NBER WORKING PAPER SERIES

BUSINESS CYCLES AND FERTILITY DYNAMICS IN THE U.S.: A VECTOR-AUTOREGRESSIVE MODEL

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Working Paper No. 3177

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 1989

This paper is part of NBER's research program in Health Economics. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

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ABSTRACT

Using recent developments in time-series econometrics, this paper investigates the behavior of fertility over the business cycle. The sex-specific unemployment rates, the divorce rate and the fertility rate are shown to be governed by stochastic trends. Furthermore, fertility is determined to be co-integrated with the divorce and unemployment rates.

In the bivariate vector-autoregressions between fertility and unemployment, an increase in the female or male unemployment rates generate a decrease in fertility, which confirms the findings of previous time-series research concerning the procyclical behavior of fertility. However, when the models include the divorce rate and the proportion of young marriages as additional regressors, shocks to the unemployment rates bring about an increase in fertility, implying the countercyclicality of fertility.

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INTRODUCTION

The relationship between fertility and business cycles has frequently drawn the attention of researchers. In the beginning of the century, Udny Yule reported that there was a positive correlation between the oscillations in the birth rate and economic fluctuations in nineteenth century England (Yule 1906). Subsequent studies also demonstrated the procyclical behavior of fertility, i.e. the positive association between economic activity and fertility (Thomas 1927, Galbraith and Thomas 1941, Hyrenius 1946, Kirk 1960, Silver 1965, Ben-Porath 1973). All of these studies used aggregate time series data. The typical analysis involved either regressing fertility rates on a business cycle indicator or investigating the correlations of the trend deviations of the two series. The procyclicality of fertility seemed to exist even after controlling the marriage rate, although the response of the birth rate was substantially lower when the marriage rate was held constant (Silver 1965, p.247; Kirk 1960, Tables 1 and 2).

In contrast to the analyses in this literature, Butz and Ward (1979), using a microeconomic fertility model, concluded that the recent and current fertility patterns are countercyclical in nature and future fertility can be expected to move countercyclically.

The countercyclicality of fertility does not mean that children are "inferior goods". Since raising babies is a time intensive activity, countercyclicality of fertility only implies that the substitution effect of a decline (increase) of the opportunity cost of female time during an economic downturn (upswing) dominates the effect of a decrease (increase) in income.

Using vector-autoregressions (VARs) this paper shows that fertility moves countercyclically over the business cycle. This result is not due to the estimation technique employed because we are able to duplicate the findings of previous research within the VAR context. The procyclical behavior of fertility reported by previous time series research is spurious due to methodological weaknesses. This paper shows that the U.S. fertility is not governed by a deterministic trend as was assumed by previous studies. Rather, fertility evolves around a stochastic trend. Similarly, sex-specific unemployment rates have stochastic trends. It is shown that a <u>bivariate</u> analysis between fertility and unemployment yields a procyclical picture of fertility. However, when one considers the effects on fertility of early marriages and the divorce behavior as well as economic activity, fertility moves countercyclically.

Section II summarizes the previous research and describes briefly the methodology and findings of this paper. Section III describes the estimation procedure and reports the results. Section IV is the conclusion.

II. BACKGROUND AND METHODOLOGY

The previous time-series research on the cyclical behavior of fertility unanimously reported procyclicality. The studies which analyzed the simple correlations between trend deviations of fertility and unemployment, or fertility and income were constructed on the assumption that the series were composed of growth and cyclical components. The growth component was assumed not to have strong fluctuations over time, at least for short periods. The cyclical component was assumed to be transitory, and the short-run fluctuations were attributed to it. Under these assumptions, one could "de-trend" the series by regressing them on time, and the residuals could be referred to as the cyclical component (Yule 1906, Thomas 1927, Galbraith and Thomas 1941, Kirk 1960, Silver 1965).

The growth component, however, does not necessarily have to have a deterministic trend. Just as there are cyclical movements in the series, there might be variations in the growth trend as well. For example, the class of integrated stochastic processes exemplified by the random walk also exhibit secular movement but do not follow a deterministic path. If the growth component is of a stochastic, rather than deterministic in nature, then models based on time trend residuals are misspecified (Nelson and Plosser 1982). In fact, there is overwhelming evidence showing the existence of variable trends in many macro-economic variables. For example, GNP, a variable which is frequently employed by previous studies on fertility cyclicality, has been shown to have a stochastic trend (Nelson and Plosser 1982, Campbell and Mankiw 1987, Clark 1987, Cochrane 1988, Stock and Watson 1988, Shapiro and Watson 1988). Although unemployment, another frequently used business cycle proxy, does not show evidence of having a variable trend, this paper shows that the sex-specific unemployment and fertility rates are governed by variable trends.

The analysts who regressed fertility on business cycle indicators and other explanatory variables did not pay enough attention to the problem of simultaneous equation bias. A typical case was the inclusion of age at marriage as a regressor, which might be correlated with the unobservable determinants of fertility. If that is true, the estimation of a fertility equation by ordinary least squares produces biased estimates of the parameters. One could use two-stage least squares to avoid the problem.[1]

Recently Macunovich and Easterlin (1988) estimated bi-variate vector-autoregressions between fertility and unemployment with the U.S. data. They applied Granger-Sims causality tests, and reported a significant causal effect from unemployment to fertility. They also showed that the sign of the causality was negative, implying that there was an inverse relationship between fertility and the unemployment rate.

Although Granger-Sims causality tests have been widely used since the pioneering article of Sims (1972), failure to include more than two variables in these analyses has been recognized as a serious problem (Pierce 1977, Sims 1977). Sims (1981) argued that if the set of variables included in a VAR model is incomplete, then there is a strong possibility of spurious Granger-causal findings. Newbold described the problem as simply analogous to the problem of left-out variables in regression models (Zellner 1979). Lütkepohl(1982) demonstrated that the Granger-causalities obtained from bivariate systems may be invalidated by the inclusion of additional variables. Therefore, the results of Granger-Sims causality tests reported by Macunovich and Easterlin should be viewed with caution.

This paper attempts to overcome these weaknesses by estimating multivariate vector-autoregressions among fertility, proportion of young marriages, the divorce rate, and the unemployment rate. The proportion of young marriages and the divorce rate are variables which need to be included in the analysis of fertility dynamics. An increase in the female age at marriage affects the fertility rates by shortening the period during which women are exposed to pregnancy and by lengthening the interval between generations. Also, if women delay their marriages to get greater education or employment opportunities, fertility decisions might be influenced directly by these experiences.

The divorce behavior is also an important element in the system because tensions prevailing in a marriage that eventually dissolves may affect decisions concerning the number and/or spacing of births. Couples experiencing marital discord may decide not to have any children, or if they have already begun a family, not to have any additional offspring, thus reducing their fertility. (Cohen and Sweet 1974, Thornton 1978) (Koo and Janowitz 1983).

After estimating the models, shocks are applied to the unemployment rate, and the impulse responses of fertility are observed. It is seen that, in the bivariate vector-autoregression models between fertility and unemployment, an increase in unemployment generates a decrease in fertility. This confirms the findings of previous time-series research concerning the procyclical behavior of fertility. However, if the models include the proportion of young marriages and the divorce rate as additional regressors, the relationship between unemployment and fertility turns around. Shocks to unemployment generate an increase in fertility, indicating the countercyclicality of fertility.

III. EMPIRICAL IMPLEMENTATION

This paper uses multi-variate VARs to describe the dynamic interrelations between fertility, unemployment, proportion of young marriages, and the divorce rate. This technique allows us to treat all the variables as endogenous. A VAR can be interpreted as the reduced form relationship that arises from a dynamic stochastic structural model, the underlying structural parameters of which are based on the utility functions and technological constraints (Eckstein et al. 1985). In a VAR system, each variable is regressed on its own lagged values, lagged values of the other endogenous variables as well as lagged values of the relevant exogenous variables. Because the right-hand side variables in each equation consist of past values, they are all predetermined. Thus, the system can be consistently estimated using OLS. Furthermore, estimating each equation separately using OLS produces asymptotically efficient estimates because the right-hand side variables are the same in every equation (Hakkio and Morris 1984).

We employ monthly U.S. data which cover the time period 1963-1982. Fertility is measured as the number of births per 1000 women between the ages of 16 and 44. The proportion of brides between ages 16 and 24 in their first marriages to 1000 women in the same age group shows the tendency to marry early. We call this variable the proportion of young marriages. The divorce rate is measured as the number of divorces per 1000 married women who are 18 years of age and over. The proxies for economic activity are the unemployment rate for women who are 16 years of age and over, and the unemployment rate of men who are 16 years of age and over.[2] Figures 1 to 5 present the plots of the series. The fertility and divorce rates level off after mid-seventies following a continuous decrease and increase respectively. Both series are seen to have time-dependent variances. The female and male unemployment rates display similar patterns, while the female unemployment rate is higher than that of the male for any given time period. The proportion of young marriages exhibits an interesting behavior. The series seems to be stationary but has a very significant seasonality. The jumps correspond to the months of June, July and August: Younger brides prefer the summer season for marriage.

A. LEVELS vs. DIFFERENCES AND CO-INTEGRATION

Recent developments in time-series econometrics have underscored the importance of differentiating between difference-stationary processes (DSP) and trend-stationary processes (TSP).

If a series is a TSP, the trend deviations of it are stationary, whereas in the DSP they are accumulations of stationary changes. Neither current, nor past events will alter long-term expectations in a TSP. In the DSP, however, the forecast are influenced by past events, and the variance of the forecast error is increasing without bound.

Failure to distinguish between TSP and DSP, can generate seriously misleading results (Nelson and Kang 1984, Stock and Watson 1988). A test developed by Dickey and Fuller (1981) can be used to test the hypothesis that a particular series belongs to DSP type against the alternative that it belongs to TSP type. To implement the Dickey-Fuller test we estimate

$$z_t - z_{t-1} = \alpha + \beta_0 t + \beta_1 z_{t-1} + \sum_{i=1}^{k} \delta_i (z_{t-i} - z_{t-i-1}) + \varepsilon_t, \qquad (1)$$

where z is in natural logs and t is the trend term.

The variable z belongs to DSP type if $\beta_0 = \beta_1 = 0$.

The results are presented in Table 1. We reject the null hypothesis of a stochastic trend only for the proportion of young marriages. With respect to fertility, divorce, and the male and female unemployment rates we can not reject the null that the series are DSP processes. Consequently, in our estimations we use the first differences of fertility, divorce and the unemployment rates, and the trend deviations of the proportion of young marriages.

A series is defined as being "integrated of order d", if it needs to be differenced "d" times to generate a stationary series. The components of a vector x_t are said to be co-integrated of order (d,b), if i) all components of x_t are integrated of order "d"; ii) there exists a non-zero vector α so that $z_t=\alpha x'_t$ is integrated of order "d-b", b>0 (Engle and Granger 1987). Put differently, time series which are stationary after differencing are called co-integrated, if they have a linear combination which is stationary without differencing.

Engle and Granger show that vector-autoregressions in differences will be misspecified if the variables are co-integrated. In this case an error correction procedure must be adopted (Engle and Granger, 1987). To implement the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) co-integration tests, we estimate

$$X_{1t}=\alpha+\beta_2 X_{2t}+\beta_3 X_{kt}+\varepsilon_t, \qquad (2)$$

where X_1 represents fertility, X_2 stands for the male or female unemployment rate, and X_3 is the divorce rate. The residuals obtained from (2) are then used in

$$\varepsilon_t - \varepsilon_{t-1} = \tau\varepsilon_{t-1} + u_t \tag{3}$$

and

$$\varepsilon_t - \varepsilon_{t-1} = \tau\varepsilon_{t-1} + \sum_{i=1}^{4}\delta_i(\varepsilon_{t-i} - \varepsilon_{t-i-1}) + u_t, \tag{4}$$

where the hypothesis $\tau=0$ is tested.

Table 2 reports the results of the DF and ADF co-integration tests. As is seen, fertility is not co-integrated with the female or male unemployment rates. On the other hand, fertility is co-integrated with the divorce rate and the female unemployment rate, and with the divorce rate and the male unemployment rate. Therefore, in the multi-variate models which include the proportion of young marriages and the divorce rate in addition to the unemployment variables, the error correction model proposed by Engle and Granger (1987) is employed. The lagged levels of co-integrated variables are included in each equation of our VAR systems as error correction terms.

B. ESTIMATION

We estimate two multivariate and two bivariate VAR models. Each multivariate model includes fertility, the proportion of young marriages, the divorce rate and either the female or male unemployment rates. The bivariate VARs consider the relation between fertility and unemployment variables only, omitting the proportion of young marriages and the divorce rate. Since the variables are not seasonally adjusted, eleven dummy variables are included in each equation to account for monthly variation. All variables are expressed in natural logs.[3]

For the bivariate VARs we found that the female unemployment rate affects the fertility rate most significantly with the lags 12 to 26. The male unemployment rate has the most significant effect on fertility with lags 3 to 9. The F-statistics of the lags of the female unemployment rate was 1.85 with a marginal significance level of .032; the F-statistics of the lags of the male unemployment rate was 2.00 with a marginal significance level of .057. In the multivariate VARs, the lag structure was 18 to 24 in the model with the female unemployment rate. The F-statistic was 2.24 with a marginal significance level of .033. The multivariate model with the male unemployment rate is estimated with the lags 22 to 26. The F-statistic of the lags of the male unemployment rate was 2.35 with the marginal significance level .043.[4]

Table 3 reports the residual correlograms of the fertility equations in the multivariate models. If the errors are a white noise process, their autocorrelations should not be different from zero; and their first difference should follow an MA(1) process with the moving-average parameter equal to 1, and the first autocorrelation equal to -.5. Also a Lagrange Multiplier (LM) test was applied to the residuals.[5] The tests are based on additional regressions in which the residuals of fertility equations are regressed on the same set of variables plus a set of lagged residuals. One rejects the null hypothesis of no autocorrelation (white noise errors) if the set of lagged residuals is different from zero.

Although the first autocorrelation of the residuals in both models are significant at .05 level, there is no decay in the partial autocorrelations. Hence there is no evidence of a moving-average structure in the errors. Moreover, the first differences of the residuals are clearly MA(1) processes with coefficients equal to 1. These considerations and the results of the LM tests let us accept the hypotheses that the errors are white noise.

C. IMPULSE RESPONSE FUNCTIONS

A very useful way to characterize the dynamic relationships among the variables is to map out their responses to unanticipated shocks in one of the variables. To that end, after estimating the VAR models, they are converted into a linear combination of the innovations. As long as the errors of the variables are contemporaneously correlated (the off-diagonal elements of the variance-covariance matrix is nonzero), changes in errors occur simultaneously, hence a change in a variable can not be attributed to the innovation in that variable alone. Therefore an orthogonalization of the errors is needed, which is obtained by triangularization of the variance-covariance matrix of residuals, to create a block recursive system among errors.[6]

The transformation imposes a causal ordering among the contemporaneous errors. The impulse response functions presented below are based upon the following causal ordering: The unemployment rate, the proportion of young marriages, fertility, and the divorce rate.[7]

Figures 6 and 7 present the responses of fertility to the disturbances in the unemployment rates in the models which exclude the proportion of young marriages and the divorce rate (bivariate vector-autoregressions between fertility and unemployment). Figures 8 and 9 show the reactions of fertility to the increases in the unemployment rates in the models which include the proportion of young marriages and the divorce rate. Since fertility was determined to be a DSP process, the first-differences of the natural logarithms were used. Therefore, the impulse response functions yielded the reactions of the growth rates. Those values are then used to calculate the percentage changes in the level of fertility following the shock, with respect to its initial level.

Figure 6 presents the reaction of fertility to a shock in the female unemployment rate. After the unexpected increase in the female unemployment rate, fertility declines below its initial level, and after almost the third year following the shock, fertility stays roughly .3 percent below its initial level. In figure 7 one observes that the increase in the male unemployment rate initially yields an increase in fertility. But after the eleventh month fertility declines and stays below its initial level. According to figures 6 and 7, an increase in the female or male unemployment rates generates a decline in fertility, which confirms the findings of previous time-series research on the cyclicality of fertility that reported a procyclical behavior.

Figures 8 and 9 on the other hand, demonstrate that in the multi-variate models, which do not omit the divorce rate and the proportion of young marriages, an increase in the unemployment rates generate an increase in fertility. The shocks to the female or male unemployment rates bring about an increase in fertility as much as 1 percent with respect to its initial level.
The outcome of a procyclical behavior of fertility obtained from bivariate VARs is totally reversed in the case of multi-variate VARs. More complete models, which allow the dynamics of the divorce rate and the tendency to marry early to be integrated into the dynamics of fertility, change the direction of the correlation, and fertility is seen to move to the opposite direction of the economic activity.

As a check of the robustness of the results, we substituted the labor force participation rate for women who are 16 years of age and over for the unemployment rate. In the VAR which includes the proportion of young marriages, the divorce rate and the female labor force participation rate, a shock to the labor force participation of women generated a decline in fertility (not shown), which was consistent with the countercyclical behavior observed earlier.

In sum, the estimation of a multi-variate VAR yields that fertility increases whenever unemployment increases. Since we were able to duplicate the results of previous studies within a bi-variate VAR context, this study casts doubt about the often reported procyclical behavior of fertility which was mainly based on bivariate analyses.

IV. CONCLUSION

Previous time-series research on the cyclical behavior of fertility concluded that there was a positive correlation between economic activity and fertility. These studies have some methodological weaknesses. They are either based on very limited specifications or can not account for a potential simultaneous equation bias. Studies which focused on the correlations of the trend deviations of fertility and business cycle proxies fail to control for potential stochasticity in the secular component of the series.

Using recent developments in time-series econometrics, this paper investigates the dynamic interrelations between fertility, the divorce rate, the proportion of young marriages, and the female and male unemployment rates. The unemployment rates, the divorce rate, and the fertility rate have been shown to be governed by stochastic trends. Furthermore, fertility was determined to be co-integrated with the divorce and unemployment rates.

After estimating bivariate vector-autoregressions, shocks were applied to the male and female unemployment rates. In each case an increase in unemployment brought about a decrease in fertility, which implied fertility moved procyclically. When estimating the same models including age at marriage and the divorce rate, shocks in the unemployment rates generated an increase in fertility, demonstrating the countercyclical behavior of fertility.

Focusing on pairwise relations between fertility and unemployment generates a procyclical picture, whether one uses a regression analysis or deviations from trend terms as was the case in previous studies, or a VAR, as has been done in this study. This finding, however, is spurious due to the omitted variables. Inclusion of other relevant variables like the divorce rate and the proportion of young marriages yields the opposite outcome: the countercyclicality of fertility.

TABLE 1

DICKEY-FULLER TESTS FOR UNIT ROOTS

z	F-stat
Fertility	2.46
Proportion of young marriages	35.71
Divorce rate	1.95
Female unemployment rate	2.42
Male unemployment rate	3.43

All variables are in natural logs. F-stat represents the F-statistics under the null hypothesis $\beta_0=\beta_1=0$ in the regression

$$z_t-z_{t-1} = \alpha_0+\beta_0 t+\beta_1 z_{t-1}+\sum_{i=1}^{k}\delta_i(z_{t-i}-z_{t-i-1})+\varepsilon_t,$$

where t is a linear trend term. For the proportion of young marriages, the divorce rate, and the female unemployment rate, the first difference of logs were characteristic of an AR(2) process. For fertility, male unemployment rate and the labor force participation rate, an autoregressive representation (with k=12) is used to approximate MA(1) processes. The F-ratio tabulated by Dickey and Fuller is 6.49 at the 5% level when the sample size is 100, and 6.34 when it is 250 (Dickey and Fuller 1981, p.1063, Table VI).Since our sample sizes vary between 227 and 237, our critical F-ratio lies between 6.34 and 6.49.

TABLE 2

CO-INTEGRATION TESTS

Right-hand side variable(s) of equation (2)	DF	ADF
Female unemployment rate and the divorce rate	-6.14	-4.99
Male unemployment rate and the divorce rate	-6.23	-5.06
Female unemployment rate	-2.69	-2.51
Male unemployment rate	-2.46	-2.25

Sample sizes are 239 and 235 for the first and last two regressions, respectively.

The log-level of fertility is regressed on the log-levels of other integrated variables in equation (2). The Dickey-Fuller (DF) statistic is the t statistic associated with τ in the regression $\varepsilon_t-\varepsilon_{t-1}=\tau\varepsilon_{t-1}+u_t$. The Augmented Dickey-Fuller (ADF) statistic is the t statistic associated with τ in the regression

$\varepsilon_t-\varepsilon_{t-1}=\tau\varepsilon_{t-1}+\sum_{i=1}^{4}\delta_i(\varepsilon_{t-i}-\varepsilon_{t-i-1})+u_t$, where ε_t is the residual from equation (2) and u_t is the white noise error term. With 3 variables and a sample size of 200, the critical t-value given by Engle and Yoo is 3.78 for both the DF and ADF statistics at 5% level. With 2 variables, the t-values are 3.37 and 3.25 for DF and ADF respectively for the same sample size and significance level (Engle and Yoo 1987, Table 2 and Table 3).

TABLE 3

SPECIFICATION TESTS FOR THE ERRORS OF THE ESTIMATED MULTIVARIATE VAR MODELS

	Model with Female Unemployment Rate[a]		Model with Male Unemployment Rate[b]	
Sample autocorrelations and partial autocorrelations of the residuals[c]	AC	PAC	AC	PAC
r_1	-.161	-.161	-.175	-.175
r_2	-.018	-.045	-.032	-.065
r_3	.087	.078	.058	.042
r_4	.018	.046	-.042	.001
r_5	.049	.066	.006	.009
r_6	.033	.048	.038	.039
r_7	.064	.077	.152	.174
r_8	.033	.050	.013	.080
r_9	-.002	.005	-.005	.024
r_{10}	.012	-.004	.071	.067
r_{11}	.049	.036	.018	.045
r_{12}	-.061	-.063	-.069	-.062
Sample autocorrelations and partial autocorrelations of first-differenced residuals	AC	PAC	AC	PAC
r_1	-.557	-.557	-.555	-.555
r_2	.012	-.433	.019	-.417
r_3	.085	-.261	.073	-.251
r_4	-.054	-.220	-.048	-.206
r_5	.022	-.164	-.0007	-.191
r_6	-.014	-.156	-.035	-.267
r_7	.027	-.095	.107	-.131
r_8	.006	-.020	-.049	-.060
r_9	-.030	-.011	-.044	-.099
r_{10}	-.003	-.039	.062	-.059
r_{11}	-.057	.047	.001	.046
r_{12}	-.079	-.014	-.076	.0009
The MA(1) coefficient of first-differenced residuals[d]	.98 (76.22)		.96 (52.30)	
LM-test, Chi-square[e]				
H_0: $p_1 = \ldots = p_6 = 0$	9.15		8.68	
H_0: $p_1 = \ldots = p_{12} = 0$	14.96		19.16	

a The model which includes the female unemployment rate in addition to fertility, the divorce rate, and the proportion of young marriages.

b The model which includes the male unemployment rate in addition to fertility, the divorce rate, and the proportion of young marriages.

c r_i is the ith order autocorrelation or partial autocorrelation coefficient. The autocorrelations are under column AC, the partial autocorrelations are under column PAC. The large sample standard error under the null hypothesis of no autocorrelation is $1 \div \sqrt{n}$, where n is the sample size. For our sample size of 215, the .05 confidence interval is approximately ±.13.

d The numbers in the parentheses are the t-ratios.

e The residuals are regressed on same right-hand side variables and a set of lagged residuals. An F-statistic is computed for the coefficients on the lagged residuals. Multiplying F by the number of autocorrelations in the null hypothesis yields the Chi-square statistic, where the number of autocorrelations in the null hypothesis is the degrees of freedom. The critical value for Chi-square at the .05 level for 6 and 12 degrees of freedom are 12.591 and 21.026 respectively.

FOOTNOTES

* I would like to thank Ted Joyce, Michael Grossman and Jeffrey Zax for helpful comments. Any errors reflect my shortcomings only.

1. There has been theoretical and empirical work pertaining to the determinants of age at marriage. See Keeley (1977, 1979), where household production theory and search theory are incorporated to explain the incentives to marry and the determinants of age at first marriage.

2. The data are obtained from various issues of National Center for Health Statistics Monthly Vital Statistics Report, Vital Statistics of the U.S., Department of Health, Education and Welfare, Statistical Abstract of the United States and the Citibase.

3. Induced abortion became legal nationwide in the United States due to a Supreme Court decision on January 22, 1973. To the extent to which abortion is a method of birth control, the legal availability of abortion might have altered the level of the fertility series. Since the law did not apply to pregnancies greater than 24 weeks, the effect of the law on the number of births would not be observed until at least 16 to 20 weeks later. Furthermore, the full impact of the law could not be felt until October 1973 when the pregnancies of the first cohort of women who conceived on or after February 1973 reached term. To control for this potential break in the series we estimated the versions of the models including a dummy variable which is zero prior to October 1973 and one thereafter. The results remained practically unchanged.

4. Different lag specification were tried. Although the sign of the relationship was always the same (for the bivariate VARs the sum of the lags was always negative, for the multivariate VARs it was positive), the Granger-Sims causalities were not always significant at .05, even at .10 level.

5. The Durbin-Watson statistic is not appropriate when the specification includes a lagged dependent variable; nor strictly speaking, is the Box-Pierce Q-statistic. The LM statistic provides a general test for autocorrelation of errors, and is valid when the set of regressors includes lagged dependent variables (Breush 1978, and Godfrey 1978).

6. For details see Gordon and King (1982), Sims (1980) and Litterman (1979).

7. Although in most studies employing VAR methodology the ordering remains arbitrary and controversial, researchers try several orderings, placing the variables which are known to respond most strongly to contemporaneous events at the bottom of the ordering list (Gordon and King 1982). Different orderings we tried yielded very similar impulse responses.

FIGURE 1

The fertility rate

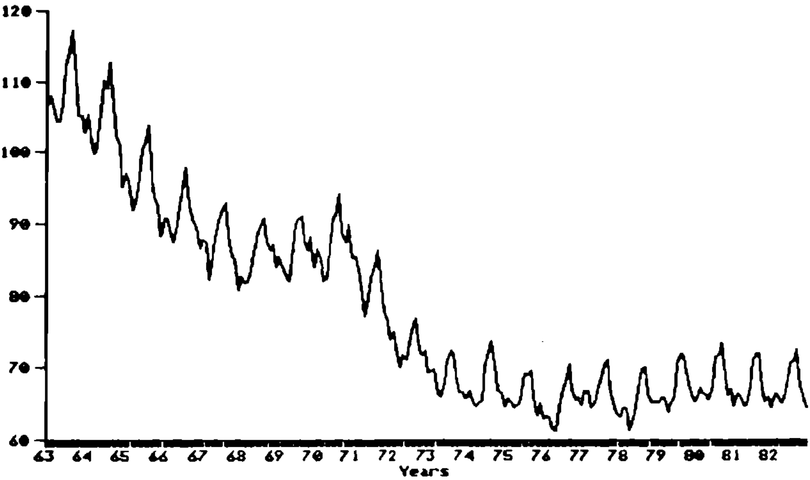


FIGURE 2

The divorce rate

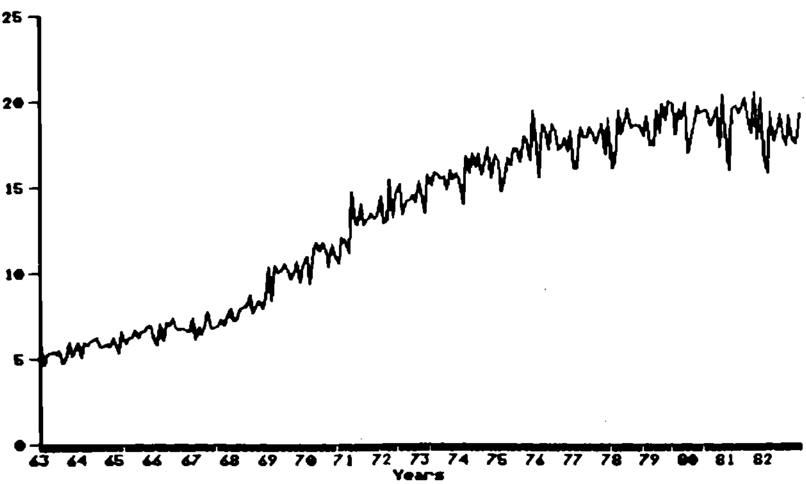


FIGURE 3

The female unemployment rate

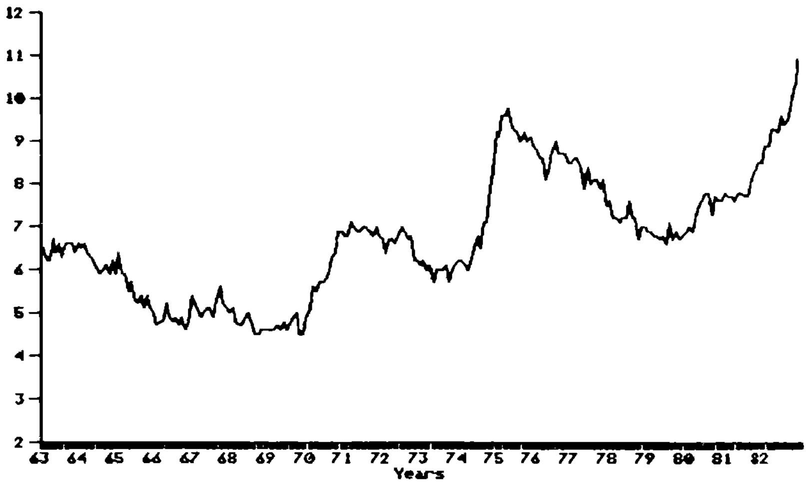


FIGURE 4

The male unemployment rate

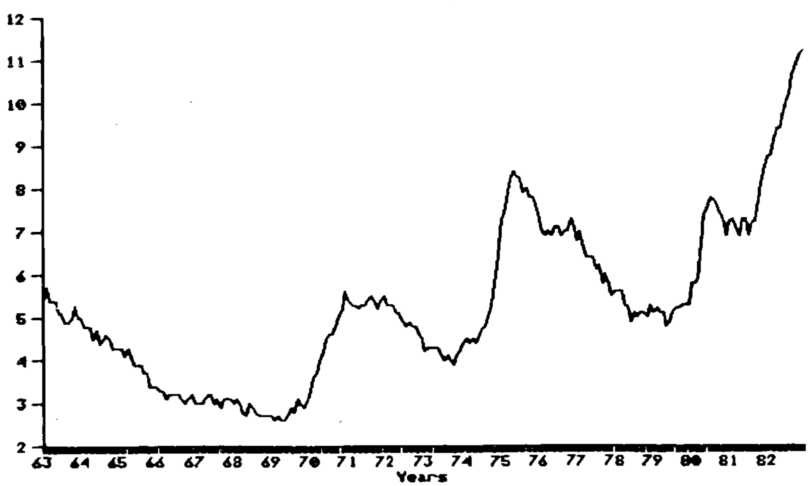


FIGURE 5

The proportion of young marriages

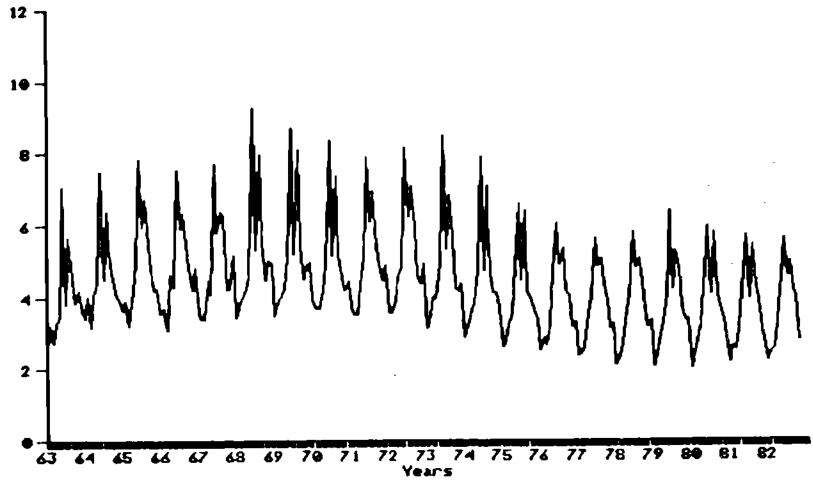


FIGURE 6

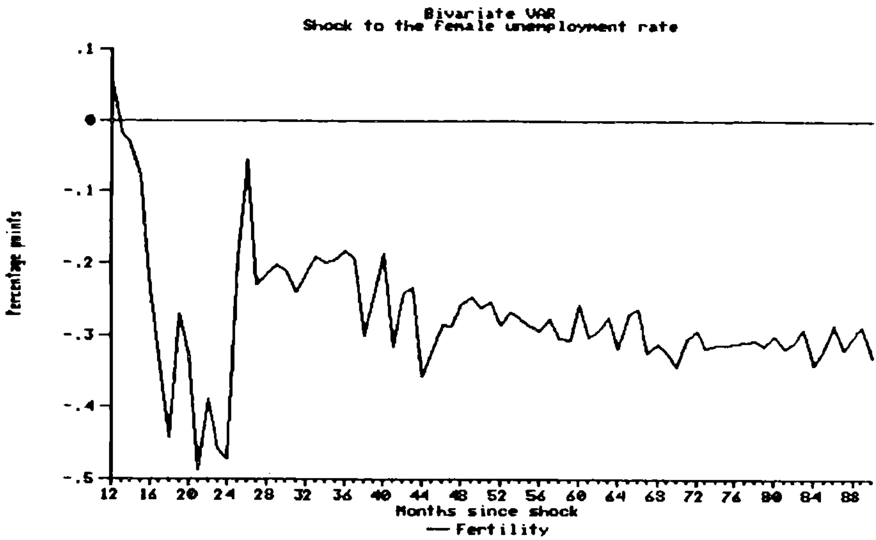


FIGURE 7

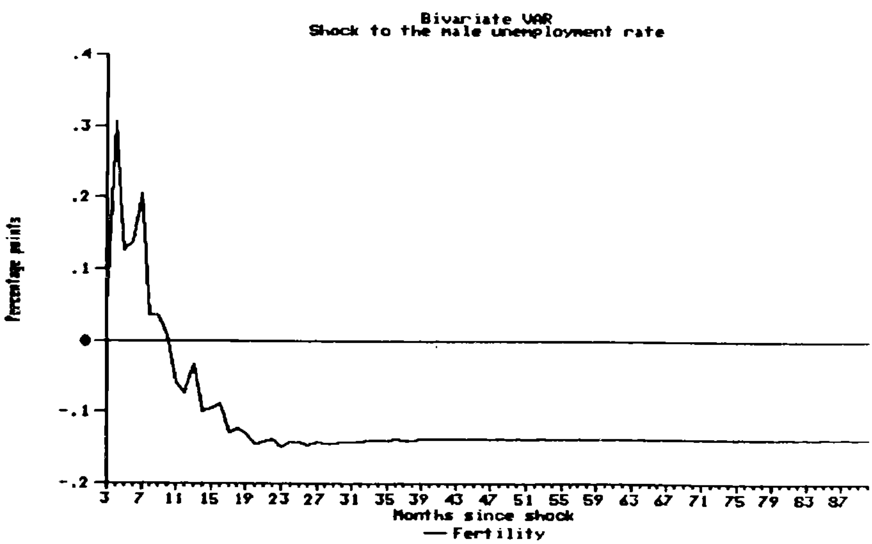


FIGURE 8

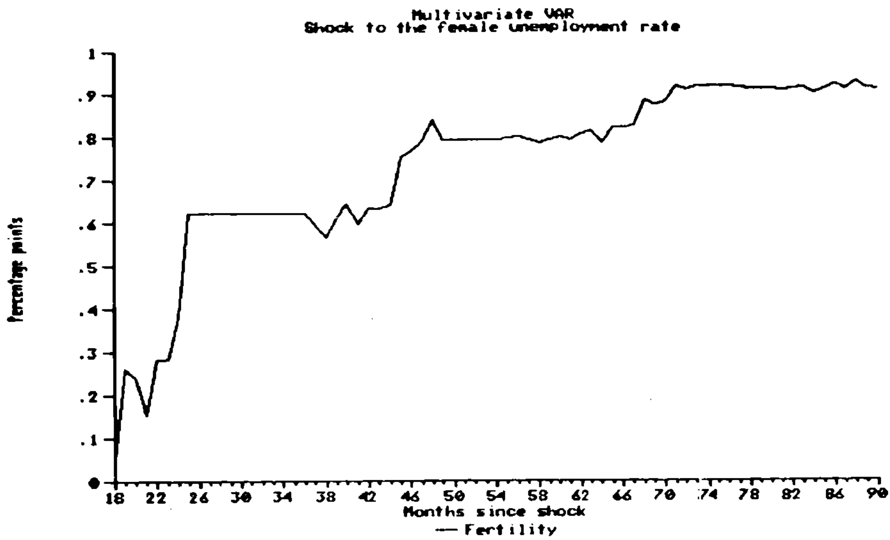
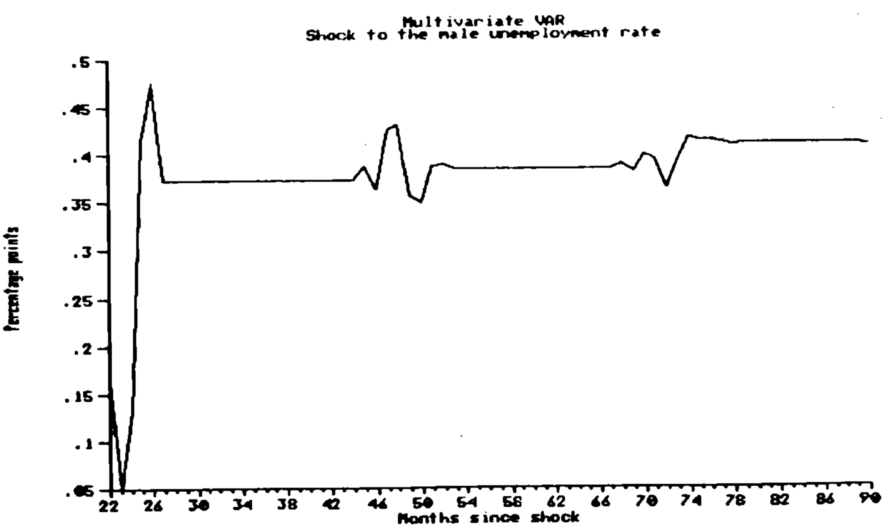


FIGURE 9



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