Husband-wife disagreement in rural Malawi: A longitudinal analysis

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Paper to be presented at the 2004 Meeting of the Population Association of America
April 1-3, Boston, MA

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Abstract

Several couple studies have found discordance between partners on subjective, as well as objective, matters. Explanations of couple disagreement generally consist of *ex-post* interpretations of quantitative data collected by individual cross-sectional surveys, such as the Demographic and Health Survey. In this paper, we adopt a different approach and we investigate husband-wife discordance in reporting by using quantitative and qualitative couple data from a longitudinal study in rural Malawi. Specifically, we expand on previous analyses of couple data in two main respects. First, we exploit the longitudinal nature of the survey to verify whether couples that disagree in the first round are more or less likely to disagree in the second round. Second, we draw on qualitative data that were purposively collected during the second round of the survey to debrief the respondents on their interpretation of the survey questions to explore the underlying reasons of couple disagreement. We find that the quantitative and qualitative evidence is consistent with the interpretation that contextual influences on individual reporting are the most important factor in explaining husband-wife inconsistencies, above and beyond different understanding of survey questions between spouses.

1. Introduction

Although spouses are expected to agree more than unrelated pairs, there is consistent evidence that husbands' and wives' responses to survey questions often differ (Miller, Zulu and Watkins 2001). Discordance between partners has been identified for subjective reports, such as desired family size (e.g. Bisson and Piche 1977; Coombs and Chang 1981; Fapohunda and Todaro 1988; Williams 1989) and intentions to use contraception (Thomson and Hoen 1996). Couple discrepancies have also been found for objective reports, such as coital frequency (e.g. Bachrach et al. 1992; Lagarde et al. 1995; Suzuki and Becker 2001), current and ever use of contraceptives, number of living children and household possessions (e.g. Green 1969; Coombs and Fernandez 1978; Mott and Mott 1985; Ezeh 1993; Becker and Costenbader 2001; Miller, Zulu and Watkins 2001; for a review, see Becker 1996).[1]

Couple discrepancies in reporting indicate response error on the part of one spouse or both, but determining which respondent (or if either) gave the correct response is usually impossible because validation studies of these indices are lacking (Becker 1996: 293). Ultimately, couple discrepancies are therefore a measurement problem. However, attempts to explain or to account for spousal differences in reporting have seldom been methodological. Most studies have tried to interpret these differences by focusing on the circumstances of reproductive decision-making, or on gender relations and normative behavior across sexes (Miller, Zulu and Watkins 2001).

[1] For most objective reports of reproductive health phenomena presented in surveys of couples, partners give identical responses to the same question less than 90 percent of the time. With respect to fertility and family planning intentions, the proportion of agreement between partners drops to 60-70 percent (Becker 1996: 301).

In this paper, we analyze couple discrepancies in reporting from a methodological standpoint, by using a measurement model that considers them as the indicator of response errors arising because of specific gendered interactions. The main thrust of this approach is that it is necessary to first understand couple discrepancies as a measurement problem in order to disentangle the underlying factors that account for them. We apply this methodological approach to the longitudinal analysis of couple discrepancies in reporting in a panel study carried out in rural Malawi, the Malawi Diffusion and Ideational Change Project (MDICP). This paper therefore considerably expands on previous analyses of couple disagreement, which have been primarily cross-sectional.[2]

The importance of the analysis presented in this paper stems from two sets of considerations. On the one hand, it helps assessing the validity and reliability of demographic measures obtained by means of survey interviews. For example, questions about household possessions are generally used to derive estimates of household assets in less developed countries. If husband-wife disagreement about household goods is culture-specific, then measures of household assets based on men's, rather than women's, reports might be dramatically biased, in Malawi as elsewhere. On the other hand, the analysis presented in this paper allows for inferences about the response process in the survey interview—namely, whether gender influences the way respondents negotiate the social norms implicitly regulating the survey process. This last consideration is of particular importance to correctly assess the importance of context effects in demographic research.

[2] Longitudinal couple studies have been used only to evaluate the relative importance of husbands and/or wives variables in predicting prospective fertility outcomes, not to evaluate and/or interpret couple discrepancies in reporting.

2. Data and methods

2.1 Data sources

The data for the analysis come from quantitative and qualitative information collected by the first and second wave of the Malawi Diffusion and Ideational Change Project, a household panel survey that examines the role of social networks in changing attitudes and behavior regarding family size, family planning, and HIV/AIDS in rural Malawi.

The first round of the MDICP (MDICP-1) was carried out in the summer of 1998, and interviewed 1541 ever-married women of childbearing age and 1065 husbands of the currently married women in three Malawi districts: Balaka in South, Mchinji in the Centre and Rumphi in the North. In the summer of 2001, the second round of the survey (MDICP-2) followed-up the same respondents (if still eligible), and also interviewed all their new spouses, if they had remarried between the two survey waves.

The focus of the MDICP questionnaire is on family planning, AIDS and social networks, with other questions about women's autonomy and basic socio-economic information (age, education, income and wealth), and some questions about children, contraception and marriage. Most questions on background characteristics, family planning and attitudes and behaviors towards HIV/AIDS are modeled on WFS/DHS questions. The questionnaire of the MDICP-2 also included a section on sexual partnerships, which was expected to be a sensitive issue given the magnitude of the HIV/AIDS epidemic in the country and the emphasis of prevention programs on marital fidelity (for a more detailed discussion of sampling and fieldwork procedures, *see*: Bignami-Van Assche 2003; Watkins et al. 2003).

2.2 Quantitative data

Couple analyses using the MDICP data present two main challenges. First, there is high marital mobility (Reniers 2003). This increases the difficulty of locating respondents to be interviewed. As Table 1a illustrates, in 1998 it was not possible to locate and interview either spouse for 5% of the couples sampled; in 2001, this percentage had increased threefold (up to almost 15%), mostly due to divorces and remarriages of either spouses originally sampled by the MDICP-1. Second, there is a high incidence of polygyny. The MDICP-1 data show that 11.4% of men and 12.2% of women report being in a polygynous marriage; the corresponding figures from the MDICP-2 data are 18.4% for men and 20.8% for women. Additional evidence of the relevance of polygyny for couples analyses of the MDICP data is provided by the fact that 8% of all monogamous couples sampled in 1998 were not monogamous anymore in 2001 (Table 1b).

[Table 1a and Table 1b about here]

[Table 2 about here]

Because of these difficulties, the present analysis is restricted to monogamous married couples. In particular, the longitudinal analysis presented in this paper focuses on 528 monogamous married couples for which both spouses were interviewed in the MDICP-1 as well as in the MDICP-2 (*see* Table 1b). For these couples, we evaluate consistency in reporting about 13 yes/no questions about household assets, fertility and family planning (Table 2) that were asked, with the same wording, in the MDICP-1 and the MDICP-2.[3]

[3] These are 13 of the 17 questions considered by Miller, Zulu and Watkins (2001) in their analysis of couple consistency in reporting in the MDICP-1. We could not analyze couple discrepancies in reporting for all

2.3 Qualitative interviews

In addition, this paper uses data from qualitative interviews carried out with 10 discrepant couples during the fieldwork operations for the MDICP-2. The couples were identified and selected in the field by Bignami-Van Assche the same day they had completed the survey interview. The following day, a different interviewer from the one who administered the original questionnaire visited the selected respondents, and asked them to describe the meaning they attributed to words in the questions and the method of constructing their answers to the questions.

These qualitative interviews were organized around three main themes:

1. the respondents' understanding of the underlying aims of the survey (*prompt*: "When you heard about these questions, what did you think they meant when asking these questions? What did you think yourself?");
2. the respondents' definition of household possessions (*prompt*: "Some people have been thinking differently when we were asking about things that they may include at this household, therefore, I will read a list of things and see if you can include it as a thing at your household"); and
3. the respondents' interpretation of having a discussion with their spouses (*prompt*: "what do you understand by the term 'discussion', for example if the wife tells the husband about family planning and the husband says nothing, can you say that they discussed or not?").

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items they considered because the MDICP-2 questionnaire did not ask questions about either children born in the five years preceding the survey or about discussing AIDS risk with the spouse.

2.4 Methods of analysis

Analysis of couple agreement in reporting is problematic because of the confounding effect of unreliability of measurements. Although it is defined as error, unreliability can produce patterns of manifest change that look very systematic. The research questions this paper addresses are: do couple discrepancies in reporting remain after controlling for random error? And, if that is the case, are there systematic trends in husband-wife disagreement over time?

To identify and account for the systematic consequences of unreliability in the analysis of husband-wife disagreement we use loglinear modeling with latent variables, which offers an excellent framework for this purpose (Hagenaars 1993: 52). Latent class models assume that observed (or 'manifest') variables do not directly reflect theoretical concept researchers wish to analyze but are instead imperfect indicators of that concept, and that the latent variable derived from those indicators more adequately reflects the concept. For each respondent's distinct observed pattern for a set of response variables, latent class analysis permits obtaining the set of conditional probabilities of that respondent's belonging to various latent classes (Yamaguchi 2000: 1703-4).

A basic latent structure model with four manifest categorical variables denoted by *A, B, C,* and D (with, respectively, *I, J, K* and *L* classes) that serve as indicators for one categorical latent variable *X* (with *T* classes) can be formalized as follows:

$$\pi_{XABCD}^{tijkl} = \pi_{X}^{t}\pi_{A|X}^{it}\pi_{B|X}^{jt}\pi_{C|X}^{kt}\pi_{D|X}^{lt} \qquad (1)$$

where π_{X}^{t} is called 'latent probability', and $\pi_{A|X}^{it}$ and $\pi_{B|X}^{jt}$ are called 'conditional response probabilities'. Equation 1 embodies the so-called *hypothesis of local independence:* the

manifest variables are independent of one another within the classes of the latent variable. The basic model in equation 1 can be extended to the case in which there are two latent variables (*Y* and *Z*), each having two indicators (Goodman 1984):

$$\pi_{YZABCD}^{tmijkl} = \pi_{YZ}^{tm}\pi_{A|Y}^{it}\pi_{B|Y}^{jt}\pi_{C|Z}^{km}\pi_{Z|Y}^{lm} \quad (2)$$

This latter model can be used when the items concern measurements at two points in time, and, by relaxing the assumption of local independence, permits taking into account test-retest effects, response consistency effects or, more in general, correlated response errors, and omitted variables (Hagenaars 1986; 1988).

[Figure 1 about here]

In this paper, we used the models presented above to analyze longitudinally couple discrepancies in reporting. For each item listed in Table 2, the four manifest variables of interest are represented by the husbands' (*H*) and wives' (*W*) responses at time 1 (1998) and time 2 (2001). We first postulate a classic latent class model (such as that in equation 1) in which the associations among these manifest variables are explained by one underlying, latent dichotomous variable *X* (a graphical representation of this model is given in Figure 1a). This variable corresponds to the true score of the manifest variables, namely, the actual ownership of the household assets and the attitudes and other unobservable characteristics corresponding to the items listed in Table 2.[4] However, to assume one latent state (variable) is equivalent to postulating no real change in the true score of the manifest variables over time. This assumption might be unrealistic, especially

[4] As it is the case for the observed variables, the latent variable(s) are dichotomous with classes 0 (No) and 1 (Yes).

for household assets that most likely vary over time. For this reason, we then estimate a model that allows manifest change to be produced by a combination of unreliability and true latent change. As in equation 2 above, this model assumes two latent dichotomous variables *Y* and *Z*, representing, respectively, the true score of the manifest variables at time 1 and time 2 (see Figure 1b). In this model, the husband and wife's responses at time 1 (H_1 and W_1, respectively) are directly related to *Y*, but only indirectly to *Z* via *Y*; similarly, the husband and wife's responses at time 2 (H_2 and W_2, respectively) are directly related to *Z*, but only indirectly to *Y* via *Z*.

The latent class models in equation 1 and equation 2 permit testing several hypotheses. First, they permit verifying whether couple disagreement in reporting simply reflects unreliability of measurements, and whether the observed changes in husbands' and wives' reports over time persists after measurement error is taken into account. Second, it is possible to gain insight into whether couple discrepancies are the result of different understanding of the survey questions, rather than specific gendered interactions during the survey interview. If husband and wife have identical understanding of the same survey question, the latent structure estimated from the husband's response to that question should be the same as the latent structure estimated on the basis of the wife's response. In other terms, the 'reliabilities' (i.e. the conditional probabilities of giving the 'correct' answer in agreement with one's latent class) should be the same for husbands and wives at each point in time, although they may vary over time. This hypothesis for, respectively, the one- and two-latent variable models, can be formalized as follows:

$$\pi^{11}_{A|X} = \pi^{22}_{A|X} \qquad \pi^{11}_{B|X} = \pi^{22}_{B|X} \qquad \pi^{11}_{C|X} = \pi^{22}_{C|X} \qquad \pi^{11}_{D|X} = \pi^{22}_{D|X} \tag{3}$$

$$\pi^{11}_{A|Y} = \pi^{22}_{A|Y} \qquad \pi^{11}_{B|Y} = \pi^{22}_{B|Y} \qquad \pi^{11}_{C|W} = \pi^{22}_{C|W} \qquad \pi^{11}_{D|W} = \pi^{22}_{D|W} \tag{4}$$

If the models estimated by imposing these restrictions fit the data well, we might conclude that husbands and wives have the same understanding of the survey question. The magnitude of the conditional response probabilities in the estimated models would then permit identifying whether there are systematic trends in the validity of husbands' and wives' responses at one point in time and over time.

The estimates reported in this paper were obtained by using the ℓEM program developed at Tilburg University (Vermunt 1997a).[5] In ℓEM parameters' estimates of models containing latent variables are computed by means of the Expectation Maximization (EM) algorithm (Dempster, Laird, and Rubin, 1977), which has been shown to be extraordinarily stable to compute maximum-likelihood estimates in models with latent variables (Vermunt 1996, 1997b). Respondents with missing data were excluded from the analysis.

3. Results and discussion

3.1 Descriptive analysis

Overall, spousal agreement about the items considered has remained almost unchanged between the two survey waves (Table 3). The major exceptions are the items for which couple agreement was lowest in the first survey wave, namely owing a bicycle (-5% between 1998 and 2001), currently using family planning (-4%), owning a pit latrine

[5] ℓEM can be freely downloaded from: http://www.uvt.nl/faculteiten/fsw/organisatie/departementen/mto/

(+4%), having discussed the desired number of children (+6%) and having discussed family planning use (+8%). In addition, when spousal agreement is higher in 2001 than in 1998, it is because the percentage of women saying 'yes' increases more than the percentage of men saying 'yes'. This might indicate that the five items indicated above are questions that leave more room for individual interpretation or strategizing on the part of the respondent. We return to this point later.

[Table 3 about here]

The apparent lack of variation in spousal agreement between the two MDICP survey waves masks significant differences between couples giving concordant answers about the items considered in 1998 and those giving discrepant answers. This is evident when the proportion of couples agreeing about the items considered in both survey rounds is tabulated (Table 4). As it can be seen by comparing the figures in Table 4 with those in Table 3, in all cases this proportion is lower (and, in the case of the family planning items, considerably lower) than the proportion of couples agreeing in either round considered separately.

[Table 4 about here]

To investigate further the reasons underlying this apparent contradiction, we calculated what percentage of the couples agreeing in 1998 also agrees in 2001 about the same items. We find (Table 5) that couples who gave concordant answers in 1998 are, as expected, more likely to give concordant answers in 2001 as well; but we also find, surprisingly, that this also applies to couples who gave discrepant answers in 1998. The high proportion of

couple agreeing in 2001 (see Table 3) is therefore due to a shift in agreement status among discrepant couples between the two survey waves.

[Table 5 about here]

Is there a systematic tendency of husbands and/or wives in discrepant couples to change their answers in the second wave? To answer this question, in Table 6 we cross-tabulated husbands' and wives' responses to each item in 1998 and 2001. We distinguish two patterns: discrepant couples in 1998 that are concordant in 2001 (in the shaded cells) and concordant couples in 1998 that are discrepant in 2001 (in bold), and we investigate whether there is a systematic trend in the husbands' and wives' responses that accounts for these two patterns.[6] On the one hand, it is evident that couple discrepancies diminish over time because wives tend to systematically change their answers from 'no' to 'yes', at the same time as their husbands consistently report 'yes'.[7] Questions with the highest disagreement in 1998 are those for which it is more likely that the wife changes her answer in 2001. On the other hand, couple discrepancies seem to arise over time more randomly, as there is no systematic tendency of concordant husbands and wives to change their answers between the first and second wave: for half of the items considered in fact the husbands change their answers between 1998 and 2001, and for the other half the wives do.

[Table 6 about here]

[6] It can incidentally be noted that in 2001 the couples that consistently report not to have an item they consistently reported to own in 1998 are always less then the couples reporting to have an item they consistently reported not to own in 1998. This might indicate an overall increase in living standards.

[7] In other terms, in Table 6 the combination *YYNY* tends to have the highest frequency for most items considered. The exceptions are: owing a glass lamp, cows, or pigs, and currently using family planning.

These patterns of change in couple agreement in reporting might indicate underlying real changes, but might also be produced by unreliability of measurements. To identify and account for measurement error in the longitudinal analysis of husband-wife agreement, we use latent class analysis. The results are presented in the next section.

3.2 Latent class analysis

Test statistics for the one- and two-latent variables models are presented in Table 7. For three items (owning pigs, reporting of pregnancy status, and currently using family planning), no latent class model is identifiable; these cases are therefore excluded from the discussion below.[8] For the other items, the one-latent variable models do not fit the data well, suggesting, as expected, that the latent (true) ownership and attitudinal structure for the items presented in Table 2 changes over time. There are, however, two exceptions: owning chickens or ducks, and having had a discussion with the spouse about the desired number of children. For these two items, a model which assumes no real change in the observed measures fits the data best; in other terms, the underlying variables—owning chickens and having discusses about desired family size—are stable over time. This is probably because, as we shall see later, most households in rural Malawi do own chickens and have discussed about the number of children.

[Table 7 about here]

The estimates of the conditional response probabilities according to the unrestricted, two-latent variables models (not shown) indicate a systematic tendency for wives to

[8] The model for "wife currently pregnant" cannot be estimated because the manifest variables have too many zero frequencies.

answer 'no' more often than husbands, and for husbands to answer 'yes' more often than wives at each point in time. They also indicate that, for wives, this tendency becomes more evident over time, as we have found in the descriptive analysis. In order to test whether these differences are significant, we imposed on the conditional response probabilities estimated with the basic two-latent variable model the restrictions in equations 3 and 4. In particular, we tested restricted models with equality of conditional response probabilities between husbands and wives at time 1 (M_1), at time 2 (M_2), and at both points in time (M_3). Test statistics for the restricted models are displayed in Table 8.

[Table 8 about here]

Restricted, two-latent variables models fit the data better than unrestricted models, thus supporting the hypothesis that husbands and wives have the same understanding of the survey questions. This conclusion is reinforced by the qualitative data: even if discrepant in their answers, when asked about how they interpreted the survey questions husbands and wives gave similar explanations.

For a small proportion of items (i.e. owning a bed, a lamp or a bicycle), the best-fitting restricted models imply that husband-wife differences in conditional response probabilities in 1998 as well as 2001 are not significant—in other terms, that couple disagreement in reporting about these items at both points in time is due primarily to random error. The parameter estimates corresponding to the final models for these items are presented in Table 9. In the case of owning a lamp or a bicycle, it can be noticed that husbands' and wives' responses are also highly valid, and that their validity increases over time. In the case of owning a bed, however, spouses' reports are not as valid. This is particularly the

case in 2001, as a result of the tendency of husbands' and wives' to report that they do not have a bed although they actually own it. This tendency is similar to that observed for all other items, as it is illustrated below.

[Table 9 about here]

Except for the three items discussed above, in all other cases the model that best fits the data incorporates the restriction that the conditional response probabilities are the same for husbands and wives at time 1 (1998), but *not* at time 2 (*see* Table 9). The restrictions on the conditional response probabilities imply that husband-wife disagreement in reporting in 1998 arise mainly as a result of measurement error, but that couple discrepancies in reporting in 2001 are statically significant and do not reflect different understandings of the same survey question between spouses.[9] Despite husband-wife differences in reporting in 1998 seem to be mainly due to random error, there is a tendency at the couple level not to give valid responses. The probability of given an invalid response is particularly high if the true score for the item considered is 'no', in which case both husband and wife tend to answer 'yes'. The items that elicit the most invalid responses in this respect are having discussed about family planning (44%), owning a pit latrine (17%), and owning a radio (13%).[10]

There might be two competing interpretation to account for this pattern. First, both spouses have a wrong understanding of what is asked by the survey question: this might be particularly true for behavioral items such as discussing about family planning, but it

[9] It is reasonable to assume that, if husband and wife have similar understanding of the same survey question in 1998, they also would have it in 2001. For this reason, differences in conditional response probabilities in 2001 might safely not be attributed to different understandings of the same survey question between spouses.
[10] The probability of given an invalid response when the true score is 'yes' is always less than 5%.

would hardly apply to factual items such as the household assets. Second, spouses 'strategize' to give, for example, the impression to the interviewer to be better off than they actually are or, in the case of discussing about family planning, to give 'socially desirable' answers. Evidence in favor of the latter interpretation is provided by the longitudinal analysis of the response probabilities in Table 9. The tendency to answer 'yes' when the true score of the variable considered is 'no' at time 1 in fact decreases over time more for wives than husbands, so that at time 2 a gendered pattern of responses emerge. When the true score of the variable considered is 'no', husbands systematically answer 'yes' more than wives; whereas when true score of the variable considered is 'yes', wives systematically answer 'no' more than husbands. Besides, in all cases there are more inconsistent responses than expected on the basis of the estimated best-fitting model when the wife says 'no' and the husband says 'yes' at both points in time.[11] In sum, for the majority of the items in Table 2, couple discrepancies in reporting tend to represent random error when data are analyzed cross-sectionally, but once they are analyzed longitudinally permit uncovering specific gendered patterns in reporting.

Better insight into the specific individual strategies that might be adopted by the respondents in answering survey questions is provided by the qualitative data. One of the main theme that consistently emerge in all interviews is that the respondents expect a certain material gain for their effort in participating in the survey and, if this gain is not perceived as appropriate, they might 'strategically' change their answers the second time.

[11] In other terms, the sequences *1 2 1 2* and *2 1 2 1* tend to have the largest standardized residuals.

The following excerpt summarizes this point very well:

> *I*: "Right, still last week when my friends came here, they asked you if you had a bed and mattress, and other things, so when you heard about these questions, what did you think they meant when asking these questions?"
>
> *R*: "In fact, up to now, I didn't know what they meant because in my opinion I thought that when they were asking me those questions then they will provide me with the things when they heard that I didn't have these things. [...] Because, you know, with your questions, we really need to spend time attending to you instead of doing something profitable and at the end of chatting with you, you just give us this sugar, what do you think it will help us. [...] And sometimes people do hide information because they think that it's useless to tell you everything since you just provide very small things. But if it was very good things like the one you ask, people would have been more open that even your bosses would have been proud with what people would have been telling you. [...]"
>
> *I*: "Okay, so how did you arrive at that decision that when you were asked about these things, then you will be provided?"
>
> *R*: "It's because it is the third[12] time that I have been asked about this. At first they asked about houses, bed, toilet, radio and I told them that I did not have those things and they came in another year and asked about the same questions and still told them that I did not have and finally they have come this year and asked me the same questions so, I was surprised why they keep on asking the same questions but never implement." [H17520]

Although the set of qualitative interviews we refer to is not representative of attitudes and behaviors in the general survey population, it therefore agrees well with, and helps interpreting, the results of the analysis of the quantitative data presented in this paper.

[12] The respondent refers to the MDICP-1, the MDICP-2, and a related research project that was carried out in between them, the Family Transfers Project.

4. Conclusions

By analyzing data from the MDICP-1, Miller, Zulu and Watkins (2001) identified gender differences in reporting within couples about household assets, children and fertility, family planning and AIDS. One of the main findings of their analysis was that, when there are discrepancies, husbands consistently answer "yes" as often or more often than wives, particularly for questions on family planning and AIDS. The descriptive analysis presented in this paper about husband-wife agreement between the MDICP-1 and the MDICP-2 complements their findings by identifying two main trends. First, it is the case also in the MDICP-2 data that when there are couple discrepancies in reporting, husbands answer "yes" more often than wives, particularly for questions on family planning.[13] Second, when crude agreement between spouses shows a significant change between the two survey waves (as it is particularly the case for family planning variables), it is because the proportion of wives saying 'yes' increases more than the proportion of husbands saying 'yes'. In turn, this happens because wives tend to systematically change their answers from 'no' to 'yes' between the first and second wave, at the same time as their husbands consistently report 'yes'.

Once the possibility of measurement error is allowed, the question arises to what extent these patterns and trends in couple discrepancies in reporting simply reflect unreliability of measurements. The most extreme answer is that there is no true change at all and that the observed changes result solely from measurement error. The latent class analysis presented in this paper suggests that this might be the case in 1998, but that in 2001 there is evidence of real and systematic change in the observed measures after random error is accounted

[13] *See* footnote 3.

for. In addition, the analysis presented in this paper lends support to the explanation that gendered strategies in responding to survey questions are the most important factor in explaining husband-wife inconsistencies in 2001, as the questions considered do not result to be susceptible to different understandings between spouses. The main implication of these findings is that husband-wife disagreement in reporting will not bias cross-sectional analyses if the MDICP data. It might have an important role, however, in longitudinal analyses that do not control for the gendered response pattern of husband and wives.

The latent class models presented in this paper provide a reasonable explanation of couple discrepancies in reporting at one point in time and over time. However, with these models it is not possible to test the basic postulate that husband's and wife's responses are independent from one another at each point in time and over time. It is also not possible to verify whether there are external variables that influence the latent distribution. To address these issues, in future research we will consider extensions of the latent class models presented in this paper that allow local dependence between manifest variables and include covariates.

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Table 1a: Interview status of monogamous married couples sampled by the MDICP-1 and by the MDICP-2

Couples' interview status	MDICP-1	MDICP-2
Both spouses interviewed	827	794
Only wife interviewed	344	261
Only husband interviewed	92	41
Neither spouse interviewed	67	191
Total monogamous couples sampled	1330	1287

Table 1b: Interview status in the MDICP-2 of monogamous married couples for which both spouses had been interviewed in the MDICP-1

	Number of couples
Not sampled	11
Not monogamous	101
Neither spouse interviewed	91
Only wife interviewed	68
Only husband interviewed	28
Both spouses interviewed	528
Total monogamous couples with both spouses interviewed in MDICP-1	**827**

Table 2: Questions considered for the analysis of couple consistency in reporting in the Malawi Diffusion and Ideational Change Project, 1998 and 2001 [a]

Household items

First, I'm going to read a list of things that households might have. Could you please tell me whether your household has any of them?

1. Bed
2. Radio
3. Bicycle
4. Pit latrine
5. Paraffin glass lamp

Now I'm going to read a list of animals. Would you please tell me about how many of these your household owns now?[b]

6. Cows
7. Goats
8. Pigs
9. Chickens/ducks

Children and fertility

10. Are you (is your wife) currently pregnant?

Family planning

11. Are you (and your wife) now using any method of child spacing or family planning?
12. Have you and your husband (wife)/partner ever discussed the number of children you would like?
13. Have you and your husband (wife)/partner ever talked about using modern child-spacing/family planning?

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[a] All questions presented in the table were asked with the exact same wording in both the MDICP-1 and MDICP-2. [b] For this analysis, responses to these questions were reduced to dichotomous form: any animals/no animals.

Table 3: Descriptive statistics of spousal reports, by question and survey wave, Malawi Diffusion and Ideational Change Project, 1998 and 2001: Monogamous couples interviewed in both rounds

Question	1998				2001			
	Crude agreement (%)	% 'yes' among husbands	% 'yes' among wives	Sample size	Crude agreement (%)	% 'yes' among husbands	% 'yes' among wives	Sample size
Household items								
- Bed	91	19	18	528	90	28	26	524
- Radio	88	67	62	527	88	73	69	524
- Bicycle	93	61	60	528	88	68	65	522
- Pit latrine	85	85	77	528	89	85	80	524
- Paraffin glass lamp	86	34	30	528	85	44	37	524
- Cows	96	11	9	528	95	12	11	524
- Goats	90	37	33	528	88	41	37	524
- Pigs	95	16	14	528	95	15	15	524
- Chickens/ducks	88	81	79	527	89	86	86	523
Children and fertility								
- Wife currently pregnant	95	21	18	526	96	16	15	509
Family planning								
- Currently using FP	77	64	61	229	73	62	56	279
- Discussed number of children	62	62	51	524	68	67	63	516
- Discussed FP	69	66	59	525	77	80	76	467

Table 4 Proportion of couple agreeing in both MDICP-1 and MDICP-2, by question

Question	% agreeing in both waves
Household items	
- Bed	83
- Radio	79
- Bicycle	84
- Pit latrine	76
- Paraffin glass lamp	75
- Cows	92
- Goats	80
- Pigs	90
- Chickens/ducks	80
Children and fertility	
- Wife currently pregnant	89
Family planning	
- Currently using FP	58
- Discussed number of children	37
- Discussed FP	54

Table 5 Proportion of couple agreeing in MDICP-2 conditional on spousal agreement in MDICP-1, by question

Question	Couple disagrees in 1998				Couple agrees in 1998			
	Crude agreement (%)	% 'yes' among husbands	% 'yes' among wives	Sample size	Crude agreement (%)	% 'yes' among husbands	% 'yes' among wives	Sample size
Household items								
- Bed	72	57	54	46	91	25	23	478
- Radio	83	73	63	60	89	73	70	463
- Bicycle	90	61	58	33	90	69	65	489
- Pit latrine	85	78	68	60	89	87	82	444
- Paraffin glass lamp	78	55	41	71	86	42	36	453
- Cows	57	48	24	21	96	10	10	503
- Goats	78	50	40	54	89	40	36	470
- Pigs	93	33	26	27	95	14	14	497
- Chickens/ducks	79	79	90	61	91	87	86	461
Children and fertility								
- Wife currently pregnant	89	22	22	27	94	16	14	493
Family planning								
- Currently using FP	82	56	50	34	74	65	60	121
- Discussed number of children	67	64	57	200	70	69	66	312
- Discussed FP	73	73	70	149	79	83	78	318

Table 6 Cross-tabulation of husbands' and wives' responses in 1998 and 2001, by item

1. Owns bed

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	62	**3**
		No	**4**	3
	No	Yes	11	5
		No	2	7
No	Yes	Yes	8	1
		No	5	7
	No	Yes	31	**23**
		No	**11**	341

2. Owns radio

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	245	**14**
		No	**13**	35
	No	Yes	27	7
		No	0	10
No	Yes	Yes	9	1
		No	2	4
	No	Yes	59	**18**
		No	**6**	73

3. Owns bicycle

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	248	**18**
		No	**7**	29
	No	Yes	10	1
		No	1	8
No	Yes	Yes	9	1
		No	0	4
	No	Yes	55	**14**
		No	**10**	108

4. Owns pit latrine

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	323	**27**
		No	**10**	22
	No	Yes	39	9
		No	1	12
No	Yes	Yes	13	1
		No	1	4
	No	Yes	28	**6**
		No	**5**	23

5. Owns glass lamp

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	100	**11**
		No	**6**	15
	No	Yes	15	10
		No	1	18
No	Yes	Yes	11	3
		No	2	11
	No	Yes	47	**34**
		No	**11**	229

6. Owns cows

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	29	**4**
		No	**4**	5
	No	Yes	3	6
		No	0	5
No	Yes	Yes	0	1
		No	2	4
	No	Yes	12	**6**
		No	**5**	438

7. Owns goats

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	104	**8**
		No	**4**	40
	No	Yes	12	8
		No	2	15
No	Yes	Yes	6	1
		No	1	9
	No	Yes	49	**26**
		No	**14**	225

8. Owns pigs

			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	25	**4**
		No	**1**	36
	No	Yes	5	1
		No	0	11
No	Yes	Yes	2	1
		No	0	7
	No	Yes	33	**8**
		No	**12**	378

Table 6 (cont.)

9. Owns chickens/ducks				
			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	329	**18**
		No	**16**	24
	No	Yes	29	2
		No	2	1
No	Yes	Yes	16	1
		No	8	2
	No	Yes	47	**7**
		No	**2**	18

10. Wife pregnant				
			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	15	**1**
		No	**1**	1
	No	Yes	71	0
		No	0	0
No	Yes	Yes	0	0
		No	0	0
	No	Yes	0	**0**
		No	**0**	0

11. Currently using FP				
			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	44	**12**
		No	**9**	18
	No	Yes	6	2
		No	1	9
No	Yes	Yes	9	0
		No	3	4
	No	Yes	16	**6**
		No	**4**	12

12. Discussed # children				
			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	120	**33**
		No	**21**	14
	No	Yes	51	30
		No	13	33
No	Yes	Yes	35	11
		No	15	12
	No	Yes	43	**20**
		No	**21**	40

13. Discussed @ FP				
			W_2	
H_1	W_1	H_2	Yes	No
Yes	Yes	Yes	191	**20**
		No	**12**	7
	No	Yes	53	18
		No	3	14
No	Yes	Yes	33	5
		No	15	7
	No	Yes	33	**20**
		No	**13**	20

Legend: **Concordant → discrepant**
Discrepant → concordant

Table 7 Test statistics for one- and two-latent variables models, by item

	1 latent variable				2 latent variables			
Question	L^2	*df*	p	χ^2	L^2	*df*	p	χ^2
Household items								
- Bed	54.78	6	.000	56.46	14.06	4	.007	19.05
- Radio	208.69	6	.000	241.99	8.40	4	.078	8.22
- Bicycle	209.43	6	.000	250.90	1.10	4	.895	0.62
- Pit latrine	84.34	6	.000	98.33	3.98	4	.409	3.84
- Paraffin glass lamp	116.19	6	.000	144.82	6.56	4	.161	7.96
- Cows	49.81	6	.000	46.97	20.08	4	.001	23.08
- Goats	226.42	6	.000	251.4	8.19	4	.085	10.83
- Pigs	***	***	***	***	***	***	***	***
- Chickens/ducks	118.91	6	.000	161.37	***	***	***	***
Children and fertility								
- Wife pregnant	***	***	***	***	***	***	***	***
Family planning								
- Currently using FP	***	***	***	***	***	***	***	***
- Discussed number of children	17.72	6	.007	17.99	***	***	***	***
- Discussed FP	22.86	6	.001	20.40	18.16	4	.001	17.71

*** Indicates that the model cannot be estimated because of (nearly) boundary or non-identified (log-linear) parameters.

Table 8 Test statistics for unrestricted and restricted latent class models, by item

	Unrestricted model		Restricted models						Test statistics for restricted vs. unrestricted models							
	M_0		M_1		M_2		M_3		$M_1 \mid M_0$		$M_2 \mid M_0$		$M_3 \mid M_1$		$M_3 \mid M_2$	
Question	L^2	*df*	L^2	*df*	L^2	*df*	L^2	*df*	L^2	*df*	L^2	*df*	L^2	*df*	L^2	*df*
Household items																
- Bed	14.1	4	18.7	6	14.4	6	19.0	8	4.6	2	0.4	2	0.3	2	4.5	2
- Radio	8.4	4	17.6	6	22.0	6	31.3	8	9.2	2	13.6	2	13.7	2	9.3	2
- Bicycle	1.1	4	7.2	6	2.9	6	8.9	8	6.1	2	1.8	2	1.7	2	6.0	2
- Pit latrine	4.0	4	16.1	6	27.2	6	39.3	8	12.1	2	23.2	2	23.2	2	12.1	2
- Paraffin glass lamp	6.6	4	26.5	6	10.9	6	30.7	8	19.9	2	4.3	2	4.2	2	19.9	2
- Cows	20.1	4	21.7	6	23.4	6	25.0	8	1.6	2	3.3	2	3.3	2	1.6	2
- Goats	8.2	4	15.7	6	15.8	6	23.5	8	7.5	2	7.6	2	7.8	2	7.7	2
- Chickens/ducks	118.9	6	118.9	8	123.4	8	123.5	10	0.0	2	4.5	2	4.6	2	0.1	2
Family planning																
- Discussed number of children	17.7	6	21.6	8	33.1	8	37.8	10	3.9	2	15.4	2	16.2	2	4.7	2
- Discussed FP	18.2	4	22.1	6	23.8	6	27.8	8	3.9	2	5.6	2	5.7	2	4.0	2

Table 9 Estimated conditional probabilities and standard errors (in parentheses) for best-fit restricted models, by item

Owns bed ($L^2 = 0.4$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.7340	.96 (.01)	.04 (.01)	.96 (.01)	.04 (.01)	.98 (.01)	.02 (.01)	.98 (.01)	.02 (.01)
2	No	Yes	.0677	.94 (.01)	.06 (.01)	.94 (.01)	.06 (.01)	.17 (.03)	.83 (.03)	.17 (.03)	.83 (.03)
3	Yes	No	.0064	.09 (.03)	.91 (.03)	.09 (.03)	.91 (.03)	.98 (.01)	.02 (.01)	.98 (.01)	.02 (.01)
4	Yes	Yes	.1919	.09 (.03)	.91 (.03)	.09 (.03)	.91 (.03)	.17 (.03)	.83 (.03)	.17 (.03)	.83 (.03)

Owns bicycle ($L^2 = 1.8$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.2698	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.96 (.02)	.05 (.02)	.96 (.02)	.05 (.02)
2	No	Yes	.1227	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.02 (.01)	.98 (.01)	.02 (.01)	.98 (.01)
3	Yes	No	.0679	.04 (.01)	.96 (.01)	.04 (.01)	.96 (.01)	.96 (.02)	.05 (.02)	.96 (.02)	.05 (.02)
4	Yes	Yes	.5395	.02 (.01)	.98 (.01)	.02 (.01)	.98 (.01)	.02 (.01)	.98 (.01)	.02 (.01)	.98 (.01)

Owns glass lamp ($L^2 = 4.3$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.5786	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.94 (.01)	.06 (.01)	.94 (.01)	.06 (.01)
2	No	Yes	.1119	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.10 (.03)	.90 (.03)	.10 (.03)	.90 (.03)
3	Yes	No	.0371	.08 (.02)	.92 (.02)	.08 (.02)	.92 (.02)	.94 (.01)	.06 (.01)	.94 (.01)	.06 (.01)
4	Yes	Yes	.2724	.08 (.02)	.92 (.02)	.08 (.02)	.92 (.02)	.10 (.03)	.90 (.03)	.10 (.03)	.90 (.03)

* *Legend*:
Y = 'True' value at time 1
A = Husband's response at time 1
B = Wife's response at time 1
Z = 'True' value at time 2
C = Husband's response at time 2
D = Wife's response at time 2

Note: Identical parameter estimates result from a priori equality restriction.

Table 9 (cont.)

Owns radio ($L^2 = 9.2$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.2116	.87 (.03)	.13 (.03)	.87 (.03)	.13 (.03)	.90 (.04)	.10 (.04)	.95 (.03)	.05 (.03)
2	No	Yes	.1363	.87 (.03)	.13 (.03)	.87 (.03)	.13 (.03)	.02 (.02)	.98 (.02)	.08 (.03)	.92 (.03)
3	Yes	No	.0952	.04 (.01)	.96 (.01)	.04 (.01)	.96 (.01)	.90 (.04)	.10 (.04)	.95 (.03)	.05 (.03)
4	Yes	Yes	.5569	.04 (.01)	.96 (.01)	.04 (.01)	.96 (.01)	.02 (.02)	.98 (.02)	.08 (.03)	.92 (.03)

Owns pit latrine ($L^2 = 12.1$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.1056	.83 (.06)	.17 (.06)	.83 (.06)	.17 (.06)	.67 (.09)	.33 (.09)	.88 (.07)	.12 (.07)
2	No	Yes	.0929	.83 (.09)	.17 (.09)	.83 (.09)	.17 (.09)	.03 (.01)	.97 (.01)	.08 (.03)	.92 (.03)
3	Yes	No	.0607	.04 (.01)	.96 (.01)	.04 (.01)	.96 (.01)	.67 (.09)	.33 (.09)	.88 (.07)	.12 (.07)
4	Yes	Yes	.7408	.04 (.01)	.96 (.01)	.04 (.01)	.96 (.01)	.03 (.01)	.97 (.01)	.08 (.03)	.92 (.03)

Owns cows ($L^2 = 1.6$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.8588	.99 (.01)	.01 (.01)	.99 (.01)	.01 (.01)	.99 (.01)	.01 (.01)	.99 (.05)	.01 (.05)
2	No	Yes	.0349	.99 (.01)	.01 (.01)	.99 (.01)	.01 (.01)	.07 (.05)	.93 (.05)	.19 (.06)	.81 (.06)
3	Yes	No	.0089	.20 (.05)	.80 (.05)	.20 (.05)	.80 (.05)	.99 (.01)	.01 (.01)	.99 (.05)	.01 (.05)
4	Yes	Yes	.0973	.20 (.05)	.80 (.05)	.20 (.05)	.80 (.05)	.07 (.05)	.93 (.05)	.19 (.06)	.81 (.06)

* *Legend*:
Y = 'True' value at time 1
A = Husband's response at time 1
B = Wife's response at time 1
Z = 'True' value at time 2
C = Husband's response at time 2
D = Wife's response at time 2

Note: Identical parameter estimates result from a priori equality restriction.

Table 9 (cont.)

Owns goats ($L^2 = 7.5$, $df = 2$)

Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
				No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.5584	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.93 (.02)	.07 (.02)	.97 (.01)	.03 (.01)
2	No	Yes	.1043	.92 (.02)	.08 (.02)	.92 (.02)	.08 (.02)	.04 (.03)	.96 (.03)	.08 (.04)	.92 (.04)
3	Yes	No	.1000	.03 (.02)	.97 (.02)	.03 (.02)	.97 (.02)	.93 (.02)	.07 (.02)	.97 (.01)	.03 (.01)
4	Yes	Yes	.2373	.03 (.02)	.97 (.02)	.03 (.02)	.97 (.02)	.04 (.03)	.96 (.03)	.08 (.04)	.92 (.04)

Owns chickens ($L^2 = 0.0$, $df = 2$)

Latent Class	X	$\hat{\Pi}^{t}_{X}$	$\hat{\Pi}^{it}_{A\|X}$		$\hat{\Pi}^{jt}_{B\|X}$		$\hat{\Pi}^{kt}_{C\|X}$		$\hat{\Pi}^{lt}_{D\|X}$	
			No	Yes	No	Yes	No	Yes	No	Yes
1	No	.1790	.69 (.04)	.31 (.04)	.69 (.04)	.31 (.04)	.81 (.08)	.19 (.08)	.97 (.08)	.03 (.08)
2	Yes	.8210	.10 (.01)	.90 (.01)	.10 (.01)	.90 (.01)	.08 (02)	.92 (.02)	.02 (.02)	.98 (.02)

Discussed with spouse about desired family size ($L^2 = 3.9$, $df = 2$)

Latent Class	X	$\hat{\Pi}^{t}_{X}$	$\hat{\Pi}^{it}_{A\|X}$		$\hat{\Pi}^{jt}_{B\|X}$		$\hat{\Pi}^{kt}_{C\|X}$		$\hat{\Pi}^{lt}_{D\|X}$	
			No	Yes	No	Yes	No	Yes	No	Yes
1	No	.3772	.67 (.07)	.33 (.07)	.67 (.07)	.33 (.07)	.58 (.05)	.42 (.05)	.78 (.06)	.22 (.06)
2	Yes	.6228	.16 (.03)	.84 (.03)	.16 (.03)	.84 (.03)	.27 (.04)	.73 (.04)	.32 (.05)	.68 (.05)

* *Legend*:
Y = 'True' value at time 1
A = Husband's response at time 1
B = Wife's response at time 1
Z = 'True' value at time 2
C = Husband's response at time 2
D = Wife's response at time 2

Note: Identical parameter estimates result from a priori equality restriction.

Table 9 (cont.)

Discussed with spouse about family planning ($L^2 = 3.9$, $df = 2$)											
				$\hat{\Pi}^{it}_{A\|Y}$		$\hat{\Pi}^{jt}_{B\|Y}$		$\hat{\Pi}^{km}_{C\|Z}$		$\hat{\Pi}^{lm}_{D\|Z}$	
Latent Class	Y	Z	$\hat{\Pi}^{tm}_{YZ}$	No	Yes	No	Yes	No	Yes	No	Yes
1	No	No	.0949	.56 (.06)	.44 (.06)	.56 (.06)	.44 (.06)	.63 (.07)	.37 (.07)	.69 (.07)	.31 (.07)
2	No	Yes	.3091	.56 (.06)	.44 (.06)	.56 (.06)	.44 (.06)	.10 (.04)	.90 (.04)	.16 (.04)	.84 (.04)
3	Yes	No	.0109	.06 (.02)	.94 (.02)	.06 (.02)	.94 (.02)	.63 (.07)	.37 (.07)	.69 (.07)	.31 (.07)
4	Yes	Yes	.5850	.06 (.02)	.94 (.02)	.06 (.02)	.94 (.02)	.10 (.04)	.90 (.04)	.16 (.04)	.84 (.04)

* *Legend*:
Y = 'True' value at time 1
A = Husband's response at time 1
B = Wife's response at time 1
Z = 'True' value at time 2
C = Husband's response at time 2
D = Wife's response at time 2

Note: Identical parameter estimates result from a priori equality restriction.

Figure 1 Representation of one- and two-latent variables models