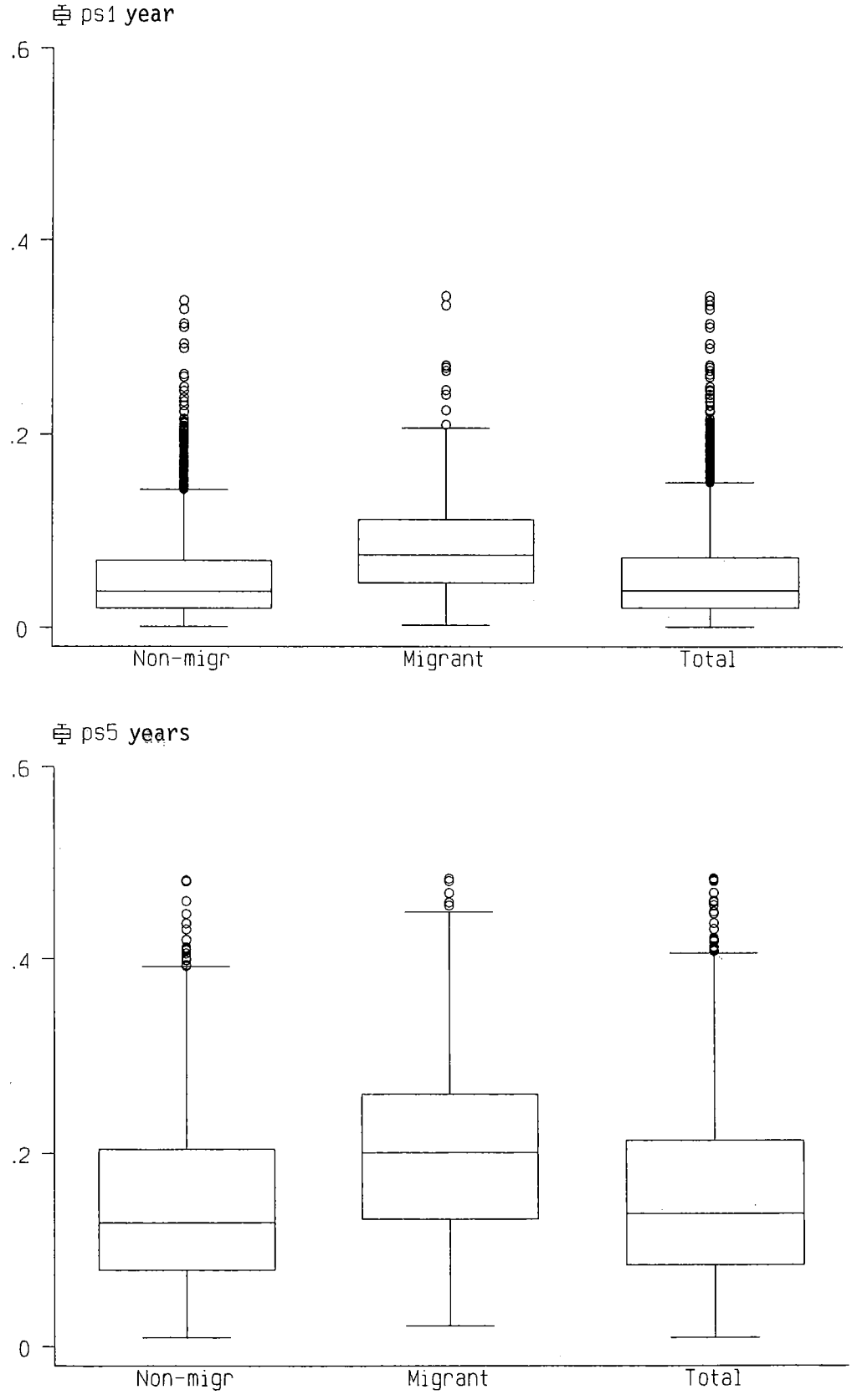


Table 4. Goodness of fit of a logit model that predicts the probability of migration within an observation interval prior to the interview (Propensity Score)

	One-Year Interval	Five-Year Interval
Log-Likelihood	-1,146.64	-2,493.83
Pseudo-R^2[a]	0.081	0.065
Hosmer-Lemeshow Chi-Square Test[b]		
χ^2 (2)	1.94	0.49
p	0.379	0.781
Model Sensitivity[c,d]	72.8%	67.2%
Model Specificity[c,d]	63.2%	59.7%
False Positive Rate[c]	90.4%	76.8%
False Negative Rate[c]	2.3%	9.1%
Overall Predictive Power[e]	45.1%	36.7%

[a] The pseudo-R^2 is defined as the reduction in the value of the likelihood function for the null model attributable to the model under consideration.

[b] Table collapsed on quartiles of predicted probabilities.

[c] A positive event (that is, whether a woman migrated within the observation interval) occurs when the predicted probability of experiencing the event is greater than or equal to the observed average proportion of women who migrated within the observation interval.

[d] Sensitivity is defined as the proportion of true positive events that were predicted to be positive. Specificity is the proportion of true negative events that were predicted to be negative.

[e] Defined as (area under ROC curve - 0.5)/0.5, where the receiving operating characteristic (ROC) curve is a graph of sensitivity versus (1 - specificity) the cutoff varied. A model without predictive power has an area of 0.5; a perfect model has an area of 1.

But a crucial test of the propensity score method is whether the distribution of specific characteristics among a group of persons with similar predicted probabilities of migration is balanced, that is, it does not differ for migrants and nonmigrants. The quartiles of the distribution of the predicted probability of migration yields four propensity groups. Although Rosenbaum and Rubin (1984) claim that using five groups reduces selection bias by almost 90 percent, this study uses four propensity groups as a compromise between achieving a reasonable reduction in bias and preserving a sufficiently large sample size in each group to lend stability to the parameter estimates of the models that are fitted within each propensity class.

In brief, the propensity score grouping is highly successful at balancing the distribution of migrants within each class. In only two of 104 comparisons (13 variables x 2 study periods x 4 propensity groups) did the distribution of an individual characteristic differ significantly between migrants and nonmigrants (results not shown). This success in

making the observable characteristics of women who migrated similar to those of women who did not migrate is illustrated in Figure 2 for the type of contraceptive method used at the beginning of the one-year study period. The figure shows that, within each propensity-to-migrate group, the distribution of the type of contraceptive method used one year prior to the interview is similar for migrants and nonmigrants. In contrast, the distribution for the entire sample (the last group of bars in Figure 2) shows a considerably larger percentage of nonmigrants who had opted for sterilization relative to those who had moved within the study period, as reported in Table 3.

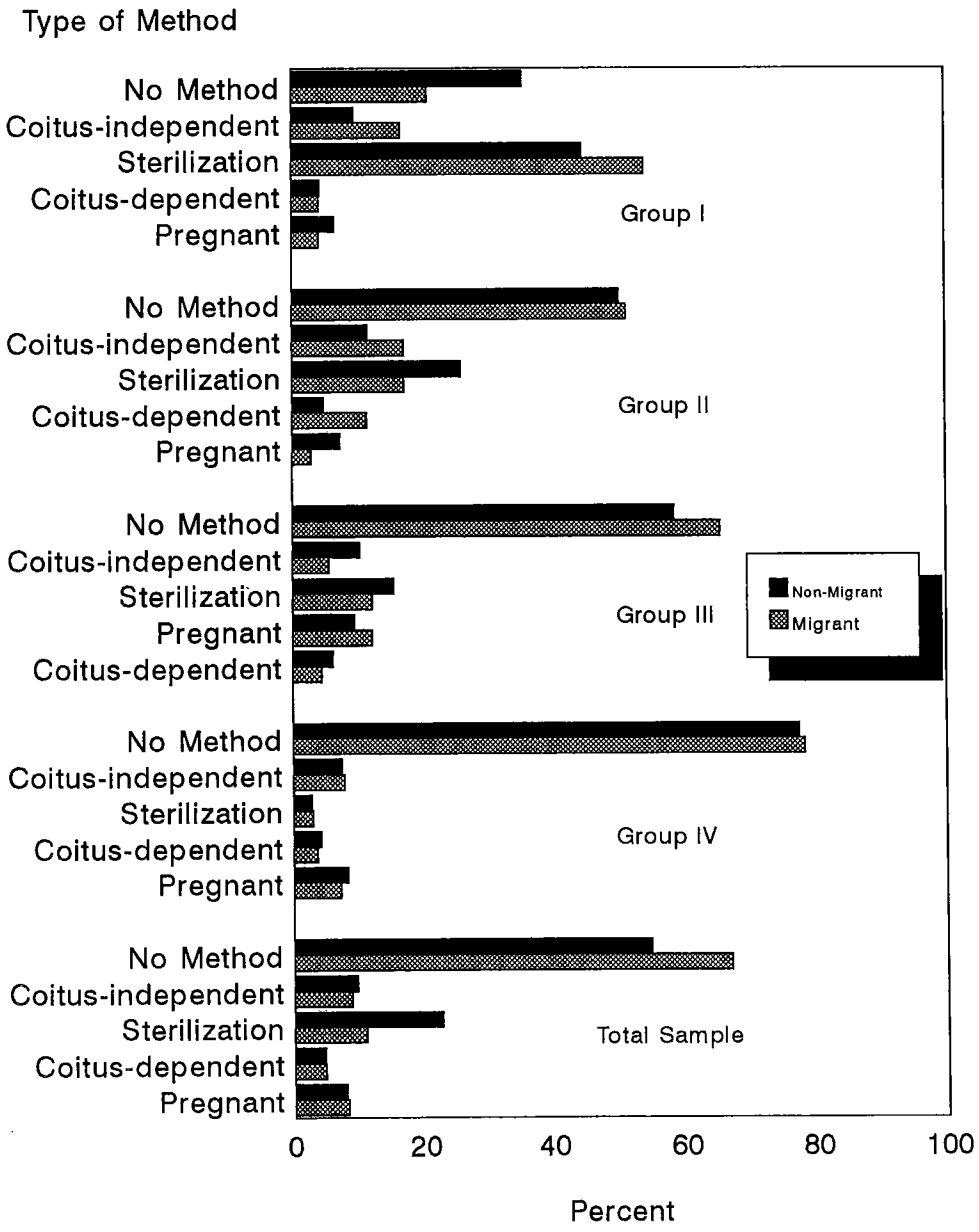
Models of Contraceptive Use and Choice

When the sample has been partitioned into groups whose characteristics are comparable, the influence of migration on contraceptive choice within each group can be analyzed with a higher degree of confidence that the inferences from this relationship will be less biased than in the absence of a control on observable characteristics from the propensity score (Rosenbaum and Rubin, 1984; Theorem A.1).

In this study, tests of two of the hypotheses described under the heading Selection, Adaptation and Disruption Hypotheses are based on multinomial logit models of contraceptive choice (no use or the use of coitus-independent methods, sterilization, and coitus-dependent methods). The models include the additive effects of several social and demographic factors, as well as whether a woman migrated within the pre-interview period, on the log-odds of choosing a specific type of contraceptive method. No interaction terms are included in the specification of these models.

Among the factors considered, the (self-reported) type of place of residence—either at the interview or earlier at the beginning of the observation interval, depending on the hypothesis tested—accounts for the influence of the level of urbanization and other characteristics of the place of residence on contraceptive choice. Age, the number of children ever born, and union and employment status at the beginning of the observation interval are baseline controls. A dummy variable that measures whether the woman changed residence prior to the beginning of the observation interval is a control for previous experience with changes in community. The inclusion of a woman's years of education reflects the finding in many other studies that the likelihood of contraceptive use is higher among better educated women. Finally, information on who decides which of the couple's members should use contraceptive methods should identify women with similar attitudes toward regulating fertility and desired family size. Both years of education and the decision about who should use contraceptive methods are measured as of the interview.

Figure 2. Method distribution 1 year prior to interview by migration status and propensity-to-migrate groups



In turn, two models of contraceptive method choice have been tested: (1) the type of method used by nonpregnant women as of the interview, regardless of their contraceptive or pregnancy status at the onset of the observation interval, and controlling for the place of residence as of interview; and (2) the type of method used as of the interview by nonpregnant women who were *not using* a method at the beginning of an observation interval prior to the interview, and controlling for the place of residence at the onset of the study period. The first model assesses whether women *adapted* to the contraceptive regime of their destination, whereas the second assesses whether migrants adopt contraceptive practices just before the move or immediately upon destination in response to the *disruption* that a change in the place of residence may have imposed on their lives. In contrast, the test for the *selection* hypothesis entails using information from an econometric model of contraceptive use among migrants, and it is conducted with a sample of migrant women who were not pregnant.

Both models fit the data well, as measured by the pseudo-R^2 criterion (Good, 1950). In some instances, this statistic reached values of close to 0.4, implying that the factors included in the model reduced the likelihood function by almost 40 percent from the function in a model that assumes that the odds of a specific contraceptive method use among all women in the sample are equal (that is, the null model). In addition, the coefficients for the factors considered show the expected sign (results not shown). For instance, women with more years of education are more likely to use a specific type of contraceptive method as of the interview than women with fewer years of schooling. Similarly, women who migrated prior to the study period are more likely to use a contraceptive method than those who had never migrated. As expected, the likelihood of contraceptive use increases with the number of children ever born, as well as when a woman is in union. Women currently living in a rural area are less likely to use a contraceptive method than their more urbanized counterparts, and similar results are reached when the model controls for the place of residence at the beginning of the observation interval. The employment status at the onset of the study period has a mixed effect on the likelihood of using a method. The magnitude of these effects varies according to the type of method selected by a woman.

Results

1. Selectivity Hypothesis

Evidence of selection bias in the sample of Brazilian women is inconclusive. For example, a bivariate probit specification with structural shift modelled whether women were using *any* contraceptive method at the time of the interview. The factors used in the selection (to migrate) equation are those used to estimate the propensity score. The factors used in the contraceptive-choice equation are those used in a multinomial model of method choice by nonpregnant women as of the interview regardless of their contraceptive status at the beginning of the observation interval.[16] For both study periods, the results indicate that this sample is nonrandomly selective according to the migrant variable (that is, the correlation between the unobserved factors in the migration equation and the

contraceptive-use equation is positive and statistically significant), although the model did not converge for the one-year observation interval.

Note that the conclusions from this probe are not necessarily generalizable to the analysis of contraceptive choice by the migrants and nonmigrants considered in this research. Thus, in the absence of more conclusive evidence about selection bias due to unobservable characteristics, the adaptation and disruption hypotheses are tested with the propensity score analysis assuming the exogeneity of migration.

Finally, note that a finding that the sample of migrants is selective would imply that the family planning practices of women who changed their community of residence are more innovative or "modern" than are those of women who did not move. Thus, the belief that socioeconomic pressures are forcing women with little knowledge of contraceptive practice out of their communities of residence would *not* be compatible with the findings presented in this research. Moreover, the support for the selection hypothesis would indirectly lend credibility to advocates of the "innovation/diffusion" hypothesis of fertility control (see, for example, Brown et al., 1992), which has gained popularity as a determinant of the large fertility reductions in Europe and, more recently, in low-income countries.

2. Adaptation Hypothesis

Evidence of the adaptation hypothesis is also difficult to corroborate. To facilitate the discussion of results, Table 5 reports adjusted probabilities of using specific contraceptive methods at a given point in time by whether women changed their community of residence within an observation interval prior to the interview. The adjusted probabilities were calculated from the model in which migration status was varied but all other factors were held constant. Thus, the reported figures reflect the net effects of migration after controlling for the demographic and socioeconomic factors listed earlier. The table presents the adjusted probabilities of using a type of contraceptive method for each of the propensity groups and for the combined sample for the one-year and five-year study periods,[17] and also the results of a likelihood-ratio test that assesses whether the coefficients of the migration status variable differed significantly from zero in all three equations of the multinomial logit model. In other words, this test ascertains whether the contraceptive use of migrants and nonmigrants differs significantly.

According to the results, after controlling for residence as of the interview, the probabilities of contraceptive use among nonpregnant women who migrated within the study period do not differ from those of women who did not change their community of residence in that interval. Although for about half of the propensity groups a higher percentage of migrants were using a method as of the interview, the differences are not statistically significant at the conventional levels (see the p-value for the Chi-square test). For all groups combined, the differences between migrants and nonmigrants are negligible for the one-year and five-year observation intervals. The similarity of the

Table 5. Adjusted probabilities of using specific contraceptive methods as of the interview among migrant and nonmigrant nonpregnant women within an observation interval prior to the interview (Adaption Hypothesis)

Propensity-to-Migrate Group Type of Method	Observation Interval: One Year Prior to Interview Migration Status: Migrated	Observation Interval: One Year Prior to Interview Migration Status: Did Not Migrate	Observation Interval: Five Years Prior to Interview Migration Status: Migrated	Observation Interval: Five Years Prior to Interview Migration Status: Did Not Migrate
Group I	(n = 24)	(n = 1,522)	(n = 93)	(n = 1,461)
No method	36.0	39.2	44.7	46.0
Coitus-independent	9.2	8.9	10.8	6.5
Sterilization	54.8	47.9	38.0	43.9
Coitus-dependent	0.0	4.0	6.5	3.6
	χ^2 (3) = 1.40; p = 0.706		χ^2 (3) = 3.80; p = 0.284	
Group II	(n = 35)	(n = 1,511)	(n = 164)	(n = 1,390)
No method	55.6	53.7	49.8	50.3
Coitus-independent	18.1	11.9	12.1	11.5
Sterilization	19.9	29.3	31.2	33.2
Coitus-dependent	6.4	5.1	6.9	5.0
	χ^2 (3) = 2.96; p = 0.398		χ^2 (3) = 1.21; p = 0.751	
Group III	(n = 90)	(n = 1,456)	(n = 272)	(n = 1,281)
No method	63.7	62.2	67.6	64.5
Coitus-independent	11.4	11.6	10.2	10.8
Sterilization	21.5	20.2	18.9	18.3
Coitus-dependent	3.4	6.0	3.3	6.4
	χ^2 (3) = 1.28; p = 0.733		χ^2 (3) = 4.84; p = 0.184	
Group IV	(n = 166)	(n = 1,380)	(n = 425)	(n = 1,130)
No method	77.6	79.1	74.4	71.9
Coitus-independent	10.1	12.4	13.9	16.7
Sterilization	7.0	4.7	6.5	7.3
Coitus-dependent	5.3	3.8	5.2	4.1
	χ^2 (3) = 2.58; p = 0.461		χ^2 (3) = 2.24; p = 0.524	
All Groups	(n = 316)	(n = 5,869)	(n = 955)	(n = 5,262)
No method	58.6	58.2	58.1	57.8
Coitus-independent	12.5	11.1	11.9	11.3
Sterilization	25.2	25.9	23.8	26.1
Coitus-dependent	3.7	4.8	6.2 *	4.8
Total	100.0	100.0	100.0	100.0
	χ^2 (12) = 7.03; p = 0.855		χ^2 (12) = 15.04; p = 0.239	

NOTES: Coitus-independent methods are the pill, IUD, injections, and implants; coitus-dependent methods are condoms, rhythm, coitus interruptus, and vaginal methods; and sterilization includes male and female operations.

The probabilities were adjusted for the following factors: place of residence at interview; age, number of children ever born, and employment status at the beginning of the observation interval; whether the woman was in union at the onset of the interval; whether the woman had ever migrated prior to the beginning of the observation interval; the woman's years of education at the interview; and who decides about contraceptive use. The estimates for "All Groups" also include the propensity group as a factor and its interaction with migration status.

The likelihood-ratio test assesses whether the coefficients of migration status within an observation interval differ significantly from zero in all equations of the discrete choice model.

Totals may not add up to 100 due to rounding.

*The coefficient in the multinomial logit model differs significantly from zero ($p \leq 0.05$; two-tailed test).

results for the two study periods calls into question whether migrant women adapt to the contraceptive regime of their place of destination immediately after their change in community or whether their adaptation spans over several years after migration.

Note that the small migrant-nonmigrant differences in the percentage of women using a specific type of contraceptive method (or no method at all) across the propensity-to-migrate groups suggest that the selectivity of migrants might be less important than suggested before. If selection bias were present in the samples under consideration, then the migrant-nonmigrant differences among women less likely to change their community of residence (that is, women classified in the first propensity-to-migrate group) would be larger than among women classified as the most likely to change their community of residence (that is, those in group IV). However, the data do not support this pattern. Finally, note that the percentage opting for sterilization as of the interview is lower among women whose predicted probability of migration fell above the 75th percentile of the distribution of the propensity-to-migrate score (that is, in group IV) than among women who were classified in the lower quartiles of the distribution. Although this pattern indicates that the sociodemographic characteristics that are associated with the likelihood of changing community of residence are also related to the type of contraceptive method chosen by Brazilian women, the small migrant-nonmigrant differences in the proportion of women opting for sterilization as of the interview again suggest that migrants adopted the reproductive behavior of their place of destination very soon after they changed their residence.

3. Disruption Hypothesis

The adjusted probabilities of using specific contraceptive methods as of the interview among nonpregnant women who were *not using* a method at the beginning of the observation interval lend some support to the disruption hypothesis (see Table 6). Indeed, for most of the propensity-to-migrate groups, and for the combined sample as well, more migrant women were using efficient methods—primarily sterilization—as of the interview than were their counterparts, although the differences between migrants and nonmigrants are not statistically significant. Still, these results suggest that more women are using contraceptive methods after migration and, consequently, are modifying their reproductive practices around the time of migration. This change, however, could also result from rapid adaptation of migrants to the contraceptive practices of the receiving area, as suggested in the previous section. Coitus-independent methods seem to be popular methods among those who change residence. In other words, among women who adopt a contraceptive method at the time they changed their residence, at least 30 percent use a coitus-independent method, although sterilization is another favorite choice among Brazilian women, as shown by the results for group II in the five-year observation interval. A similar analysis for those who were using a contraceptive method at the beginning of the study period also suggests that migrants are more likely to continue using a method as of the interview than those who remain in their community of residence (results not shown), although the differences are not statistically significant.

Table 6. Adjusted probabilities of using specific contraceptive methods as of the interview among migrant and nonmigrant nonpregnant women who were not using a method at the beginning of an observation interval prior to the interview (Disruption Hypothesis)

Propensity-to-Migrate Group Type of Method	Observation Interval: Migration Status — One Year Prior to Interview: Migrated	One Year Prior to Interview: Did Not Migrate	Five Years Prior to Interview: Migrated	Five Years Prior to Interview: Did Not Migrate
Group I	(n = 24)	(n = 1,522)	(n = 93)	(n = 1,461)
No method	100.0	88.5	72.8	77.8
Coitus-independent	0.0	5.4	11.1	6.6
Sterilization	0.0	3.8	10.8	12.7
Coitus-dependent	0.0	2.3	5.3	2.9
	χ^2 (3) = 1.90; p = 0.595		χ^2 (3) = 2.04; p = 0.565	
Group II	(n = 35)	(n = 1,511)	(n = 164)	(n = 1,390)
No method	76.1	88.9	70.5	71.0
Coitus-independent	13.1	5.8	5.7	9.6
Sterilization	10.7	3.6	16.7	16.2
Coitus-dependent	0.0	1.7	7.2	3.3
	χ^2 (3) = 4.68; p = 0.197		χ^2 (3) = 4.67; p = 0.198	
Group III	(n = 90)	(n = 1,456)	(n = 272)	(n = 1,281)
No method	83.0	87.6	72.8	76.6
Coitus-independent	9.1	6.2	10.6	7.0
Sterilization	6.6	3.8	12.1	12.6
Coitus-dependent	1.4	2.4	4.5	3.8
	χ^2 (3) = 2.42; p = 0.490		χ^2 (3) = 3.42; p = 0.331	
Group IV	(n = 166)	(n = 1,380)	(n = 425)	(n = 1,130)
No method	86.8	88.8	74.8	78.2
Coitus-independent	9.3	8.1	15.0	13.5
Sterilization	1.0	1.6	5.2	4.6
Coitus-dependent	2.9	1.5	5.0	3.6
	χ^2 (3) = 1.66; p = 0.647		χ^2 (3) = 2.37; p = 0.500	
All Groups	(n = 316)	(n = 5,869)	(n = 955)	(n = 5,262)
No method	86.5	88.4	72.9	76.0
Coitus-independent	8.3	6.6	10.7	9.5
Sterilization	3.7	3.0	11.1	11.0
Coitus-dependent	1.4	2.0	5.2	3.5
Total	100.0	100.0	100.0	100.0
	χ^2 (12) = 10.06; p = 0.611		χ^2 (12) = 10.89; p = 0.538	

NOTES: Coitus-independent methods are the pill, IUD, injections, and implants; coitus-dependent methods are condoms, rhythm, coitus interruptus, and vaginal methods; and sterilization includes male and female operations.

The probabilities were adjusted for the following factors: age, place of residence, number of children ever born, and employment status at the beginning of the observation interval; whether the woman was in union at the onset of the interval; whether the woman had ever migrated prior to the beginning of the observation interval; the woman's years of education at the interview; and who decides about contraceptive use. The estimates for "All Groups" also include the propensity group as a factor, and its interaction with migration status.

The likelihood-ratio test assesses whether the coefficients of migration status within an observation interval differ significantly from zero in all equations of the discrete choice model.

Totals may not add up to 100 due to rounding.

*The coefficient in the multinomial logit model differs significantly from zero ($p \leq 0.05$, two-tailed test).

In summary, the results indicate that a change in the community of residence seems to be associated with a higher likelihood of using a contraceptive method, net of the effects of other important social and demographic determinants of contraceptive use. This difference could stem from the more innovative fertility-control behavior among migrant women than among those who remain, i.e, selectivity effects. The adaptation hypothesis is supported somewhat by the data, but it is unclear how rapidly a contraceptive method is adopted. Similarly, it is unclear whether migrants switch to more efficient methods around the time of the move or how different their behavior is relative to the behavior of those who do not migrate.

Discussion and Conclusions

Although this research offers promising conceptual and methodological insights into how the influence of migration on reproductive behavior can be assessed in a society undergoing demographic transition, several issues associated with this relationship remain unknown. Several recommendations stemming from this study are listed below.

Study Contraceptive-Use Practices in More Detail

Although Brazilian women who changed their community of residence within a period prior to DHS-II seem to be more likely to use a contraceptive method than women who remained in their usual residence (regardless of their contraceptive status at the beginning of the study period), the relationship is not strong enough to reassure researchers that the adaptation and disruption hypotheses are supported by the data. The selection hypothesis is supported somewhat by the available evidence, although the evidence comes from models other than those used in this research. This result, if confirmed clearly, would lend credibility to the postulate that innovative ideas or information on fertility regulation spread to less "modern" areas, where the most informed or more "modernized" women adopt fertility control in imitation. In turn, these young, educated, unmarried, and unemployed women who live in rural areas or small villages migrate to large urban centers or state capitals. Either in anticipation of their change in residence, or when they arrive at their new destination, Brazilian women living in the Northeast are likely to begin using modern contraceptive methods, primarily the pill. As these women settle down in their localities of destination (primarily large cities) they seem to opt rapidly for sterilization, despite the irreversibility of this method and the high prices charged for the operation. Moreover, because almost 50 percent of the women abandon the pill within a year after adopting it (primarily because of health concerns) they face the prospect of sterilization in order to avoid unintended pregnancies or else use no method at all. When and why this method-switching occurs remains to be clarified. Thus, the pattern of contraceptive-method adoption, use, and discontinuation among recent migrants in northeastern Brazil should be examined in more detail to support a better understanding of the previous results. This type of analysis would broaden our understanding of the relationship among the residential mobility, urbanization, and reproductive practices of women in this region of Brazil.

Refine the Data Available for Analysis

A second lesson from the research presented herein is that, although the data collected from a retrospective calendar of events could enhance our understanding of the relationship among migration, reproduction, and other socioeconomic processes, these data are far from complete. For instance, it would be desirable to be able to identify the community from which migrants move, so that the analysis would include the traits of the place of earlier residence. Because information on the characteristics of the place where the interview was conducted is available from the sampling frame of the survey, researchers would like to assess whether changes in the attributes[18] of the communities in which women lived both before and as of the interview may be associated with their decision to change communities and to use contraceptive methods.

Use the Study Results to Target Family Planning Programs

Finally, this research recommends that policymakers target women who have recently changed their community of residence as a group who will probably seek family-planning services. Because the fertility regulation practices of these women would seem to be selective at origin, they would continue to require family planning services in their new communities of residence. Due to their selectivity, to their rapid adoption of the contraceptive choices of residents in areas where contraceptive methods are used more frequently, or to the potentially disruptive effect of migration on their contraceptive practices, women who have recently changed place of residence should become a target of family planning programs.

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NOTES

1. Only in Egypt, the Philippines, and Mexico did the Contraceptive Prevalence Surveys collect information on why respondents had discontinued contraceptive use or how long they used recent methods. In some cases, the World Fertility Survey (WFS) asked about use in the open interval and last closed birth interval, but restricted this information to the type of method used and the reason for discontinuation; in very few cases was information obtained on the timing and duration of use (Singh, 1984). Only in Malaysia and Korea did the WFS collect more detailed contraceptive-use information on the timing and duration of use in all closed birth intervals.

2. Only in Turkey did the WFS include a history of residential mobility, which was ascertained for each household member age eight or older for the preceding eight years, counting only places where the member stayed for six or more months. The duration of the stay and the location of each place of residence were also obtained, as was the place of birth. In Ecuador, Mexico, and Yemen Arab Republic, the WFS asked some questions related to migration, but these fell short of a migration history (Singh, 1984).

3. A fourth premise, ***the socialization model***, is postulated on the observation that rural fertility generally is greater than urban fertility and, consequently, that contraceptive practice entails using more efficient methods or these methods more consistently. This model assumes that urban reproductive practices will be assimilated only after a considerable length of residence at destination. The socialization model differs significantly from the adaptation model, which assumes that fertility values occur among the migrants themselves and do not require several generations (Goldstein and Goldstein, 1983). This study does not address the socialization model.

4. The PSFNE was fielded in order to obtain more detailed information on the levels of fertility, contraceptive use, infant and child health, and mortality in northeastern Brazil than that provided by its predecessor—the *Pesquisa Nacional sobre Saúde Materno-Infantil e Planejamento Familiar* (Arruda et al., 1987). Most of the information from these two surveys is comparable.

5. Moreover, an experimental version of the calendar in the DHS-II core questionnaire which was evaluated in Peru (Goldman et al., 1989) and in the Dominican Republic (Westoff et al., 1990) yielded information on contraceptive use that was more complete and internally more consistent with other types of information, for example, employment histories, than were other approaches.

6. For more detailed discussions of definitions, see United Nations (1970) and Bilsborrow et al. (1984).

7. In the experimental study in Peru, Goldman et al. (1989) assessed the fit between the subjective reports of the degree of urbanization in the place of residence and more objective criteria, such as community size (or geo-code). They found that a large proportion of women living in rural areas and towns tended to classify their current place of residence in the next category of urbanization (that is, a town) when the place of residence was classified as a rural center according to geographic criteria. These results call for a cautious interpretation of perceived level of urbanization, since the accuracy of the reports cannot be assessed.

8. However, the PSFNE questionnaire ascertains the date of residential change before January 1986, if applicable, as well as the level of urbanization in the place of residence before the last move.

9. In the calendar, every move that is followed by a duration of at least one month is recorded, as is the urbanization level of the origin and destination. For moves in adjacent months, the urbanization level of the intervening place of residence cannot be recorded. This information generates a series of spells—an event history that begins with a left-censored interval (a residential spell that commences prior to the observation window, for which the duration of residence in January 1986 is known), continues with closed intervals (none to several), and ends with an open interval. It is possible that no migration takes place in the calendar period, and that the spell is open-ended on the right.

10. A contraceptive segment is defined as a period in which a contraceptive method is used, followed by a pregnancy, nonuse, or another method.

11. Note that the propensity score method does not require using exogenous variables for identifying the parameters of the model, as is usually required by other selection models (Heckman and Robb, 1986).

12. Coitus-dependent methods are condoms, rhythm, coitus interruptus, and vaginal methods; coitus-independent methods are the pill, IUD, injections, and implants; and sterilization includes male and female operations.

13. A Chi-square test was used to assess whether the distribution of a characteristic differed between migrants and nonmigrants.

14. The overall predictive power is defined as (area under ROC curve - 0.5)/0.5, where the receiving operating characteristic (ROC) curve is a graph of sensitivity versus (1 - specificity) the cutoff varied. A model without predictive power (0 percent) has an area of 0.5; a perfect model (100 percent) has an area of 1.

15. A positive event (that is, whether a woman migrated within the observation interval) occurs when the predicted probability of experiencing the event is greater than or equal to the observed average proportion of women who migrated within the observation interval.

16. These models were fitted with LIMDEP (Green, 1992).

17. The estimated probabilities and likelihood-ratio test for the combined sample are derived from a model that includes the propensity group as another factor in the model, and the interaction of the propensity score and the migration status. No attempt was made to correct for selection bias because there is no tractable solution to determine whether it exists and to correct for it in multinomial choice models.

18. Such attributes as the unemployment rate, the availability of family planning and maternal-child health services, and the cost of contraceptive methods, among others.