Diffusion Effect in Fertility Decline in China: Study on Time-Series Model at Provincial Level

(Draft)

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ABSTRACT

Using the cross-section time-series data from 28 provinces in China from 1950 to 2000, the paper analyzes the spatial diffusion and temporal diffusion of fertility decline at provincial level in China. The results reveal that there exists diffusion effect in fertility decline of China. Analysis of spatial diffusion shows that the sustained fertility decline began with a few big cities and provinces located in coastal areas of east China, with northern provinces followed, while the decline happened even later in northwest and south China; analysis of temporal diffusion indicates that determinants of fertility decline vary from period to period and within-provincial fertility decline diffusion shows more remarkable effects than that of cross-provincial diffusion.

Key words: diffusion, fertility, provincial level, China

BACKGROUND

Traditional discussions on determinants of fertility transition focused on the effects of socio-economic and policy change on transition of fertility rate. However, in recent decades, more and more studies have been devoted to applying diffusion theory to explain fertility rate transition. With the diffusion theory, it is held that people's choice will affect others' choice when they adopt new ideas (or actions) of birth control(Montgomery and Casterline,1993). European Fertility History Project conducted by Princeton University and investigation of world fertility in the 1980s show that fertility transition has weak link with socio-economic changes but has very strong link with language, ethnic and religion(Cleland and Wilson,1987; Watkins,1986). These discoveries have shaken the explanation for the transition of fertility rate made by traditional mainstream scholars and boosted the prosperity of diffusion theory in the 1980s. Diffusion effects exist independent of social and economic development and it has enhanced the influence of social economy upon fertility rate(Rosenfield et al.,1973; Rogers,1995)。 Therefore, diffusion effects have helped to stabilize the fertility decline.

In micro research fields, the diffusion theory has been mainly applied to study the effects- of social networks in the spreading of contraception ideology and behaviors(Montermery,1998). However, because it's difficult to get micro materials and measure them, most studies tend to be transferred to macro research and the major achievements of these studies are some dynamic diffusion models(Roser-Bixby and Casterline,1993; Montgomery and Casterline,1993). Two of the most influential studies are the research of using regional data analysis to prove the existence of diffusion effects in fertility decline. Montgomery and Casterline(1993) adopted time-series model and cross-sectional model to study the fertility of 361 towns in Taiwan between the year of 1961 and 1981. They have proved the existence of diffusion effects by exploring the time and space model of fertility decline. Similarly, Roser-Bixby and Casterline(1993) also adopted time series model and cross-sectional model to analyze the fertility data of 100 counties in Costa Rica between 1958 and 1988 and found that diffusion effects are more remarkable within a county than that between counties, which proved that diffusion effects had enhanced the influence of social economy upon fertility in fertility decline.

Along with the development of society and economy and implementation of birth control policy, fertility rate of China underwent rapid decline from 5.8 in 1970 to .2 in 1980 and down to 1.8 in 2000(Wang, 2004; Retherford, et al, 2004). As for the reason for the decline of China's fertility rate, most researchers held that it's socio-economic development(Jiang, 1986; Whyte and Parish,1984)or birth control(Wolf,1986) that resulted in the fertility decline, while some other scholars held that China's fertility decline resulted from the common effect of both socio-economic development and birth control(Gu, 1987). But on the fertility rate of China, there have been few studies using diffusion theory to explain its decline. This paper is aimed to prove the applicability of diffusion theory in explaining the fertility decline in China and explore determinants of regional difference in fertility transition of China through quantitative analysis of the tendency and relativity of fertility transition within a province and that between provinces in different stages of the fertility decline, so as to provide theoretical basis and policy proposals for stabilizing fertility rate in the future.

RESEARCH DESIGN

Research Framework

Previous studies show that difference lies in the effects of macro fertility diffusion between areas and within an area(Peng, 1993). In this paper, the fertility rate and tendency of middle factors are described at first, including descriptions of overall tendency and provincial tendency, in order to have a general understanding of the fertility tendency. In the paper, firstly the author tries to use diffusion models to study the spatial diffusion effect in China's fertility decline; and in this part when temporal diffusion effect is analyzed, its result is compared with that without diffusion effect in order to confirm the degree of diffusion effect.

With provinces as the units of research, spatial diffusion and temporal diffusion of fertility decline at provincial level in China are studied in this paper with various data sources used. Firstly the spatial diffusion effect is studied. Spatial diffusion effects of different periods of all provinces in China are analyzed and the ten-year fertility rate of each province from 1950 is presented with figures, so that spatial diffusion gets better understood. Secondly, fertility diffusion models are employed to study temporal diffusion effect. Taking the characteristics of birth control and the fact that fertility decline in China has stages into consideration, we adopt a strategy of dividing the whole period from 1950 to 2000 into for stages: 1950-1969, which was before implementation of the birth control policy. Fertility rate was relatively high in this stage; 1970-1979, when birth control policy was not so strict and the fertility rate declined rapidly; 1980-1989, when strict birth control policy was implemented and the fertility rate kept declining; 1990-2000, when stable birth control policy was implemented and the fertility rate fluctuated around the replacement level. On the basis of such stage division, within-provincial and cross-provincial diffusion effects of fertility decline at different stages are analyzed.

Data Sources

Data of macro diffusion at provincial level mainly come from the collection of second-hand materials. Because of the change of division of China's administrative regions and the fact that data of Xizang Autonomous Region is not available, there are totally 28 provinces covered in this study, without Hainan, Chongqing and Xizang. Categorizations of the data and their sources are shown as blow:

Data of fertility rate

As the indicator Total Fertility Rate(TFR) can give a precise reflection of current fertility level without the affection from age structure, it's the indicator mostly used to measure fertility level. Data of TFR of China as a whole and that of China's provinces from 1950 to 2000 are used in this paper. Data of TFR of China as a whole from 1950 to 2000: data from 1950 to 1990 come from the paper written by Sun and Qi(1994); data from 1991 to 2000 come from the paper written by Wang (2004). Data of TFR of China's provinces: data from 1950 to 1992 come from the thesis for doctor's degree written by Zhang (1997); data from 1993 to 2000 come from *Collection of China's Population Data Since the 1990s*(2003).

Social and economic data

Social and economic data mainly cover indicators that reflect economy, urbanization, health and education of a country. The specific indicators are National Income, Proportion of Urban Population, Doctors' Number for per 10,000 Persons, Number of Middle School Students for per 10,000 Persons. Social and economic data of China's provinces from 1950 to 1992 come from the thesis for doctor's degree written by Zhang (1997) and the data from 1993 to 2000 come from the annual statistics yearbook of all provinces(1994-2001).

Data of birth control

Marriage form and contraception choice witness the effect of birth control policy. The current birth control policy began with 1979; therefore, for provinces only the data from 1979 is available. Data of marriage and contraception of China from 1970 to 2000: including Average age of first marriage, Late-marriage proportion and Contraception proportion of Chinese people, all coming from *Comprehensive Reports of Data from Sampling Surveys of Birth and Birth Control in China*(1993). Data of birth control of all provinces from 1979 to 2000: including Late-marriage proportion, Contraception proportion and Proportion of birth control, all coming from annual statistics yearbook of birth control(1986-2001).

Preliminary Data Processing

1) Data smoothing

In order to get more stable time series, data collected are primarily processed in this phase. The 14 indicators covered in the study are smoothed. We replace figure of the current year with the mean value of this year and its previous four years, while the first four figures of every column remain original. In this paper, data after the smoothing are used for calculations of the model while data before the smoothing are used for descriptive statistics analysis.

2) Social distance between provinces

Closeness of geographic location is very important to social interaction, but new ideologies and activities also can cross the geographic boundary, especially the cross-provincial population migration in China in the recent decade. Therefore, cross-provincial diffusion also should be taken into consideration. For the investigation of influence between two provinces, geographical distance and social distance between them should be considered. The social distance should be measured through investigating the socio-economic differences between provinces. With the fact that the difference of fertility rate between provinces in China mainly results from socio-economic differences between the provinces, social distance is adopted to measure the distance between provinces in this study.

The calculation of cross-provincial weight w_{ij} is composed of 10 indicators of each province, including both macro socio-economic indicators and related indicators of policy variables such as birth control policy. The socio-economic variables are National Income, Proportion of Industrial Output, Proportion of Urban Population, Doctors' Number per 10,000 Persons, Number of Beds in Health Institutions, Number of College Students per 10,000 Persons, Number of Middle School Students per 10,000 Persons; variables of birth control policy are Late-marriage proportion, Contraception proportion and Birth control proportion. For each indicator, it is valuated with the average of 51 years' number. The measurement distance is adopted to measure the differences between provinces to get the relative distance. Data for calculations here are the original socio-economic data. And total value of w_{ij} becomes 1 after being processed.

Selection of Models

The progress of fertility diffusion is the one that fertility changes cause further changes of the fertility rate and this dynamic progress becomes the phenomenon of fertility auto-regression when it was put into practical data(Ebring and Young,1979). Fertility diffusion model is selected for this part and the main reason for this is that immeasurable factors of the model have been taken into consideration in this model. This model has also been applied to study the fertility diffusion in other areas, but in this study the analysis strategy and estimation method with the model are widely different from previous studies.

<u>Within-provincial diffusion model</u>

$$f_{it} = \alpha F_{i(t-1)} + Z_{i(t-1)}\beta_1 + X_{i(t-1)}\beta_2 + v_i + u_{it}$$ Formula (1)

Where the Total Fertility Rate, F_{it}, has been fixed as the dependent variable. Explanatory variables are composed of three parts: $F_{i(t-1)}$ stands for lag fertility rate and its coefficient α indicates the degree of fertility diffusion within the province, that is the effect of fertility in lag stage on the fertility of the current stage. $X_{i(t-1)}$ is socio-economic variable, $Z_{i(t-1)}$ is policy variable in lag stage(birth-control-related variable). v_i and u_{it} respectively stand for the random disturbance item that changes along with time and that doesn't change with time.

Ideas of diffusion theory are applied in this formula, that is, fertility decline in the (t－1) stage will cause further fertility decline in the (t) stage. Therefore, on this basis, we can conclude that when $\alpha > 0$, it means that diffusion really has played a part in the change of fertility rate(M,1993).

Cross-provincial diffusion model

$$f_{it} = \alpha F_{i(t-1)} + Z_{i(t-1)}\beta_1 + X_{i(t-1)}\beta_2 + \gamma \sum_{j \neq i} \omega_{ij} F_{j(t-1)} + v_i + u_{it} \qquad \text{Formula(2)}$$

Both $X_{i(t-1)}$ and $Z_{i(t-1)}$ have the same meaning as they have in the within-provincial diffusion model. In addition, w_{ij} stands for the degree of interaction between two provinces i and j and it is often measured with social distance or geographical distance. Meanwhile, as each province has its own v_i, here it is presumed that there is no correlation between the v_i s of provinces.

For the model we have taken the existence of inherent differences between provinces into consideration. These differences include unobservable "inter-provincial effect" between provinces. Therefore, in the model it is permitted that there is correlation between provincial differences. In this paper, firstly it is presumed that the degree of social difference will directly affect the diffusion progress and more differences will cause more obstacles against the diffusion. Fertility diffusion progress within an area mainly depends on the degree of social differences. However, it is undeniable that there exist diffusions between areas and such communications or diffusions become more and more obvious with the development of modern communication and transportation, information and media systems. Thus distance or differences between provinces can be measured in two aspects: geographical distance and social distance. Since social distance between provinces can better reflect the fertility difference between provinces, it is adopted in this part as the measurement.

Evaluation of the models

In the case that fixed effect v_i exists, if diffusion coefficient $\alpha = 0$, there should be no dynamic diffusion progress in practice; but the existence of positive v_i maintained a high fertility rate and the positive v_i was neglected when least square method was applied, therefore, even though $\alpha = 0$, it is possible to reach the conclusion that $\alpha > 0$ because of the positive correlation between $F_{i(t-1)}$ and v_i, that is, there exists dynamic diffusion. Difference method could be applied to remove the influence of v_i. Then the following formula can be established and adopted.

$$f_{it} - f_{i.} = \alpha(F_{i(t-1)} - F_{i.}) + (Z_{i(t-1)} - Z_{i.})\beta_1 + (X_{i(t-1)} - X_{i.})\beta_2 + u_{it} - u_{i.} \quad \text{Formula (3)}$$

Those minus items are the mean value(temporal average) of variables, in this way, the influence of v_i which doesn't change with time could be removed. Meanwhile, the influence of tendency factors could be removed with difference method to eliminate first order auto-correlation.

For comparison convenience, when we make diffusion analysis, three types of models are adopted. In Model 1, the diffusion effect is not countered in and socio-economic and birth control factors are taken into regression analysis; Model 2 is designed on the basis of Model 1 with the fertility rate of lag stage countered in to analyze the diffusion effects; In Model 3, difference method is employed to remove the influence of auto-correlation in order to improve the fit index of the model, which is for the same purpose of analyzing diffusion effects as in Model 2.

Indicators for model evaluation cover those ones: adjusted multiple correlation coefficient(Adjusted R^2), D-W value and prominence of Fit test(F). The series stationarity can be tested by D-W test in auto-correlation test. When the value of stationarity gets close to 2, it reveals that the model has fine fit index. Since the F value increase with the t and all pass the Fit test when the prominence is p=0.0000, it is excluded out of the analysis result.

Measurement of Variables

According to existing macro studies on determinants of fertility decline in China and the features of this study, the following variables are selected for the models because of their theoretical explanatory significance. At the same time, accessibility of data has been considered.

Variables in the analysis of fertility diffusion effects:

The **dependent variable** is annual TFR of each province (1955-2000) , because 5 years have been smoothed for data primary process.

The **independent variables** are fertility rates of lag stage: TFR of lag stage of the province(for within-provincial diffusion analysis); TFR of lag stage of the province and other provinces(for cross-provincial diffusion analysis). Socio-economic determinants cover those variables that reflect economy, urbanization degree, health and education: Per-capita national income, Proportion of industrial output, Proportion of urban population, Doctors' number per 10,000 persons, Number of middle school students per 10,000 persons. Policy determinants cover the following variables that reflect different aspects and execution of the birth control policy: Late-marriage proportion, Contraception proportion and Birth control proportion.

RESULTS

Fertility tendency

Overall tendency

In Figure 1 TFR of China over the years are shown and we can see that the fluctuation of fertility rate bears evident stage characteristics. The TFR of China remained around 6 in the 1960s and the time before it. In 1963, due to compensatory recovery, fertility rate of Chinese women achieved the highest level since the foundation of PRC. In the same year, fertility rate of Chinese women entered the dynamic declining stage, that is, the fertility rate fluctuated at a relatively high level and declined gradually. The fertility of China began to decline noticeably from early 1970s (Yu, 2000) and dropped from 5.8 in 1970 to 2.2 in 1980. China began to witness a stable, continuous and remarkable decline of fertility rate. In the 1980s, the fertility fluctuation was around the level of a low fertility rate; in the 1990s, the fertility rate of China further declined to below the replacement level and fluctuated at a low level with slight decline. In 2000, the TFR of China is around 1.8. We can observe noticeable stages of fertility decline in China.

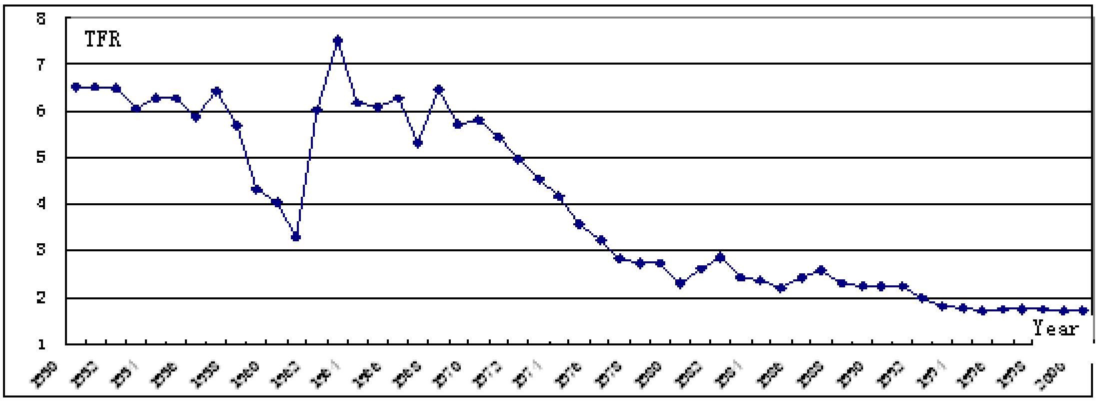

Figure 1: Transition of TFR of China from 1950 to 2000

Provincial tendency

The fertility rate of China differs greatly from stage to stage and even at the same stage there are obvious differences between provinces. In Figure 2 the boxplot of fertility transition of provinces in China from 1950 to 2000 is shown. In the figure, the bold line in the middle stands for the median. The boxes are composed with quartiles(the top of boxes is the fourth quartile and the bottom is the first quartile) and the lines protruding out of the both ends stand for extreme values(the upper one is the max and the lower one is the min). Points beyond the intervals are outliers. We can see that fertility rate in China differs evidently from area to area before the 1970s. In early 1970s, the birth control policy advocating “late marriage, long birth interval and fewer births” was boosted by the Chinese government; the fertility rate of China began to decline rapidly and cross-provincial differences got to shrink. After the implementation of Family Planning policy from 1979, mid-fertility rate maintained its decline and the cross-provincial differences got further shrink.

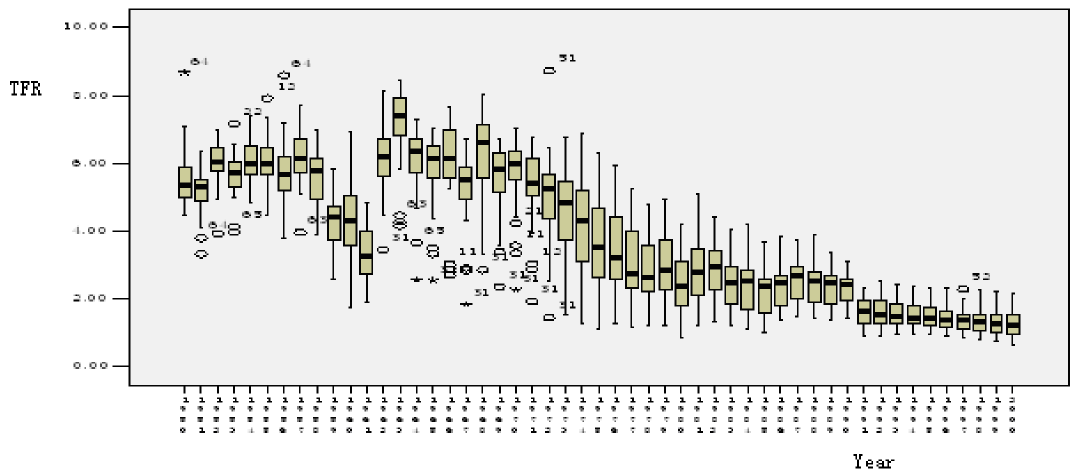

Figure 2: Inter-provincial difference of fertility transition in China from 1950 to 2000

Note: Numbers in Figure 2 are the code of provinces in China.

11:Beijing	21:Liaoning	31:Shanghai	41:Henan	51: Sichuan	61:Shaanxi
12:Tianjin	22:Jilin	32:Jiangsu	42:Hubei	52:Guizhou	62:Gansu
13:Hebei	23:Heilongjiang	33:Zhejiang	43:Hunan	53:Yunnan	63:Qinghai
14:Shanxi		34:Anhui	44:Guangdong	54:Xizang	64:Ningxia
15:Neimeng		35:Fujian	45:Guangxi		65:Xinjiang
		36: Jiangxi	46:Hainan		
		37:Shandong			

Spatial diffusion effect of fertility decline

Areas within China differ remarkably from each other in social economy and culture. Therefore, differences between areas would be covered up by national average. Study by Peng(1993)on the temporal and spatial fertility transition of 9 provinces with data from the 1982 sampling survey in China reveals that sustained fertility decline began with a few big cities and eastern provinces with Shanghai in the leading position. Then the decline began to be observed in northern provinces later and the fertility transition gradually crossed the geographic boundary. Fertility rate in eastern provinces got close to the replacement level in late 1970s, while this happened later in northwest China and south China. Yin(2003) has also found that the fluctuation of China's fertility rate follows the rule of geographical wave and the geographical diffusion progress of advanced fertility culture.

The fertility rates of every decade between the year of 1950 and 2000 of all provinces in China are illustrated in figures. With these six figures, the spatial model of China's fertility decline can be better understood. In the figures, the darker stands for the lower fertility rate. In Figure 3, the provincial TFR of all provinces in China in the year of 1950, 1960 and 1970 are shown. In the early period after the foundation of PRC, the fertility rate of China's provinces was at a relatively high level and the TFR was between 4 and 6; in the 1960s, because of natural disasters, the fertility rate of China declined and the fertility rate of the relatively developed Shanghai and the less-developed Qinghai and Sichuan province was at a low level. Because of the compensatory fertility peak appeared in many areas of China in the 1960s, the fertility rate of most areas in China returned to above 6 in the year of 1970; but the fertility rate in coastal provinces and southeast China declined. Figure 4 shows the TFR of provinces in China in the year of 1980, 1990 and 2000. In the 1970s, with the implementation of birth control policy, nationwide fertility rate began to decline; up to the year of 1980, the fertility rate of developed areas such as Beijing, Shanghai and Jiangsu province had declined to below 1.5 and that of most coastal provinces such as Liaoning, Jilin, Shandong and Fujian had declined to around the replacement level, while the fertility rate remained relatively high in less-developed northwest and southwest China. In the 1980s, with the implementation of strict birth control policy, China's fertility rate dropped rapidly. Coastal and eastern provinces maintained a fertility rate below the replacement level while the fertility rate of provinces in central and west China also dropped to a level between 2 and 3. Up to the year of 2000, the fertility rate of coastal provinces and provinces in central and east China further declined to below 1.5, while the fertility rate of northwest and southwest China also declined to around the replacement level.

Analysis of Figure 3 and Figure 4 resembles the existing results of studies, that is, fertility decline began with relatively developed coastal and eastern provinces and with the implementation of birth control policy, the fertility rate of less-developed central and western provinces began to decline in late 1970s. Almost all provinces in China finished the transition of fertility rate in the 1980s. Under the simultaneous influence of birth control policy and socio-economic development in China, the fertility decline gradually crossed the geographical boundary and diffused from coastal provinces in east China to central and western provinces.

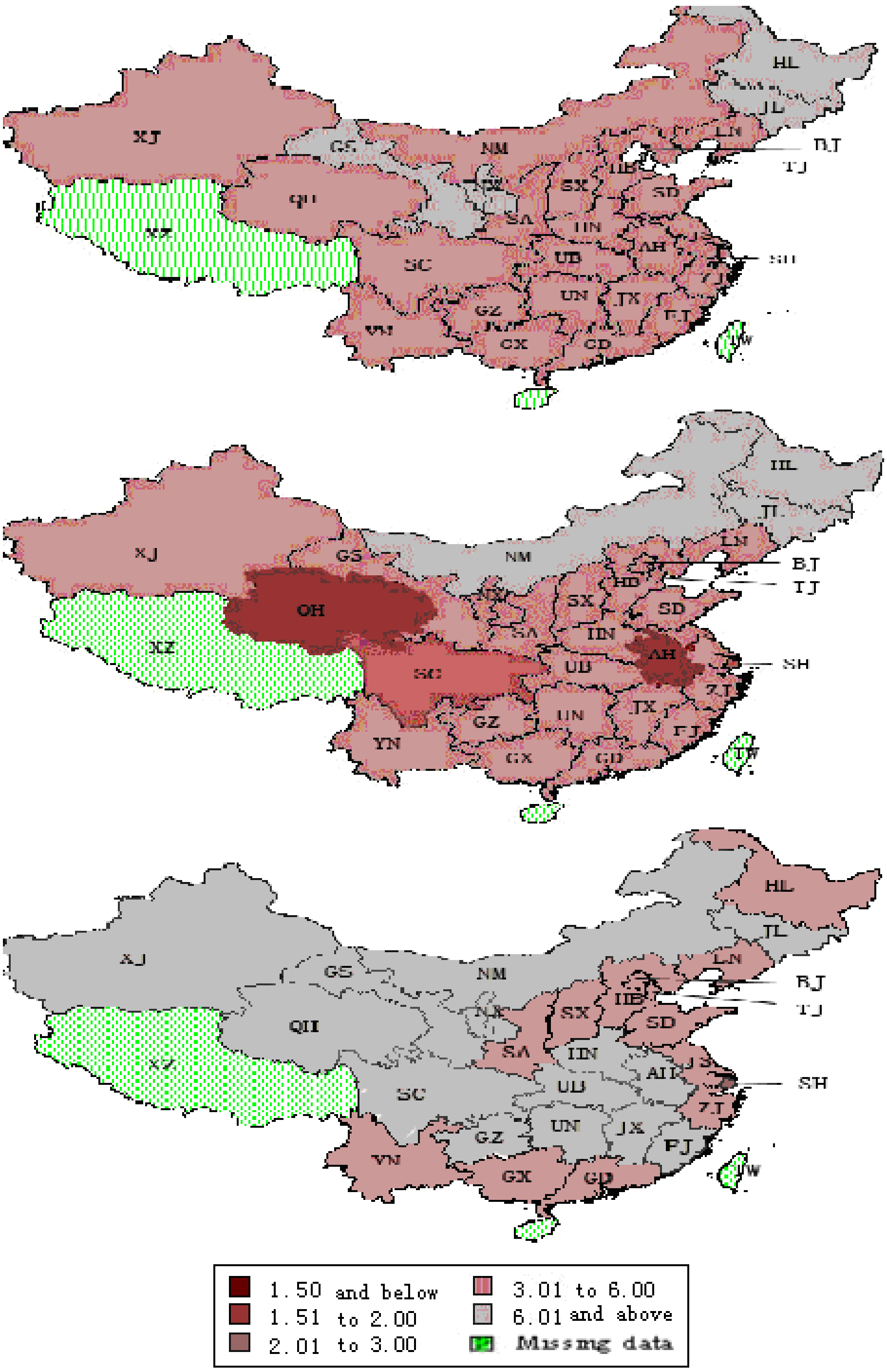

Figure 3: TFR of all provinces in the year of 1950, 1960 and 1970

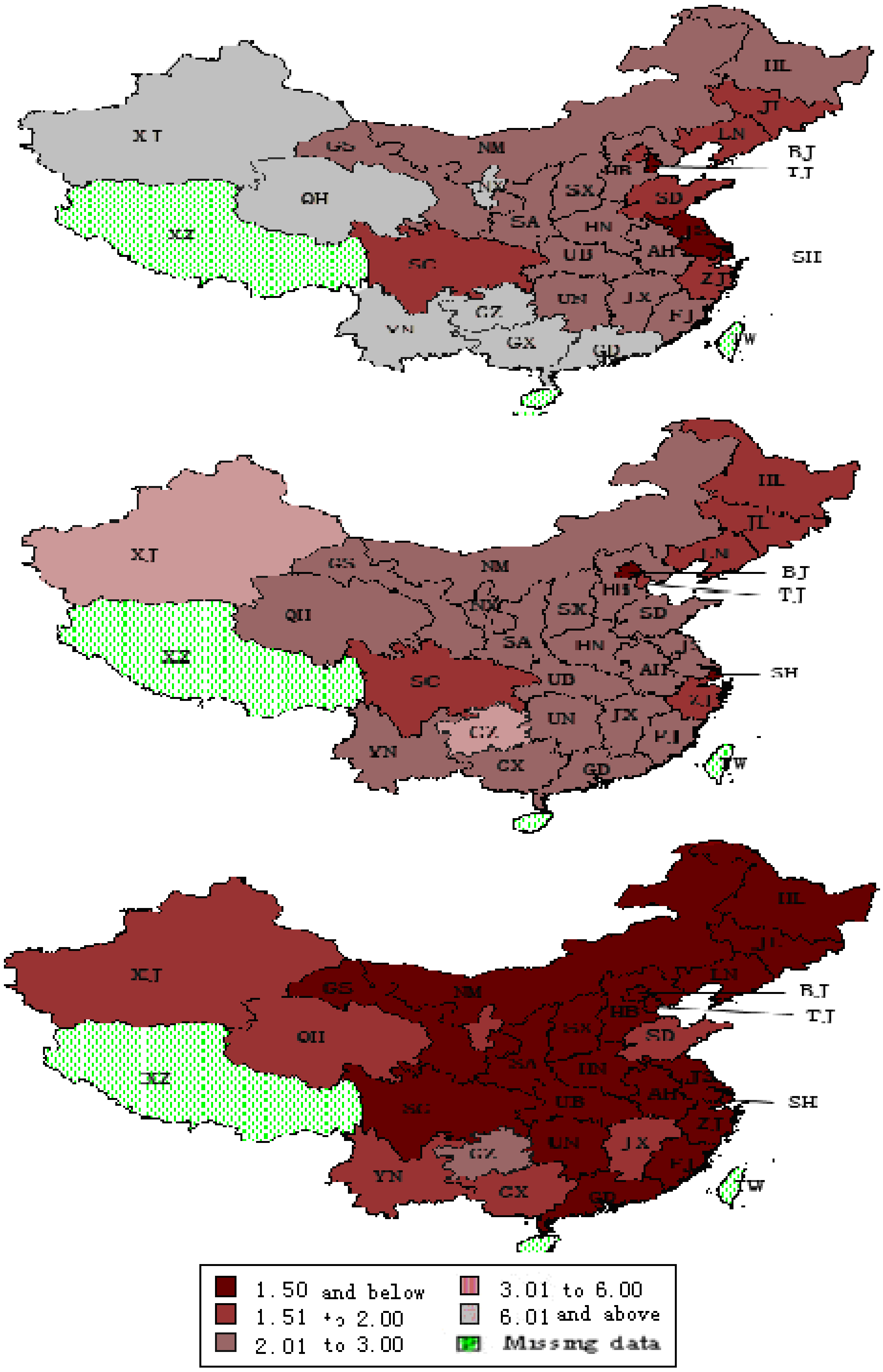

Figure 4: TFR of all provinces in the year of 1980, 1990 and 2000

Note: Codes of provinces in Figure 3 and Figure 4:

BJ: Beijing	LN: Liaoning	SH: Shanghai	HN: Henan	SC: Sichuan	SA: Shaanxi	TW: Taiwan
TJ: Tianjin	JL: Jilin	JS: Jiangsu	UB: Hubei	GZ: Guizhou	GS: Gansu	
HB: Hebei	HL: Heilongjiang	ZJ: Zhejiang	UN: Hunan	YN: Yunnan	QH: Qinghai	
SX: Shanxi		AH: Anhui	GD: Guangdong	XZ: Xizang	NX: Ningxia	
NM: Neimeng		FJ: Fujiang	GX: Guangxi		XJ: Xinjiang	
		JX: Jiangxi	HA: Hainan			
		SD: Shandong				

Figure 3 and Figure 4 reveal the geographical spread of fertility decline and technologies of fertility control, but they cannot directly prove the diffusion effect of fertility decline. Determinants of fertility decline also bear the same geographical pattern, for instance, proportion of urban population, GDP per-capita, doctors' number per 10,000persons and other indicators that show the social economy and cultural level of an area. Developed areas often have better medical services and higher investment in education as well as in Family Planning program, which contributes to the decline of fertility rate. Coastal provinces and big cities are more developed than northwestern provinces and minority regions in China, so they have lower fertility rate than northwestern provinces and minority regions do. Therefore, with Figure 3 and Figure 4, only the existence of diffusion can be proved and we need to control over socio-economic variables to make multiple regression analysis in order to verify the existence of diffusion effects in the decline of fertility rate in China.

Spatial diffusion effect of fertility decline

In this part, after socio-economic variables and birth control variables are put under control, the effects of fertility rate of lag period are studied to verify the existence of temporal diffusion effect.

Within-provincial diffusion effect.

Table 1 shows the regression result of cross-provincial diffusion in different stages. In the four stages divided in this paper, the diffusion coefficient of all models is obviously higher than zero, which reveals noticeable cross-provincial diffusion effect in these stages. Except that model 2 has good fit index in the first stage(1950-1970), in the other three stages, it's Model 3 that has good fit index which is result from differential analysis.

Between the year of 1950 and 1969, when the fertility rate of lag stage is not countered in, social economy and education have noticeable negative effect while medical and health service have obvious positive effect on fertility transition. After the fertility rate of lag stage is countered in, the effect of social economy, education and medical and health service remain noticeable and the influence of lag fertility rate also becomes significant. Between the year of 1971 to 1979, from the result from analysis the models, we can find out that after the fertility rate of lag stage is countered in, the effect of all socio-economic variables becomes insignificant while the influence of the fertility rate of lag stage becomes quite noticeable. Between the year of 1980 and 1989, late-marriage proportion and contraception proportion had significant influence upon fertility decline. When the late-marriage proportion and contraception proportion were high, the fertility rate got to be low. Social economy, health condition and the fertility rate of lag stage all had significant influence upon fertility transition. Diffusion, socio-economic and birth control factors simultaneously led to the decline of fertility rate. Between the year of 1990 and 2000, except contraception proportion and birth control proportion, all other variables cast noticeable influence on fertility fluctuation.

Table 1: Analysis of determinants of TFR of four stages between 1950 and 2000 (Within-provincial models)

		Socio-economic variables				Birth control variables				
	Lag F	GDP per capita	Proportion of urban population	Doctors' number per 10,000 persons	Students' number per 10,000 persons	Late-marriage proportion	Contraception proportion	Birth control proportion	R^2	D-W
1950-1969										
Model 1	—	-0.001*	-0.001	0.067***	-0.004***				0.45	0.48
Model 2	0.757***	-0.001*	-0.002	0.036***	-0.001***				0.78	1.80
Model 3	-0.136**	0.001+	-0.059***	0.046*	-0.002*				0.20	1.66
1970-1979										
Model 1	—	-0.002*	-0.034*	0.155**	-0.006***				0.92	0.30
Model 2	0.953***	-0.001	-0.012*	0.054**	-0.001*				0.98	1.06
Model 3	0.428***	0.005	0.005	0.024	-0.001				0.37	2.21
1980-1989										
Model 1	—	-0.001	-0.009	-0.077**	-0.001*	0.006*	-0.029***	-0.006	0.91	0.44
Model 2	0.901***	-0.001	-0.003	-0.0005	-0.001	-0.001	-0.003*	-0.001	0.99	1.14
Model 3	0.452***	0.001**	-0.002	0.044*	-0.001	-0.003***	-0.003+	-0.001	0.59	1.78
1991-2000										
Model 1		-0.006***	0.011***	-0.006+	0.001	0.001	-0.032***	-0.038***	0.89	0.38
Model 2	0.84***	-0.001***	0.001	0.001+	0.001***	0.001	0.003	0.001	0.99	0.89
Model 3	0.526***	0.004**	-0.004*	0.002*	0.002***	-0.011**	-0.006	0.005	0.65	1.59

***P < 0.001， **P < 0.01， *P < 0.05， + P < 0.10。

__Cross-provincial diffusion effect.__

In Table 2 the result from regression analysis of cross-provincial diffusion effect is shown. As the result of Model 1 in this part is the same as that in the within-provincial diffusion, only the results of analysis with Model 2 and Model 3 are shown here. Similar to the result of within-provincial diffusion analysis, in all the four stages both within-provincial and cross-provincial diffusion effects can be observed(except for the third stage). Coefficient of the provincial fertility rate of lag stage and that of the weight fertility rate of other provinces are obviously higher than zero with the former coefficient higher than the latter one. Also, except that model 2 has good fit index in the first stage(1950-1969), in the other three stages, it's Model 3 that has good fit index which is result from differential analysis. Here only the models with fine fit index are analyzed.

Between the year of 1950 and 1959, besides the noticeable influence of doctors' number and middle school students' number, the provincial fertility rate of lag stage and the weight fertility rate of other provinces had significant influence upon the fertility fluctuation in this stage. The more doctors every 10,000 persons had, the higher the fertility rate was while the more middle school students there were among 10,000 persons, the lower the fertility rate was. The higher the fertility rate of lag stage was, the higher the fertility rate of this stage would be. Between the year of 1971 and 1979, of all the socio-economic factors, only the factor of middle school students' number per 10,000 persons had significant influence upon fertility transition; both within-provincial and cross-provincial diffusion coefficients had significant effect. Between the year of 1980 and 1989, provincial fertility rate of lag stage cast significant effect on fertility transition while the weight fertility rate of other provinces was not so noticeable. GDP per-capita and doctors' number per 10,000 persons cast positive influence upon fertility transition. Contraception proportion and late-marriage proportion had significant effect on the decline of fertility rate. Higher late-marriage proportion and contraception proportion mean lower fertility rate. Between the year 1990 and 2000, except contraception proportion and birth control proportion, all other variables cast noticeable influence upon fertility fluctuation.

Table 2: Analysis of determinants of TFR of four stages between 1950 and 2000 (Cross-provincial models)

			Socio-economic variables				Birth control variables				
	F of lag stage	Weight F of lag stage of other provinces	GDP per capita	Proportion of urban population	Doctors' number per 10,000 persons	Students' number per 10,000 persons	Late-marriage proportion	Contraception proportion	Birth control proportion	R^2	D-W
1950-1969											
Model 2	0.778***	0.199***	-0.001	-0.001	0.028**	-0.001***				0.81	1.98
Model 3	-0.102**	0.055**	0.001+	-0.057***	0.047*	-0.002*				0.21	1.67
1970-1979											
Model 2	0.836***	0.136***	-0.001+	-0.009+	0.057**	-0.001				0.98	0.96
Model 3	0.480***	0.255***	-0.001	-0.003	0.001	-0.001**				0.44	2.36
1980-1989											
Model 2	0.880***	0.0340	0.002	0.003	0.006	0.005	-0.001	-0.003*	-0.001	0.99	1.12
Model 3	0.453***	0.005	0.001**	-0.003	0.045*	-0.001	-0.003**	-0.003+	-0.001	0.59	1.79
1990-2000											
Model 2	0.855***	-0.005	-0.001***	0.001	0.002+	0.001***	0.002+	0.003	-0.001	0.98	0.90
Model 3	0.628***	0.115***	0.001**	-0.004*	0.002*	0.001***	-0.009*	-0.004	-0.001	0.67	1.87

***P < 0.001， **P < 0.01， *P < 0.05， + P < 0.10。

CONCLUSION

From the analysis above we can get the following conclusions:

(1)There is obvious spatial diffusion effect in the decline of China's fertility rate. Results from the diffusion reveal that the sustained fertility decline began with a few big cities and eastern provinces; then the decline began to be observed in northern provinces later, while this happened even later in northwest China and south China. The fertility transition of China's population shows a diffusion progress: the sustained fertility decline began with a few big cities and eastern provinces; then the decline got diffused to northern provinces later and the fertility transition gradually crossed the geographical boundary. Fertility rate in eastern provinces got close to the replacement level in late 1970s, while this happened later in northwest China and south China where the fertility rate remained high in 1990s. The fertility rate used to be high in north China, but the gap is shrinking.

(2) There is temporal diffusion effect in the decline of China's fertility rate and the effect of within-provincial diffusion is stronger than that of cross-provincial diffusion. During the four stages divided in this paper, diffusion coefficients of the provincial fertility rate of lag stage and the weight fertility rate of other provinces(except for the third stage) are obviously higher than zero, which reveals the existence of diffusion effect; moreover, within-provincial diffusion coefficient is higher than cross-provincial one, which indicates that in the fertility decline of provinces, the influence from provincial fertility transition plays a more important role.

(3) Diffusion effect is independent of socio-economic factors and it has enhanced the influence of economic factors upon fertility decline. Besides the diffusion effect, socio-economic factors and birth control factors play different roles in different stages.

Between the year of 1950 and 1969, the fertility of China fluctuated around a relatively high level and had the tendency to decline. China's economy and social order got completely recovered in this stage. Both economic development and upgrading of education contribute to the decline of fertility rate, but the improvement of hospital condition and medical service in China has greatly reduced the mortality rate; moreover, the free medical services provided for pregnant women and mother and infants have promoted the growth of fertility rate. In this stage, diffusion effect and socio-economic factors simultaneously cast significant influence upon the decline of fertility rate. Between the year of 1971 and 1979, China's fertility rate began to witness remarkable decline. In early 1970s, Chinese government was dedicated to advocate and popularize birth control movement and provided nationwide free operation service for contraception and birth control. In this stage, the birth control program was well implemented and China's fertility rate declined rapidly(Coale,1984). However, data of birth control of provinces in this stage are not available. Therefore, from the result of analysis of the models, we can see that after the fertility rate of lag stage is countered in, the influence of socio-economic variables is not significant in this stage. Taking the practices in China into consideration, main determinants of the fertility decline are the birth control program and wide spreading of birth control knowledge. Between the year of 1980 and 1989, with the implementation of current Family Planning policy, the fertility rate of China fluctuated around a relatively low level and remained declining slowly. Family Planning institutions were set up by governments at all levels of provinces and cities, and series of indicators of Family Planning were established. In this stage, diffusion effect, socio-economic factors and birth control cast simultaneous influence upon fertility decline. Between the year of 1990 and 2000, fertility rate of China further declined to below the replacement level. Diffusion effect and socio-economic factors played an important role in the decline of fertility rate in this stage.

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