# THE RISING SHARE OF NONMARITAL BIRTHS FERTILITY CHOICE OR MARRIAGE BEHAVIOR? RESPONSE TO ERMISCH, MARTIN, AND WU*

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*Abstract*

In a 2006 article in Demography, Jo AnnaGray Jean Stockard and Joe Stone (GSS i)observe that among black women and white women ages 20 to 39, birth rates increased sharply for unmarried women over the period 1974 to 2000. But they also increased for *married* women, as well, and yet the total birth rate for married and unmarried women combined was essentially unchanged; ii)conclude that’s since the total birth rate did not change, it seems obvious by inspection that the rises in unmarried and married birth rates could not have come from a general rise in fertility among women 20-39; iii)argue that these patterns are an example of a phenomenon called ”Simpson’s paradox.,” often illustrated by a joke, as told at Harvard, that when a student transfers from Harvard to Yale, mean intelligence rises at both places. Both means rise *not* because the average intelligence of the combined student bodies changed, but

because the *composition* of the student body changed at each school; iv) conclude that between 1974 and 2000, sharp increases in the proportion of women who were single, termed the single share, or Su, changed the *composition* of the pools of married and unmarried women. The rising single share had a selection effect on the pools of married and unmarried women akin to the hypothetical student transfer from Harvard to Yale. Women with target fertility *below* the average for married women, but *above* the average for unmarried women, became less likely to marry than previously, so that mean birth rates for both groups rose over the period, and iv) using age/race-specific panel data, find parameter values strikingly consistent with those predicted by their illustrative model, and a dominant role for the selection effect of the single share in determining NFR IOnthis Recently Ermisch Martin and Wu (EMW have challenged the GSS findings and conclusions. In this response GSS respond to the EMW challenges, and reaafirm the GSS results and conclusions.

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We are flattered that our recent paper in this journal, GSS (2006), has attracted such close attention from EMW. While we appreciate the opportunity to expand on several key aspects of our paper, we see no reason to substantially revise any of our major conclusions based on the EMW comments. Reading EMW, one might think that we had proposed the demographic equivalent of Newton's second law of thermodynamics – the existence of a universal phenomenon, manifest in identical form in all places, for all groups, during all times periods, regardless of circumstances. It will be helpful, then, to review briefly the central points in GSS before turning the major EMW comments, along with our responses.

A major objective in GSS is to offer and test an explanation for an apparent paradox: Among black women and white women ages 20 to 39, birth rates increased sharply for unmarried women over the period 1974 to 2000. But they also increased for *married* women, as well, and yet the total birth rate for married and unmarried women combined was essentially unchanged. Since the total birth rate did not change, it seems obvious by inspection that the rises in unmarried and married birth rates could not have come from a general rise in fertility among women 20-39. We recognized these patterns as an example of a phenomenon called "Simpson's paradox," often illustrated by a joke, as told at Harvard, that when a student transfers from Harvard to Yale, mean intelligence rises at both places. Both means rise *not* because the average intelligence of the combined student bodies changed, of course, but because the *composition* of the student body changed at each school. The implication of the joke is that the intelligence of a student who chooses to transfer from Harvard to Yale must be *below* the mean at Harvard, but *above* the mean at Yale, so both means rise when the student transfers.

In the case of birth rates, GSS argue that between 1974 and 2000, sharp increases in the proportion of women who were single, which we term the single share, or Su, changed the *composition* of the pools of married and unmarried women. The rising single share had a selection effect on the pools of married and unmarried women akin to the hypothetical student transfer from Harvard to Yale. Women with target fertility *below* the average for married women, but *above* the average for unmarried women, became less likely to marry than previously, so that mean birth rates for both groups rose over the period, even as the total birth rate was flat. using age/race-specific panel data, GSS find parameter values

strikingly consistent with those predicted by our illustrative model, and a dominant role for the selection effect of the single share in determining NFR *for the particular groups and period we study*.

The empirical tests reported in GSS focus on the implications of this selection effect for the ratio of unmarried births to total births – referred to as the nonmarital fertility ratio, NFR, in our paper. The bit of algebra included in GSS was intended *only* to “highlight and illustrate” those implications, not to suggest that the effect is the only factor, or even a dominant one, in determining birth rates or NFR for *all* groups or time periods. Nevertheless, using age/race-specific panel data, GSS find parameter values strikingly consistent with those predicted by our illustrative model, and a dominant role for the selection effect of the single share in determining NFR *for the particular groups and period we study*.

**ERMISCH AND STATISTICAL CHALLENGES**

While the particulars vary, EMW share a common line of argument: (i) factors common to both NFR and Su caused the two measures to rise together, and consequently, (ii) the selection effect of Su on NFR found by GSS is spurious. Ermisch supports this argument primarily with three challenges to the statistical validity of our estimates. We argue that *all* three are invalid.

Ermisch’s central argument is that NFR and $Su^2$ are nonstationary, and *as a result*, our estimates are inconsistent and especially vulnerable to spurious regression. This argument is invalid as applied to GSS: First, NFR and Su are shares, bounded between zero and one. Neither can exhibit nonstationary behavior in a sufficiently long sample. Second, the unit root tests for NFR and $Su^2$ reported by Ermisch are based on only 23 years of annual data (1980-2002). As Ermisch himself acknowledges, standard unit-root tests of the sort he uses have weak power. The problem is particularly marked for highly persistent series, and further compounded when sample periods are short.

Third, even when the variables in a regression *are* nonstationary, inconsistent estimates arise *only* if the variables are *not* cointegrated (Hamilton 1994, Engle and Granger 1987). Seven of the eight paired (NFR and $Su^2$) cross-section time series examined in GSS (2006) exhibit unit roots, even over the longer sample periods estimated in that paper. For five of those seven, however, the data are consistent with the presence of a single cointegrating vector at significance levels of 5%. Unit roots are also present in the data when it is grouped by race but, again, we find that NFR and $Su^2$ are cointegrated for both blacks and whites, which is broadly consistent with results reported in GSS (2005). Thus, Ermisch is simply wrong in asserting that the statistical tests reported in GSS (2006) are "invalid because the variables in the analysis are not stationary time series." Finally, if unit roots and spurious correlation *were* responsible for our regression results, one might expect the addition of a time trend or period effects to significantly alter the results. As discussed below, they do not.

Ermisch also objects to the estimation procedure employed in GSS, suggesting that our estimates of the effect of the single share on NFR are inconsistent, and our test results "highly suspect", because we did not use seemingly unrelated regression (SUR). On this point Ermisch is certainly incorrect: SUR only affects estimates of standard errors, not of structural parameters, as Ermisch implies, and in our case the effect on standard errors is inconsequential. In GSS we use "panel corrected standard errors' (PCSE), which, depending on the choice of estimator, can incorporate adjustments for heteroskedasticity, for common shocks, as in SUR, and/or for autocorrelation. We only emphasize the last in GSS because it is the only adjustment that made much difference to the standard errors.

These points are illustrated in Table 1 below. Column 1 presents "White period" estimates of the key relationship developed and tested in GSS over the longer of the two sample periods reported by Ermisch (1965-2000). These estimates correct for heteroskedasticity and autocorrelation. Column 2 presents "period SUR" estimates, which account for heteroskedasticity, autocorrelation *and* contemporaneous correlations across the age-race groups, as Ermisch suggests. Note that the coefficients are identical in columns 1 and 2. SUR estimation has *no* effect on estimates of the coefficients and, furthermore, the changes in standard errors are inconsequential.

(Table 1 here)

Column (3) of Table 1 adds period effects to the estimated specification, while column (4) augments the baseline specification with a time trend. Neither modification alters the conclusions presented in GSS: we are unable to reject the hypothesis that the coefficient on $Su^2$ is equal one.

Accordingly, the results reported in GSS and replicated here in Table 1 are *not* the result of spurious correlation produced by common trends in NFR and Su[2].

A final statistical issue arises when Ermisch proposes and implements his own tests of the GSS model. Ermisch tests prediction errors generated by our stylized *theoretical* model (not its estimated counterpart) for unit roots, fails to reject a unit root in most cases (see Table 1 of Ermisch), and interprets this result as evidence against the GSS selection effect. The unit-root tests that Ermisch employs have notoriously weak power, especially in relatively short time series such as those chosen by Ermisch. New, more powerful tests for panel data exploit both the cross-section and time-series structure of panel data.[1] Of course, taking advantage of longer sample periods increases power as well. Thus, whereas Ermisch *fails to reject* unit roots in all but one of the series reported in Table 1 of his paper, we *reject* unit roots at the 1% level using the more powerful panel Dickey-Fuller test over the period 1957-2000, the time period employed in GSS. (See Table 2 below.) Perhaps surprisingly, unit roots are also rejected at the 1% level if we shorten the sample to match Ermisch (1980-2002).[2]

(Table 2 here.)

In view of the limited power of the unit root tests he employs, Ermisch goes on to assert that even if his constructed error term "does not have a unit root, its strong degree of persistency …. contradicts the GSS theory." We disagree. Clearly, evidence of a selection effect does not imply the absence of other effects – a point addressed further in the next section. Social and economic factors may influence NFR through channels other than Su and its selection effect. These influences may be strong and persistent. Thus we emphatically dispute Ermisch's assertion that persistent (serially correlated) deviations of NFR from the predictions of the GSS model contradict the model.

In conclusion, we find all three of Ermisch's statistical objections to be unpersuasive.

**ALTERNATIVE HYPOTHESES AND TESTS**

[1] These tests are available in such widely used and relatively "friendly" software packages as E-views.

[2] Our reservations regarding the test results reported in Table 1 of Ermisch also apply to those reported in Table 2 of Ermisch.

Both Ermisch and Martin suggest that factors other than the selection effect described in GSS are important – at times perhaps dominant – in explaining birth rates and birth shares over subsets of the time periods reported by GSS. Martin describes Ermisch as showing that “that the GSS model alone cannot explain all the variation in the ratio of non-marital to marital birth rates from 1974 to 2000.” We do not disagree; GSS does not claim otherwise, nor did we intend to imply otherwise. Our goal in GSS was to call attention to a selection effect that is commonly overlooked in studies of fertility behavior, illustrate its implications for measured birth rates and shares, and then demonstrate that the effect could be empirically important. Since we expected additional factors to be important in explaining birth rates and ratios at various points, we were surprised at the apparent power of the selection effect in both the relatively long samples examined in our paper. Our conclusion in GSS (2006) is that valid tests of the importance of *other* factors in explaining birth rates and ratios should take account of this effect – a conclusion reaffirmed by the present exchange, in our view..

Ermisch goes further, however, and asserts that the association between NFR and $Su^2$ documented in GSS is “spurious”. The implication is that the GSS results are due either to common trends in the data (addressed in columns 3 and 4 of Table 1 above) or to other factors that might cause both NFR and $Su^2$ to rise together. A challenge to alternative explanations of the joint behavior of NFR and $Su^2$ is that over the period 1974-2000, *the marital birth rate rose along with the nonmarital birth rate, even though the total birth rate remained unchanged.* While changes in social attitudes or other factors may or may not have had the effects claimed by Ermisch (and repeated by Martin), they do not explain how *both* married and unmarried birth rates could rise in the absence of a rise in the total birth rate. To reconcile these paradoxical patterns, we believe the selection effect GSS identify is required.

Martin takes a tact similar in spirit to Ermisch’s when he notes that the definition of NFR includes Su, so that NFR “will vary with $Su^2$ to some extent even if the GS&S model is incorrect.” This is correct., as far as it goes. As equation (1) below shows, NFR can be expressed as the product of Su and the ratio UBR/TBR – a definitional relationship. If the GSS selection effect is *not* present (UBR/TBR is independent of Su) the relationship between NFR and Su should be linear. If the GSS selection effect *is* present, the relationship should be nonlinear – indeed, quadratic if all the assumptions of the GSS illustration hold. GSS find a strong, apparently quadratic, relationship between NFR and Su. But could it be simply the spurious result of the linear relationship between NFR and Su evident in equation (1)?

The answer is provided in the final column of Table 1, which reports the results of including both Su and $Su^2$ in a statistical model of NFR. If the selection effect is present in the form hypothesized by GSS, the estimated coefficient on $Su^2$ should be one and the coefficient on Su zero. On the other hand, if the selection effect is unimportant, the coefficient on Su should be one and the coefficient on $Su^2$ zero. The coefficient on $Su^2$ in column 5 remains significantly positive and near unity, as predicted, even with Su accounted for separately in the regression. Furthermore, Su does not enter significantly alongside $Su^2$, clearly refuting Martin's suggestion that $Su^2$ appears important in the GSS analysis only because it is picking up the effects of a variable (Su) that we did not include in the regression.

Both Ermisch and Martin propose alternate tests of the GSS selection effect that focus on the ability of the effect to explain movements in the ratio of the unmarried birth rate to the married birth rate, denoted (UBR/MBR). We are puzzled by the focus on this measure for two reasons. First, it is not, as claimed by Ermisch, the "more fundamental" relationship in GSS. Indeed, the measure never arises in developing the simple model presented in our paper. The "fundamental" relationship underlying the GSS selection effect is a relationship commonly used in demographic decompositions of NFR:

(1) NFR = Su(UBR/TBR),

As Equation (1) shows, NFR differs from Su only to the extent that the childbearing behavior of unmarried women as subpopulation deviates from that of the population as a whole. Substituting our model's prediction for UBR/TBR into equation (1) produces the key equation in GSS, NFR = $Su^2$.

Given the claims of our paper, we would have expected a skeptic to challenge the much cleaner GSS predictions for UBR/TBR and MBR/TBR *individually*:

(2) UBR/TBR = Su

(3) UBR/TBR = (1+Su)

Had Ermisch or Martin chosen to focus on these more obvious implications, they might have found, as we did, that the predictions of our model, meant only as an illustration, hold up to the data remarkably well.

We are also puzzled by the focus on (UBR/MBR) because of its particular vulnerability to measurement error. Significant errors in estimating the size of the unmarried population (noted by Ermisch in his paper) mean that both UBR and MBR individually are subject to substantial measurement error. As the ratio of two ratios, each measured with substantial error, (UBR/MBR) is particularly volatile. Even so, formal statistical estimates of the model prediction for this measure -- i.e., UBR/MBR=Su/(1+Su) – over reasonably long sample periods (1957-2000 and 1968-2002) yield parameter estimates strikingly consistent with the predicted values of zero for the constant term and one for the coefficient on Su/(1+Su).[3] (See Table 3 below.) Furthermore, errors constructed by taking the difference between UBR/MBR and Su/(1+su) do *not* exhibit unit roots in *panel* tests of nonstationarity applied over longer sample periods, contrary to the conclusions drawn by Ermisch. (See Table 2 above.)

(Table 3 here.)

The issues raised by measurement error are particularly acute in the informal tests of the GSS selection proposed by Ermisch and Martin, both of whom compares arithmetic changes in NFR and UBR/MBR over intervals much shorter than the time periods those examined by GSS -- in some cases as short as 10 years. Arithmetic comparisons over short intervals can be highly problematic when the data examined are subject to substantial measurement error since movements over short intervals can be easily dominated by these errors, rather than by fundamental behaviors. This problem is especially acute for (UBR/MBR) for the reasons discussed above. An advantage of our formal statistical approach is that errors in the dependent variable do not bias estimated parameters as long as they are random.

**OTHER ISSUES RAISED BY EMW**

Regrettably, despite a reasonably generous allotment of journal space, we will not be able to address all of the remaining issues raised by EMU. In this section, we have selected several from among the most interesting for further discussion.

[3] The joint hypothesis that the constant and slope coefficient are within 5% of their predicted values is not rejected.

**Ermisch and International Comparisons**

In buttressing his argument of spurious correlation, Ermisch appeals to common international trends in NFR. Figure 4 of his paper presents data on NFR, but not $Su^2$, for eight OECD countries and U.S. whites. Ermisch interprets the rising values of NFR across these countries as evidence of the influence of common factors other than the GSS selection effect. Our reading of the international data is quite different. While we would not necessarily expect the strength of the selection effect identified in GSS (2006) to be as strong in other countries or circumstances, we would be surprised if it played *no* significant role in determining NFR in European countries. Indeed, plots of *both* NFR *and* $Su^2$ for 19 European countries over two census years, 1991 and 2001, show a striking similarity in pattern to the U.S.[4] The strong visual correspondence between NFR and $Su^2$ is confirmed by the formal statistical estimates presented in Table 5. With fixed effects to account for idiosyncratic features of both the context and the data for individual countries, the intercept term reported in Table 5 is trivially small, and the slope coefficient on the selection term $Su^2$ is both significant and near unity. Again, though, our point is *only* that the selection effects appear to be an important, *not exclusive*, factor in determining NFR.

(Figure 1 and Table 5 here.)

**Martin and Fertility Distributions**

Aside from issues raised separately by Ermisch and treated above, Martin's principal objection is that empirical distributions of time spent in marriage, conditional on fertility outcomes, are inconsistent with our model. In Table 3 of his comment, Martin present figures for two cohorts of women, one fifteen years older than the other, and argues: "The main discrepancy between Table 3 and the assumptions of the GS&S model is in trends across cohorts." While we are impressed by Martin's ingenuity, he has not quite gotten it right. His objection is based on the mistaken impression that the fertility distribution from which an individual's target level of fertility is drawn, summarized by the parameter P in our stylized model, is "fixed" across cohorts. While we do assume that P is "given" for a particular cohort (the

[4] Data are from Eurostat. NFR is for the total population of women in each country and $SU^2$ refers to women ages 15 to 44.

population to which our model applies), we do *not* assume that P is invariant across cohorts. This is actually highlighted in GSS (2006) in the final of the four predictions drawn from the simple model we develop and subsequent discussion.

**Wu and Model Properties**

Wu argues that a satisfactory demographic relationship must satisfy equation (4) below, and that the GSS model fails the criterion. We argue that criterion is not appropriate in many, if not most, models; furthermore, it is violated by relationships that are self-evidently correct. Wu's proposed condition is

(4) $y = f(x) = f(x_1) + f(x_2)$

where the subscripts represent mutually exclusive and exhaustive groups within a larger population (identified by the absence of a subscript). In Wu's application of the condition, y and x are identified with NFR and Su for some larger population such as blacks and whites combined. The subpopulation variables $x_1$ and $x_2$ are the single shares for blacks and whites, $Su_1$, and $Su_2$. Finally, in the GSS illustration, f(x), $f(x_1)$, and $f(x_2)$ are equal to $Su^2$, $Su_1^2$, and $Su_2^2$ (x), respectively. Substituting these values into equation (4) above gives equation (1) of Wu's paper. The resulting condition is obviously violated. Thus, as Wu asserts, the GSS model fails Wu's condition.

Yes, certainly. Wu's condition will be violated by any non-linear model, even a log-linear model since the log of the mean is not the mean of the logs . Indeed, it may even by violated by the most elementary relationships in which f(x) is linear and the relationship under consideration is self-evidently correct. For example, let y be the single share itself and U/N be the ratio of unmarried women (U) to the total population of women (N), so that the "model" under consideration is widely used and indisputably correct identity Su = U/N. Equally "true" are the relationships describing the single shares for black and white women as subpopulations: $Su_1 = U_1/N_1$ and $Su_2 = U_2/N_2$. And yet this relationship fails to satisfy Wu's requirement; Su, which is equal to U/N, is certainly not also equal to $U_1/N_1 + U_2/N_2$. Thus, even a self-evidently correct model may fail Wu's condition.

**WHAT MIGHT BE LEARNED?**

For our own part, we acknowledge that we might have raised fewer hackles by being more explicit and generous with qualifications, and by taking more care with presentation. Our title, for example, implies a more expansive claim than any of the claims we actually make. Nonetheless, we maintain that our analysis of the birth rate paradox from 1974 to 2000 for adult women 20-39 strongly suggests that selection effects arising from changing marriage behavior can have powerful composition effects on the pools of married and unmarried women. Certainly, effects may vary in importance across time and groups, and other factors may be more important over substantial periods of time. Still, it seems obvious by inspection that the rise in unmarried and married birth rates for women 20-39 over the final quarter of the past century could not have come from shared or idiosyncratic increases in desired fertility among unmarried and married women, simply because their combined birth rates did not rise.

It would, of course, be presumptuous of us to suggest what EMW might learn from this exchange. EMW reject our approach, but the best way to counter an idea is with a better idea. If EMW have a better explanation for the central paradox motivating the GSS model, they didn't present it. In conclusion, we appreciate the close attention to our work, and hope readers and EMW find our responses useful.

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Table 1. Nonmarital Fertility Ratio, Women 20-39, 1965-2002

| | (1) White period | (2) Period SUR | (3) Period SUR | (4) Period SUR | (5) Period SUR |
|---|---|---|---|---|---|
| <u>Variable</u> | | | | | |
| Constant | -0.0143 | -0.0143 | -0.0166 | 0.0044 | 0.0219 |
| | (0.0072) | (0.0073) | (0.0089) | (0.0140) | (0.0263) |
| $Su^2$ | 1.0099 | 1.0099 | 0.9271 | 0.9428 | 1.1461 |
| | (0.0260) | (0.0259) | (0.0548) | (0.0504) | (0.0894 |
| Su | | | | | -0.1533 |
| | | | | | (0.1015) |
| Time | | | 0.0009 | | |
| | | | (0.0006) | | |
| Age-race fixed effects | yes | yes | yes | yes | yes |
| Period effects | no | no | no | yes | no |
| Adjusted R-squared | 0.9851 | 0.9852 | 0.9861 | 0.9912 | 0.9860 |
| Number of obs | 285 | 285 | 285 | 285 | 285 |

Notes:
Standard errors are in parentheses.
The dependent variable is the nonmarital fertility ratio by race and five-year age interval.
Our data are not available until 1968 for black women and 1969 for white women 35-39.
See GSS (2006) for further explanation of the variables and data.

Table 2. Panel ADF Test Statistics.

| Null Hypothesis | Number of obs. | Lags | Chi-square test statistic |
|---|---|---|---|
| $(NFR - Su^2)$ has a unit root. | | | |
| Sample period: 1957-2000 | 274 | 0-7 | 49.40** |
| Sample period: 1980-2002 | 272 | 0-3 | 37.62** |
| [UBR/MBR - Su/(1+Su)] has a unit root. | | | |
| Sample period: 1957-2000 | 173 | 0-7 | 60.72** |
| Sample period: 1980-2002 | 172 | 0-3 | 45.81** |

Notes:

See Table 1 notes.

A double asterisk (**) indicates significance at the 1% level.

Lag length is based on the Schwarz Information Criterion.

Table 3. UBR/MBR, Women 20-39

| Explanatory Variables | 1957-2000 | 1965-2002 |
|---|---|---|
| Constant | 0.0014 | 0.0033 |
| | (0.0239) | (0.0344) |
| Su/(1+Su) | 0.9473 | 0.9693 |
| | (0.0789) | (0.1092) |
| Age-race fixed effects | yes | yes |
| Period effects | no | no |
| Adjusted R-squared | 0.8917 | 0.8711 |
| Number of obs | 292 | 284 |

Notes:

See Table 1 notes.
A single asterisk (*) indicates significance at the 1% level.
The dependent variable is UBR/TBR by race and five-year age interval.
Estimation is period SUR.

Table 4. International Evidence on NFR and Su2

| Variable | |
| --- | --- |
| Constant | -0.0176<br>(0.0538) |
| $Su^2$ | 1.2847<br>(0.2393) |
| Adjusted R-squared | 0.9592 |
| Number of obs | 38 |

Notes:

The 19 countries are indicated in Figure 1.

The dependent variable is the nonmarital fertility ratio for women of all ages in 1991 and 2001.

$Su^2$ is square of the single share for women 15-44 in 1991 and 2001.

Estimation is period SUR with individual country effects.

**Figure 1. NFR and Su2 for 19 European Countries, 1991 and 2001**