Unemployment and Family Behavior in Taiwan

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ABSTRACT: This paper utilizes official monthly time series data of Taiwan from January 1978 to April 2000 and estimates of a Vector Auto-regressive model with centered seasonal dummy variables to investigate the interrelationships between unemployment and family behavior such as divorce, marriage, and conception in Taiwan. When using the unemployment rate as a proxy for the cycle indicator, the primary finding is that the unemployment rate has a positive influence on the divorce rate in Taiwan. In addition, the marriage rate turns out to be positively affected by the unemployment rate as well. However, the conception rate is found to be negatively affected by the unemployment rate.

KEY WORDS: conception; divorce; marriage; Taiwan; unemployment.

Taiwan is currently suffering a very severe and problematic economic crisis. According to official information provided by the Ministry of Economic Affairs, Republic of China, the yearly unemployment rate rose from 1.51 percent in 1991 to 2.99 percent in 2000. The deteriorating unemployment situation became even worse in 2001, with monthly unemployment first rising to 3.35 percent in January 2001 and then sharply increasing to a record high of 5.17 percent in August. By September 2001, the monthly unemployment rate broke a new record again, hitting 5.26 percent. To be more concise, there were 519,000 unemployed workers in Taiwan during September—a number that is expected to be higher in October due to most pessimistic expectations of Taiwan's future economy.

Although business cycles can be represented by some macroeconomic indicators, some in the literature have adopted the unemployment rate as the variable for representing business cycles (Domian & Louton, 1995; Gregory & Smith, 1996; Mocan, 1990). Therefore, even if the unemployment rate is one of just many cyclical indicators,

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it is often used to represent business cycles due to its highly negative correlation with business cycles. We hence here use the unemployment rate as a business cycle indicator, and can thus conclude that Taiwan is currently undergoing an economic recession.

The relationship between family behavior and business cycles has been a focus of interest since the early 20th century. According to Becker (1988), divorces, marriages, and births in many countries have fluctuated pro-cyclically, which is to say that all of these family behaviors move together with the business cycle. In the case of Taiwan, the conclusion of Chen (1997) challenges the hypothesis of the pro-cyclical fluctuation of divorce. Chen (1997) found that divorce rates were pro-cyclical before World War II, but then turned counter-cyclical. In addition, Shieh (1994) indicated that birth rates in Taiwan are negatively related with economic prosperity.

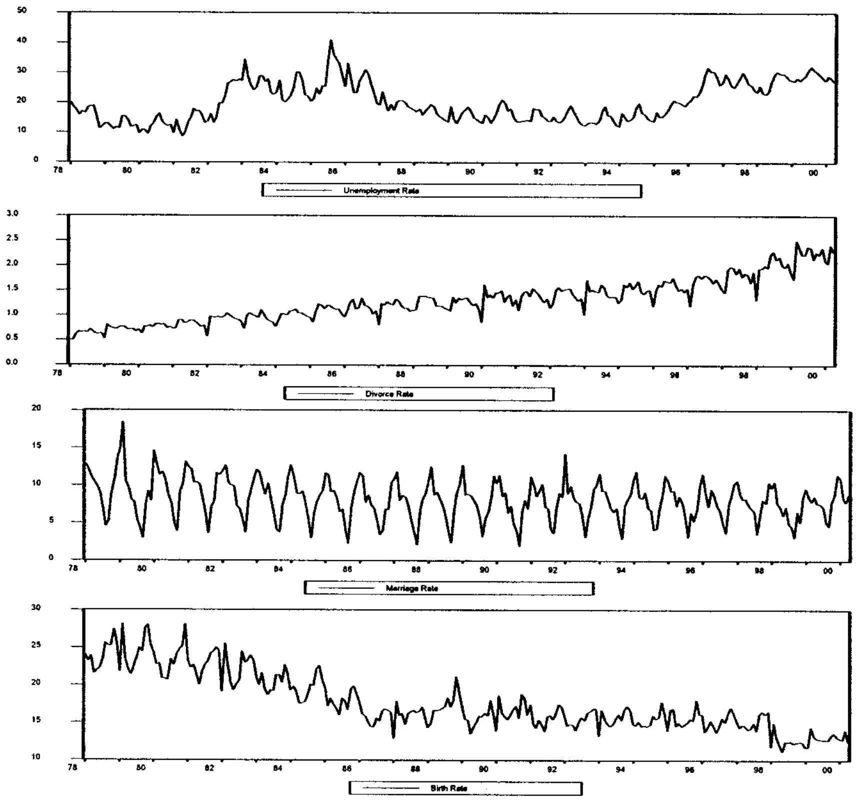
Although Chen (1997) and Shieh (1994) have conducted a related study, their research efforts focus only on one family behavior. In addition, their studies overlook the potential endogenous relationship between business cycles and family behavior. This might in fact cause a biased conclusion.

Figure 1 shows that Taiwan's divorce rates, marriage rates, and birth rates have undergone a tremendous change in the past. Hence, as Taiwan's economy is currently facing a severe recession, understanding exactly how much business cycles contribute to the fluctuation in family behavior among Taiwanese people should be of great significance and is the key issue investigated in this study. In addition, such an understanding will shed light on the causes of the decline in fertility and the increase in Taiwan's divorce rate.

Assuming that women generally give birth after 9 months of pregnancy,[1] two major conclusions emerge from this study. First, the monthly rates of unemployment, divorce, marriage, and conception are all non-stationary and there is no co-integrating relationship among them.[2] Second, after the multivariate Vector Auto-regressive (VAR) model is estimated with centered (orthogonalized) seasonal dummy variables, the divorce rate is found to positively respond to the unemployment rate, which is consistent with the conclusion in Chen (1997), while the marriage rate shows a positive response to the unemployment as well. The conception rate is negatively affected by the unemployment rate in Taiwan, which disputes the conclusion of Shieh (1994). Finally, the conception rate is found to be lower during the hot and humid summer, which has also been proposed and supported by Lam, Miron and Riley (1994), Lam and Miron (1996), and Seiver (1985).

FIGURE 1

Monthly Rates of Unemployment, Divorce, Marriage, and Birth in Taiwan (January 1971–April 2000, %)



Sources: Monthly Statistics of the Republic of China (various years), Directorate-General of Budget Accounting and Statistics, Executive Yuan, Republic of China.
Notes: The unit for all variables is ‰. The unemployment rate is defined as the number of unemployed per 1000 in the labor force. The divorce rate and marriage rate are defined as the number of divorced and married couples per 1000 in the population, respectively. The birth rate is defined as the number of live births per 1,000 in the population.

The remainder of the paper is organized as follows. Section 2 describes the relationships between business cycles and specific family behaviors, followed by a description of the empirical methodology in Section 3. Section 4 contains the empirical results of the multivariate VAR model and Section 5 details the conclusions.

Relationships Between Business Cycles and Family Behavior

The relationship between economic influences and family behavior has been investigated ever since the early 20th century. Regarding the influence of business cycles on family behavior, many studies show that marriages, births, and other family behaviors respond to fluctuations in aggregate output. The earliest empirical analysis on this issue conducted by Yule (1906) demonstrated that in the 19th century marriages and births conformed positively to the business cycle in England and Wales. Both Galbraith and Thomas (1956) and Kirk (1956) asserted that births conform positively to the business cycle, while Becker (1960) also found that cyclical changes in births move in the same direction as changes in the United States national output. With empirical results, Silver (1965) further supported the conclusion, showing that births and marriages move together with business cycles in the United States. Butz and Ward (1979) noted that United States birth rates seem to have turned counter-cyclical after many married women joined the labor force, apparently because childrearing is cheaper during a recession.

Some in the literature have concluded that family behavior has an uncertain role in a business cycle. Mocan (1990) suggested that both female and male unemployment rates have a negative effect on fertility, and that the behavior of fertility is pro-cyclical in bivariate VAR models and counter-cyclical in multivariate VAR models. Furthermore, contrary to the conclusion of Becker (1988) that divorce rates show pro-cyclical fluctuations in many countries, Ermisch (1991) indicated that there is no evidence that macro-level economic variables affect the risk of marital dissolution.

In contrast to a business cycle's influence on family behavior, the latter may also play more than just a negligible role in causing the former. For example, marital separation is an important factor for women entering the labor market, because a wife's household nonwage income drops dramatically after separation. Alimony and child support cannot fully replace the previous contribution from a husband's earnings. An increase in the labor supply can as a result induce cyclical responses in aggregate output. A potential role for family behavior in the generation of ordinary short-run business cycles (Becker, 1988) is thus hypothesized.[3]

Family behaviors can also affect each the other. Becker, Landes and Michael (1977) suggested that the number of children has a significantly positive effect on divorce.[4] In contrast, Cherlin (1977) concluded that children were a deterrent to separation and divorce, but only when they were in their pre-school years. A follow-up study by Cherlin (1979) indicated that a large portion of the rise in divorces is attributed to a change in the age-specific divorce rates.[5] Fulop (1980) pointed out that economic and demographic variables (such as fertility) affect people's decisions concerning marriage and divorce.

Although the interrelation between specific family behaviors (such as divorces, marriages, and births) and business cycles has been explored in the United States and other Western countries, it has rarely been discussed in Taiwan. Hence, this study employs an empirical model to explore this issue of the potentially endogenous relationship between various family behaviors and the business cycle.

Methodology

This paper adopts the unemployment rate as a cyclical indicator due to its high correlation with the business cycle, in order to possibly explain the recent scenario of the co-existence of high unemployment, low birth, low marriage, and high divorce rates in Taiwan. As discussed in Section 2, the unemployment, divorce, marriage, and birth rates can possibly affect each other. The hypothesis that all variables are endogenous and affect each other is thus made and needs to be examined.

One problem has arisen when using current birth rates in the analysis. Using current birth rates might cause an unreasonable conclusion of an immediate relationship between birth and other variables. As a matter of fact, it is impossible for women to give birth immediately after a change in any situation, but it is always possible for them to conceive immediately after a change in any situation. Hence, the conception rate, defined as being equal to the birth rate that occurs 9 months later, is used to replace the birth rate in this study.

This paper utilizes the official monthly data of Taiwan from January 1978 to April 2000 and a multivariate VAR model (which treats all variables as endogenous) to analyze the dynamic interrelationships between unemployment, divorce, marriage, and conception rates. The mathematical form of a VAR is as follows:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + B x_t + \epsilon_t, \tag{1}$$

where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $A_1, \dots, A_p$ and B are matrices of coefficients to be estimated, and ϵ t is a vector of innovations, which may be contemporaneously correlated with each other, but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Since Nelson and Plosser (1982) indicated that most macro-variables are non-stationary that lead to an incorrect estimation, the hypothesis that all variables are stationary has to be investigated first. According to Chua and Sharma (1998), the process for testing the VAR model involves performing both the unit root test for each variable and the cointegrating test for the variable vector.[6] If there is a unit root in each series, but no cointegrating vector for the variable vector, then the best way to estimate this VAR model is to use the log difference of all variables.[7]

Unit Root Test

In order to investigate whether time-series variables are better characterized as stationary fluctuations around a deterministic trend or non-stationary processes that have no tendency to return to a deterministic path, this paper follows Nelson and Plosser (1982) and considers two fundamentally different classes of non-stationary processes. One is the trend stationary process, which includes a time trend and has a stationary stochastic process with zero mean. The other is the difference stationary process, which is the first or higher-order difference. The fundamental difference between these two classes of processes can also be expressed in terms of the roots of the autoregression (AR) and moving average (MA) polynomials.[8]

First of all, the unit root test is conducted on all variables used in this paper. We use the Augmented Dickey-Fuller (ADF) test proposed by Dickey and Fuller (1979, 1981) for the unit root test of each variable.[9] The ADF statistics for each variable and of the first difference are shown in Table 1. According to the ADF statistics, the null hypothesis of a unit root cannot be rejected for all the series in logarithm form, but it can be rejected for all series in the log difference around a non-zero mean and a non-zero mean with a linear trend. Therefore, we can conclude that all series are stationary after the first difference—that is, they are integrated of order *I(1)*.

Johansen Cointegrating Test

Since the null hypothesis of a unit root for the log level of all series cannot be rejected in this study, the Johansen cointegrating test proposed by Johansen (1991, 1995) is employed to investigate the cointegrating relation between these variables. This cointegrating equation may be interpreted as a long-run equilibrium relationship between the variables. The test statistics' results of the Johansen cointegration test for determining the number of cointegration vectors are also shown in Table 1. Table 1 indicates that the null hypothesis of no cointegration cannot be rejected.

The mathematical form of a VAR specification adopted in this paper includes the log difference of all four variables and a constant term. In addition, since the variables are not seasonally adjusted, 11 centered (orthogonalized) seasonal dummy variables are also included to account for monthly variations.[10] The mathematical form of the VAR model is shown as follows:

$$\Delta y_t = A_1 \Delta y_{t-1} + \ldots + A_p \Delta y_{t-p} + Bx_t + C + \epsilon_t, \tag{2}$$

TABLE 1

The Unit Root Test and the Cointegration Test

A. Unit Root Test (Lag = 12)[1]				
Level:	LUR[2]	LDR[3]	LMR[4]	LCR[5]
With Constant				
ADF statistics	−2.00	−1.26	−2.44	−1.42
1% CV[7]	−3.46	−3.46	−3.46	−3.46
5% CV	−2.87	−2.87	−2.87	−2.87
10% CV	−2.57	−2.57	−2.57	−2.57
With Constant and Trend				
ADF statistics	−2.09	−2.49	−2.11	−1.83
1% CV	−4.0	−4.0	−4.0	−4.0
5% CV	−3.43	−3.43	−3.43	−3.43
10% CV	−3.14	−3.14	−3.14	−3.14
First-Order Difference:	ΔLUR[6]	ΔLDR	ΔLMR	ΔLCR
With Constant				
ADF statistics	−3.7***	−9.1***	−9.4***	−6.5***
1% CV	−3.5	−3.5	−3.5	−3.5
With Constant and Trend				
ADF statistics	−4.1***	−9.1***	−15.3***	−6.6***
1% CV	−4.0	−4.0	−4.0	−4.0

B. Cointegration Test (lags interval: 1 to 12)				
Eigenvalue	L-Ratio	5% CV	1% CV	No. of CE(s)[10]
0.098744	62.7	62.99	70.05	0
0.081675	37.1	42.44	48.45	At least 1
0.042348	16.2	25.32	30.45	At least 2
0.022268	5.5	12.25	16.26	At least 3

[1]Number of lags used in the ADF tests is determined by the Bayesian Information Criterion.
[2]Log of monthly unemployment rate.
[3]Log of monthly divorce rate.
[4]Log of monthly marriage rate.
[5]Log of monthly conception rate.
[6]Δ means the log first difference.
[7]CV stands for critical value.
[8]*, **, *** denote the rejection of the null hypothesis of a unit root at the 10%, 5%, and 1% significance level, respectively.
[9]L.R. rejects any cointegration at 5% significance level.
[10]CE stands for cointegrating equation.

where Δ represents the first difference and C is the constant term. Term x_t includes 11 seasonal dummy variables. The lag order of VAR, $p = 12$, is selected from the *LR* test that follows a backward selection procedure for testing the significance of lags.

Empirical Estimations

The estimated results of the multivariate VAR, including a constant term, monthly rates of unemployment, divorce, marriage, and conception, and 11 centered seasonal dummy variables, are shown in Table 2.

In the ΔLUR regression, it is found that the divorce rate has a negative effect on the unemployment rate most significantly with lags 11 and 12. This implies that an increase in the divorce rate 11 and 12 months ago will lead to a reduction in the current unemployment rate, which might imply that marital dissolution is the cause of an insignificantly immediate increase in women's labor supply. However, after 11 or 12 months after a divorce, more divorced women enter the labor market due to financial problems (Sen, 2000) and become employed. This further results in a lower current unemployment rate.

The marriage rate does not seem to have any significant influence on the unemployment rate. In addition, the monthly conception rate shows a positive influence on the unemployment rate with lag 9. This positive influence may be a result due to women being eager to find a job as they are about to give birth for the purpose of taking advantage of any birth subsidies or benefits from an employer or the government.[11] However, in reality employers have less incentive to hire pregnant women in the labor market based upon the Labor Standard Law promulgated on August 1, 1984, and amended on July 19, 2000.[12] They end up being unemployed and the unemployment rate increases. Finally, seasonality plays a role in the unemployment rate, as the unemployment rate is significantly higher in February and March than in other months, because more people change jobs around Chinese New Year after receiving yearly bonus.

For the ΔLDR regression, the coefficients of the unemployment rate with lags 2, 6, and 8 are significantly positive. Therefore, it is concluded that the worse the economy is, the higher the divorce rate is in Taiwan, which is consistent with that of Chen (1997). The marriage rate has a positive influence on the divorce rate only with lag 12. In addition, the conception rate is negatively related to the divorce rate with lag 8, however, it is positively related with the divorce rate with

TABLE 2

Estimation Results of VAR Model

	Dependent Variable = ΔLUR					Dependent Variable = ΔLDR				
Constant	0.01 (0.74)					0.02*** (3.78)				
	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies
(−1)	−0.22***	0.13	−0.003	0.09		0.06	−0.71***	−0.03	−0.06	
	(−3.03)	(1.02)	(−0.07)	(0.90)		(1.51)	(−9.83)	(−1.31)	(−0.95)	
(−2)	−0.04	0.10	−0.06	0.18	0.29***	0.07*	−0.51***	−0.03	−0.04	0.09***
	(−0.54)	(0.66)	(−1.13)	(1.55)	(5.15)	(1.73)	(−5.75)	(−1.14)	(−0.59)	(2.84)
(−3)	0.05	0.05	−0.07	0.11	0.15*	0.01	−0.39***	0.003	−0.002	0.21***
	(0.73)	(0.34)	(−1.17)	(0.91)	(1.92)	(0.16)	(−4.10)	(0.09)	(−0.03)	(4.62)
(−4)	0.05	0.11	−0.06	0.07	−0.02	−0.02	−0.30***	−0.01	0.03	0.22***
	(0.75)	(0.70)	(−0.97)	(0.62)	(−0.17)	(−0.57)	(−3.36)	(−0.15)	(0.44)	(4.23)
(−5)	−0.11	0.14	−0.08	0.12	0.05	−0.04	−0.17*	0.02	0.09	0.21***
	(−1.46)	(0.89)	(−1.46)	(0.96)	(0.48)	(−0.95)	(−1.87)	(0.59)	(1.20)	(3.64)
(−6)	0.07	0.04	0.01	0.13	0.07	0.08*	−0.17*	−0.03	0.06	0.18***
	(0.94)	(0.27)	(0.14)	(1.10)	(0.65)	(1.94)	(−1.86)	(−0.93)	(0.84)	(2.98)
(−7)	0.05	0.02	0.03	−0.03	0.16	−0.02	−0.13	−0.02	−0.05	0.18***
	(0.69)	(0.13)	(0.49)	(−0.23)	(1.59)	(−0.52)	(−1.42)	(−0.47)	(−0.75)	(3.13)
(−8)	0.07	−0.07	0.01	0.13	0.07	0.07*	−0.14	−0.01	−0.38***	0.14**
	(0.94)	(−0.43)	(0.15)	(1.07)	(0.77)	(1.65)	(−1.52)	(−0.14)	(−5.39)	(2.43)
(−9)	−0.09	0.03	−0.03	0.22*	−0.04	0.02	−0.04	−0.01	0.57***	0.07
	(−1.16)	(0.23)	(−0.56)	(1.75)	(−0.37)	(0.35)	(−0.47)	(−0.18)	(7.85)	(1.18)
(−10)	−0.02	−0.07	−0.05	−0.003	−0.01	−0.06	0.08	−0.02	0.17**	0.02
	(−0.28)	(−0.54)	(−0.82)	(−0.02)	(−0.05)	(−1.40)	(0.96)	(−0.54)	(1.97)	(0.34)
(−11)	0.16**	−0.22*	−0.01	0.13	−0.05	−0.001	0.05	0.01	−0.02	0.03
	(2.13)	(−1.84)	(−0.18)	(0.85)	(−0.68)	(−0.01)	(0.77)	(0.44)	(−0.21)	(0.74)
(−12)	0.16**	−0.24***	−0.05	0.14	−0.01	−0.003	−0.09*	0.04*	−0.06	0.07**
	(2.23)	(−2.83)	(−1.39)	(0.99)	(−0.16)	(−0.07)	(−1.72)	(1.92)	(−0.76)	(2.11)

TABLE 2 (*Continued*)

	Dependent Variable = ΔLUR					Dependent Variable = ΔLDR				
Constant	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies
Adj. R-squared			0.551					0.868		
Log likelihood			307.332					439.017		

	Dependent Variable = ΔLMR					Dependent Variable = ΔLCR				
Constant			0.017 (1.13)					−0.006 (−1.02)		
	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies	ΔLUR	ΔLDR	ΔLMR	ΔLCR	Seasonal Dummies
(−1)	0.04	0.13	−0.91***	0.11		−0.03	0.05	0.04	−0.65***	
	(0.31)	(0.53)	(−12.45)	(0.60)		(−0.56)	(0.54)	(1.31)	(−8.94)	
(−2)	−0.15	−0.15	−0.71***	0.18	−0.34***	−0.13**	0.13	0.06	−0.28***	0.01
	(−1.10)	(−0.53)	(−7.12)	(0.80)	(−3.10)	(−2.46)	(1.20)	(1.52)	(−3.27)	(0.23)
(−3)	0.19	−0.46	−0.48***	0.27	−0.81***	0.05	0.08	−0.02	−0.14	−0.02
	(1.37)	(−1.49)	(−4.30)	(1.18)	(−5.40)	(0.10)	(0.66)	(−0.36)	(−1.60)	(−0.42)

(−4)	0.12	−0.50*	−0.31***	0.37	−0.82***	0.003	−0.01	−0.01	−0.24***	−0.14**
	(0.84)	(−1.68)	(−2.82)	(1.60)	(−4.74)	(0.06)	(−0.07)	(−0.14)	(−2.67)	(−2.13)
(−5)	0.05	−0.60**	−0.35***	0.06	−0.66***	0.05	−0.004	−0.05	−0.23**	−0.14*
	(0.38)	(−1.97)	(−3.26)	(0.26)	(−3.44)	(0.90)	(−0.03)	(−1.10)	(−2.56)	(−1.85)
(−6)	−0.16	−0.48	−0.33***	−0.04	−0.48**	−0.02	−0.01	−0.04	−0.15*	−0.04*
	(−1.13)	(−1.57)	(−3.08)	(−0.17)	(−2.51)	(−0.30)	(−0.05)	(−0.92)	(−1.66)	(−0.55)
(−7)	−0.02	−0.50	−0.44***	0.03	−0.46**	−0.03	−0.12	0.02	−0.20**	−0.13*
	(−0.14)	(−1.62)	(−4.09)	(0.13)	(−2.43)	(−0.57)	(−1.03)	(0.42)	(−2.26)	(−1.77)
(−8)	0.03	−0.38	−0.48***	−0.18	−0.93***	−0.05	−0.08	−0.02	−0.14	−0.23***
	(0.24)	(−1.25)	(−4.34)	(−0.78)	(−5.01)	(−0.88)	(−0.67)	(−0.48)	(−1.64)	(−3.21)
(−9)	0.18	−0.27	−0.40***	0.81***	−0.98***	−0.05	−0.02	−0.002	−0.01	−0.11
	(1.28)	(−0.92)	(−3.53)	(3.38)	(−5.28)	(−0.87)	(−0.15)	(−0.04)	(−0.14)	(−1.54)
(−10)	0.16	−0.35	−0.23**	0.29	−0.27	−0.03	−0.20**	0.06	−0.12	−0.03
	(1.13)	(−1.33)	(−2.09)	(1.01)	(−1.57)	(−0.61)	(−1.94)	(1.46)	(−1.05)	(−0.45)
(−11)	0.26*	−0.37	−0.06*	0.10	−0.23	−0.03	−0.20**	0.05	−0.17	−0.13**
	(1.85)	(−1.60)	(−0.59)	(0.34)	(−1.56)	(−0.62)	(−2.27)	(1.34)	(−1.52)	(−2.34)
(−12)	−0.06	−0.13	−0.10*	0.04	−0.09	0.08	−0.06	0.004	−0.12	−0.13***
	(−0.46)	(−0.78)	(−1.40)	(0.14)	(−0.87)	(1.58)	(−0.99)	(0.14)	(−1.15)	(−3.21)
Adj. R-squared			0.799					0.561		
Log likelihood			146.529					380.558		

Notes: *, **, and *** indicate that the coefficient differs statistically from zero at the 10%, 5%, and 1% significant level, respectively. Numbers in parentheses are t values. With respect to seasonal dummies, (−n) in the first column means the dummy variable for the n^{th} month.

lags 9 and 10. Seasonality plays a more important role in the ΔLDR regression than in the ΔLUR regression. The coefficients of most seasonal dummy variables are significant, as people are more likely to be divorced during the February to August period and in December than in other months.

Unemployment has a positive influence on the marriage rate only with lag 11. The coefficients of the divorce rate with lags 4 and 5 are significantly negative, implying that the divorce rate might negatively impact people's propensity to marry. The conception rate, on the other hand, seems to have a positive effect on the marriage rate with lag 9. A higher conception rate will cause a higher marriage rate nine months later. Seasonal dummy variables also play an important role in the marriage decision. The estimated coefficients indicate that the marriage rate is lower during the period of February to September than in other months.

In the conception regression, the coefficient of the unemployment rate with lag 2 is significantly negative—a conclusion that is inconsistent with Shieh (1994). The divorce rate has a negative influence on the conception rate with lags 10 and 11, however, there is no significant influence of the marriage rate on the conception rate. The estimated coefficients of the 11 seasonal dummy variables show that the conception rate is lowest in August, but higher during January to March. This result of a reduction in the conception rate during the hot and humid summer has been also proposed and supported in the United States (Lam, Miron and Riley, 1994; Lam & Miron, 1996, and Seiver 1985).

Granger Causality Test

From the previous discussion, we find that the unemployment rate is affected by divorce, marriage, and conception rates. The divorce rate is also affected by unemployment, marriage, and conception rates, while the marriage rate is influenced by unemployment, divorce, and conception rates. Moreover, the unemployment and divorce rates significantly affect the conception rate. However, the question is then "How much is the current value of one variable explained by the past values of that one variable?" In addition, can adding lagged values of other variables improve the explanation? The Granger causality test proposed by Granger (1969) deals with this question. Granger (1969) indicated that y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the

TABLE 3

Granger Causality Test

	Dependent Variable			
	ΔLUR	ΔLDR	ΔLMR	ΔLCR
ΔLUR	2.5***	1.4	1.2	1.2
	(29.5)***	(17.0)	(15.0)	(14.9)
ΔLDR	1.3	11.0***	1.1	1.6*
	(15.0)	(131.5)***	(12.8)	(19.8)*
ΔLMR	1.0	1.4	14.4***	1.9**
	(12.1)	(16.3)	(172.7)***	(22.3)**
ΔLCR	0.9	20.0***	2.5***	7.9***
	(10.5)	(239.6)***	(30.2)***	(95.2)***

Notes: Numbers are F-statistics and numbers in parenthesis are chi-square statistics. *, **, *** indicate that the Granger causality hypothesis cannot be rejected at the 10%, 5% and 1% significance level, respectively.

lagged x are statistically significant. Two-way causation is frequently the case here; x Granger causes y and y Granger causes x. However, it is important to note that the statement "x Granger causes y" does not imply that y is the effect or the result of x.[13]

In this paper we perform the Granger test using single equation methods. In fact, the single equation estimated by the ordinary least square method should be identical to the equation estimated by the VAR. Table 3 shows the F statistics and χ^2 statistics for testing the hypothesis of Granger causality. These statistics point out that both divorce and marriage only Granger cause conception, while conception Granger causes divorce and marriage.

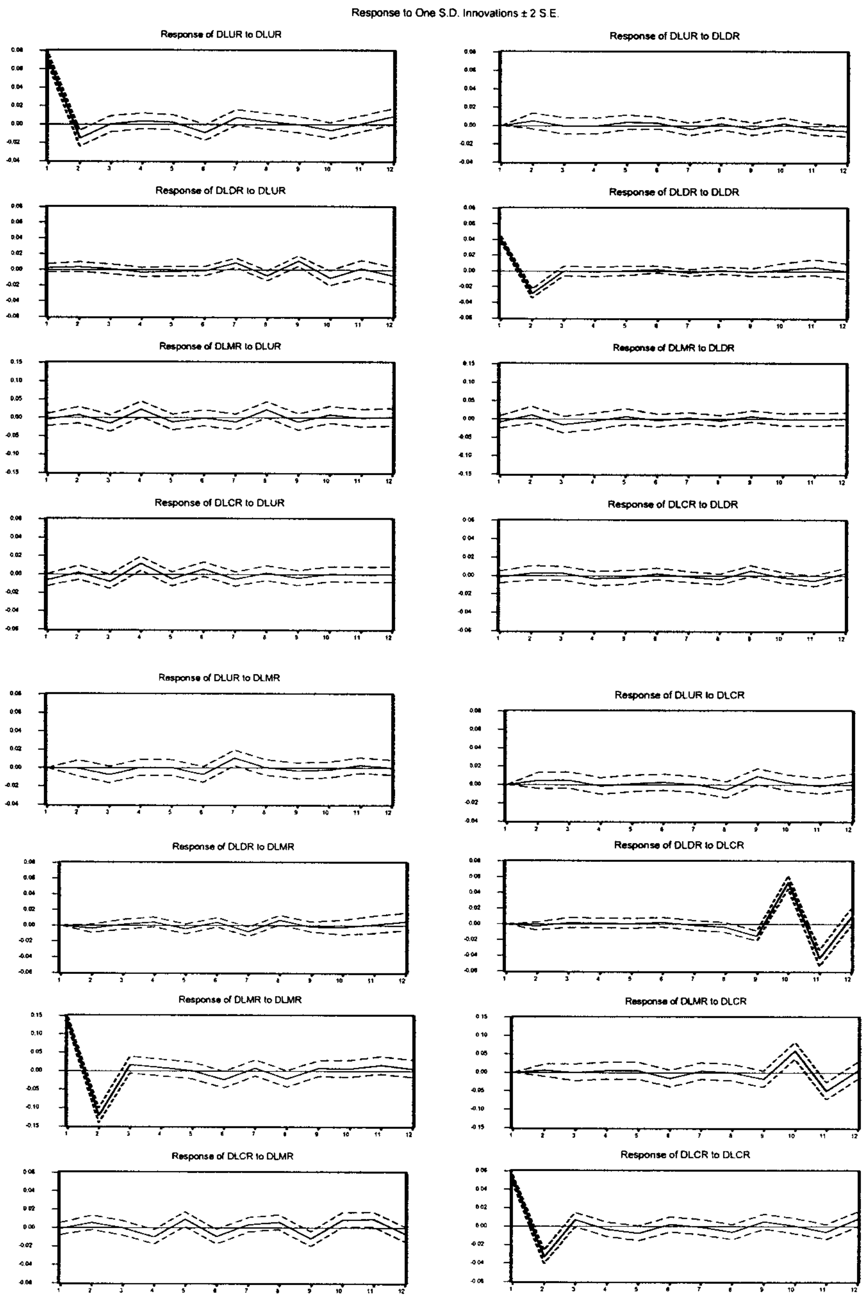
It is worth noting that none of the t values for the coefficients for the lagged marriage variable in the conception regression is significant in Table 2. However, the F value in Table 3 is 1.9, a significant statistic. A 5% significance for the joint F test is not equivalent to separate t tests that each use a 5% significance level. The conflicting result indicates that the marriage rate does not have any influence on the conception rate, but still helps in the prediction of the conception rate.

Response and Variance Decomposition

In order to measure the dynamic interrelationships among these four variables, the impulse-response function is employed, which maps one variable's response to an unanticipated shock in one of the

FIGURE 2

Impulse Function



other variables. The plots of the responses of a single variable to a standard deviation change in the unemployment, divorce, marriage and birth rates are reported in Figure 2.

From the impulse-response function, we find that after an unexpected increase in the unemployment rate, the divorce rate, marriage rate, and birth rate all increase slightly above their initial level. The effect of a change in the divorce rate on unemployment, marriage, and fertility is positive. A change in the marriage rate brings about a slight decrease in the divorce rate and a slight increase in the conception rate, but has no significant influence on the unemployment rate. Finally, we observe that an increase in the conception rate generates an increase in the unemployment rate. However, it does not seem to have an immediate influence on the divorce and marriage rates.

Another measure of the dynamic interrelationships between the four variables is provided by the variance decompositions for all variables. The forecast error variance decomposition shown in Table 4 tells us that the proportion of the movement in a sequence due to its own shocks and the shocks to another variable. At a forecast horizon of 24 months, movements of the unemployment, marriage, and conception rates are mostly due to their own shocks. The variance decomposition of the divorce rate shows that the conception rate can explain 55.65% of the forecast error variance of the monthly divorce rate. Moreover, at a forecast horizon of 24 months, the conception rate can explain almost 17.39% of the variance in the marriage rate. Finally, we also observe that marriage is the main factor explaining the forecast error variance in the conception rate 14.14% of the time.

Robustness of the VAR Model

If the VAR model is well specified, then the residuals should be white noise. As pointed out by Mocan (1990), if the estimated errors from the VAR model follow a white noise process, then 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 one and with the first-order autocorrelation equal to -0.5. The residuals of all variables from the VAR model are plotted in Figure 3. As seen in the figure, all residuals seem to be white noises.

In this paper we follow two criteria proposed by Mocan (1990), as mentioned above, to investigate whether the residuals that follow a white noise process. Table 5 shows the autocorrelation functions (AC) and partial autocorrelation functions (PAC) of the residuals and of the

TABLE 4

Variance Decomposition

Period	S.E.	ΔLUR	ΔLDR	ΔLMR	ΔLCR
Variance Decomposition of ΔLUR					
1	0.07	100.00	0.00	0.00	0.00
4	0.07	97.54	0.49	1.09	0.88
8	0.07	93.20	1.23	4.06	1.51
12	0.08	90.28	2.31	4.21	3.19
16	0.08	88.76	3.13	4.85	3.26
20	0.08	88.13	3.17	4.93	3.78
24	0.08	85.08	3.24	4.94	6.74
Variance Decomposition of ΔLDR					
1	0.04	0.27	99.73	0.00	0.00
4	0.05	1.04	97.05	1.40	0.51
8	0.05	5.99	86.38	6.30	1.33
12	0.09	5.56	30.27	2.62	61.55
16	0.09	9.25	28.84	3.63	58.27
20	0.10	8.78	27.87	8.50	54.85
24	0.10	10.23	25.31	8.81	55.65
Variance Decomposition of ΔLMR					
1	0.13	0.16	0.35	99.49	0.00
4	0.18	2.48	1.37	95.99	0.16
8	0.19	4.41	1.56	93.04	0.99
12	0.21	4.18	1.45	79.04	15.34
16	0.22	4.43	1.94	78.40	15.23
20	0.22	4.47	2.07	76.18	17.28
24	0.23	4.69	2.10	75.82	17.39
Variance Decomposition of ΔLBR					
1	0.05	1.43	0.09	0.03	98.46
4	0.06	5.78	0.63	3.07	90.52
8	0.07	7.06	1.17	7.57	84.19
12	0.07	6.65	2.47	13.29	77.59
16	0.07	8.19	2.58	13.83	75.41
20	0.07	8.33	2.65	13.86	75.16
24	0.08	8.75	2.86	14.14	74.25

first-differenced residuals from the VAR model. The estimated MA(1) coefficients of the first-differenced residuals are also in the bottom row of Table 5. The residuals' AC of all the variables are not significant. The first-order autocorrelation of the first-differenced residuals are between $-0.47 \sim -0.51$ for all variables. The PAC of all variables' residuals exhibit a decreasing trend and the MA(1) coefficients are very close to one. All these results indicate that the errors of each of the variables are white noise. The VAR model adopted in this paper is thus well specified and therefore the estimated results from the VAR model are also robust.

FIGURE 3

The Residuals from VAR

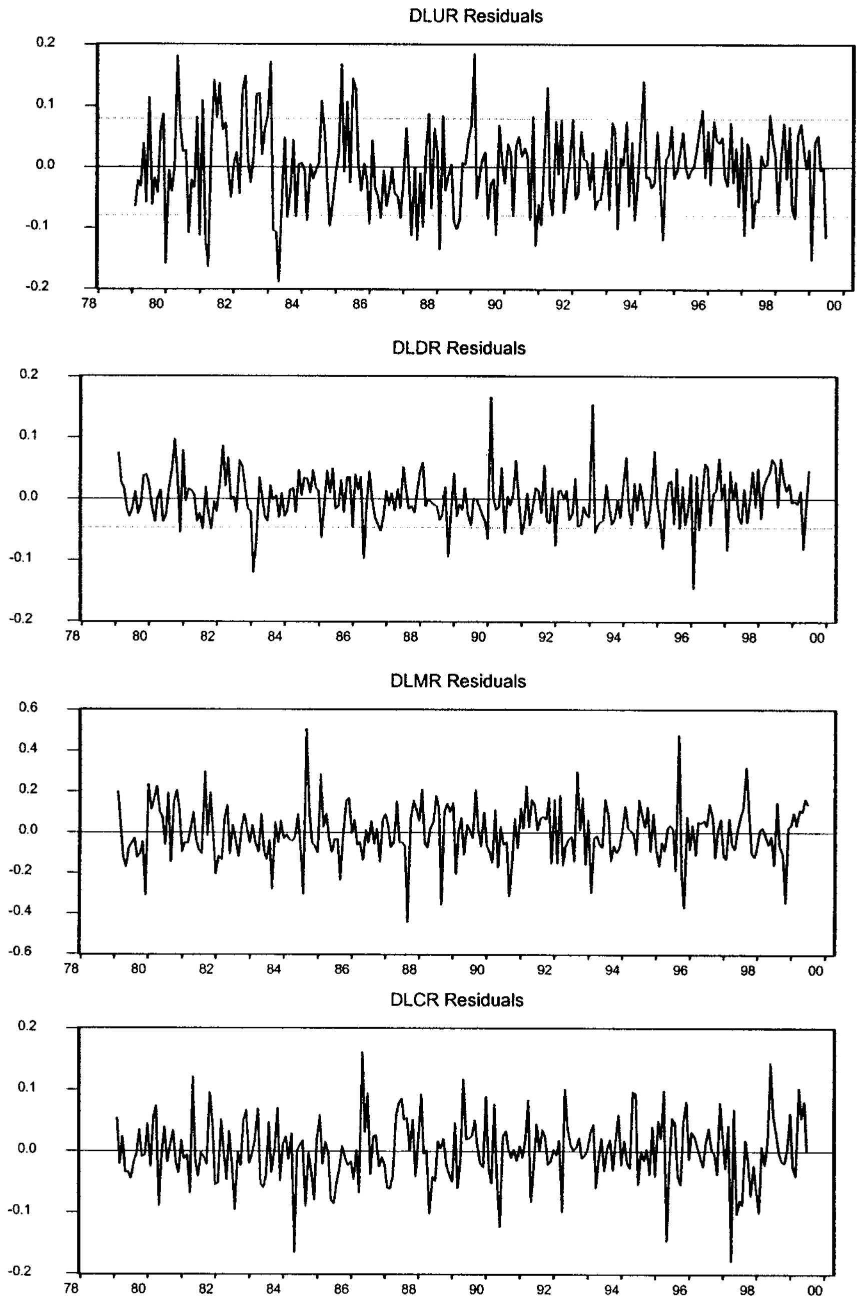


TABLE 5

Specifications Tests for the Errors of the Estimated Multivariate VAR Model

	ΔLUR		ΔLDR		ΔLMR		ΔLCR	
	AC	PAC	AC	PAC	AC	PAC	AC	PAC
A. Sample Autocorrelations and Partial Autocorrelations of the Residuals								
1	0.057	0.057	−0.023	−0.023	−0.028	−0.028	−0.015	−0.015
4	−0.038	−0.035	−0.029	−0.031	−0.058	−0.061	0.027	0.026
8	−0.026	−0.025	−0.064	−0.061	−0.047	−0.057	−0.008	−0.001
12	0.054	0.054	0.022	0.014	−0.041	−0.056	−0.039	−0.034
B. Sample Autocorrelations and Partial Autocorrelations of First-Differenced Residuals								
1	−0.480	−0.480	−0.495	−0.495	−0.521	−0.521	−0.487	−0.487
4	−0.039	−0.224	−0.046	−0.248	−0.020	−0.193	0.044	−0.120
8	−0.009	−0.091	−0.009	−0.068	−0.006	−0.075	0.000	−0.073
12	0.095	−0.030	0.041	−0.087	−0.003	−0.032	0.000	−0.074
C. The MA(1) Coefficient of the First-Differenced Residuals								
	0.99		0.99		0.99		0.99	

Conclusions

This paper has explored the interrelationships between unemployment and family behaviors in Taiwan. Using the official monthly data series of the rates of unemployment, divorce, marriage, and conception (defined as being equal to the birth rate that occurs 9 months after), a multivariate VAR model has been estimated. First of all, using the ADF Unit Root Test, it is discovered that these variables are non-stationary and all of them have only one unit root. The Johansen cointegration test tells us that there is no cointegrating relation between these variables. Therefore, the log difference of all variables is adopted to estimate the multivariate VAR model with a lag of 12.

From the empirical results of the VAR model, we can conclude that the divorce rate and marriage rate are positively affected by the unemployment rate, but the conception rate is shown to be negatively affected by the unemployment rate and is lowest in August, but higher for the period of January to March. Finally, using the two criteria proposed by Mocan (1990) to test the robustness of empirical results from the VAR model, we find that the model is well specified and the conclusions suggested in this study are robust.

This study concludes that unemployment does play an important role in the fluctuations of divorces, marriages, and conceptions in Taiwan. This study also suggests that well-managed macroeconomic policies could stabilize the economic situation on the one hand, and might also have some spillover effects on the stabilization of people's marital situation on the other. Since these macroeconomic policies not only have influences on the economy as a whole, but also on family behaviors of people, government decision-making should be more careful and sensitive.

Notes

1. Under the assumption that people can possibly control their fertility behavior completely, the economic theory of household decisions, which explores the link between reproductive behavior and which is constrained by utility maximization, is used increasingly to explain the differences in human fertility behavior.
2. The conception rate is defined as being equal to the birth rate that occurs 9 months after. That is to say, $conception\ rate_t = birth\ rate_t + 9$. More details will be discussed in the next section.
3. Becker (1988) further indicated that family behavior is likely to be crucial to long cycles in economic activity according to his modified Malthus-neoclassical model.
4. Becker, Landes and Michael (1977) estimated both logistic and regression functions to support their conclusion.
5. Cherlin (1979) used vital statistics from 15 states in the Divorce Registration Area to decompose divorce into age-specific divorce rates.
6. The cointegration refers to a linear combination of some non-stationary variables. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary or linear combination exists, then the non-stationary (with a unit root) time series are said to be cointegrated.
7. Otherwise, we have to take the first difference on all variables and then run the multivariate Vector Error Correction Model (VECM).
8. Nelson and Plosser (1982) indicated that if a series is generated by a member of the linear trend-stationary subclass, then we would fail to reject the hypothesis of a unit MA root in the ARMA model for its first difference; and if it is generated by a member of the first-order DS subclass, then we should fail to reject the hypothesis of a unit AR root in the ARMA model for its level.
9. According to Schwert (1987), in some circumstances the ADF test is better than the non-parametric Phillips & Perron method proposed by Phillips and Perron (1988). The ADF tests for the presence of non-zero mean and non-zero mean with linear trend are carried out by estimating the following two equations:

$$\Delta y_t = \mu + \gamma y_{t-1} + \sum_{i=1}^{k-1} \delta_i \Delta y_{t-i} + \epsilon_t \qquad and$$

$$\Delta y_t = \mu + \rho t + \gamma y_{t-1} + \sum_{i=1}^{k-1} \delta_i \Delta y_{t-i} + \epsilon_i.$$

These two augmented specifications are then used to test the null hypothesis that H_0: $\gamma = 1$ against the alternative hypothesis that H_A: $\gamma < 0$. If the test statistics is smaller than the critical value, then the null hypothesis cannot be accepted which means that the variable does not have a unit root.

10. If 0–1 seasonal dummy variables are included in the VAR, then this will affect both the mean and the trend of the y series. Johansen (1995) suggested using centered (orthogonalized) seasonal dummy variables, which only shift the mean without contributing to the trend.
11. For example, Taiwanese women are eligible to apply for a birth subsidy up to the total amount of two months' salary from their employer after giving birth.
12. In Article 50 of the Labor Standard Law, a female worker shall be granted maternity leave before and after childbirth for a combined period of eight weeks. In the case of a miscarriage after being pregnant for more than three months, the female worker shall be permitted to discontinue work and shall be granted maternity leave for four weeks. For a pregnant worker who has been in service for more than six months, she shall be paid wages for the maternity leave. If her service has been less than six months, she shall be paid wages at half her regular rate. Moreover, in Article 51, a female worker may apply to be transferred to easier work, if available, during the period of her pregnancy. The employer in this case shall neither reject the application nor reduce her wages. All these regulations will probably decrease Taiwanese employers' willingness to hire pregnant women.
13. The Granger causality measures precedence and information content, but does not by itself indicate causality in the more common use of the term.

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