Change in China`s SRB: An Analysis with Spatial Panel Data

Abstract

Previous studies focused on identifying the determinants of sex ratio at birth (SRB) in China since the 1980s have ignored the spatial dependence of SRB. Using data from China's censuses and inter-census surveys since 1982 and Dynamic Spatial Durbin Model, we investigated the change in China`s SRB. Results indicated that: (1) SRB and its influencing factors were spatially correlated at the provincial level; (2) The development of per capita GDP increased the SRB in the surrounding regions; (3) The improvement of urbanization level significantly lowered the SRB locally, while increasing the SRB of the neighbouring regions; (4) Improved education attainment significantly lowered the SRB both in and around the region; (5) Birth control policy increased the SRB locally, but the indirect effects were not significant.

Keywords: sex ratio at birth, spatial dependence, Spatial Durbin Model, Panel Data, China

Background

China’s sex ratio at birth (hereafter referred to as SRB) has continually increased since the 1980s. The population censuses indicate that the SRB was 108.5 in 1982 and 111.4 in 1990. This rose to 119.9 in 2000, and further to 121.2 in 2010 (LGO 1985; PCO 1993, 2002, 2012). The SRB has fallen since 2010 but remains well above normal.

Focused on the causes of abnormally SRB from the perspective of economic development (Gu & Roy, 1995; Banister, 2004; Guilmoto & Ren, 2011; Yang & Li, 2015), social transition (Guo, 2003; Yang, 2008; Li et al., 2014), education (Xie, 1989; Banister, 2004; Guilmoto, 2005; Yang & Li, 2015) and policy (Hull, 1990; Gu & Roy, 1995; Bignami-Van Assche, 2004; Yuan & Shi, 2005; Yang, 2012; Charis & Elizabeth, 2015), previous studies found some significant results.

However, the spatial dependence of SRB has not received enough attention in the current literature. There are over thirty provinces, as the administrative units under the state, in China, as they are characterized by marked differences in terms of economic development, society and culture, and the locally birth control policy (Gu et al., 2007). These differences have affected provincial SRB and the spatial pattern of SRB. The change of SRB is spatially concentrated and diffused, forming one or more severely high SRB areas, and spreading to the surrounding regions with these severely high SRB areas as the center (Wang & Liu, 2011; Hu & Yuan, 2012). Meanwhile, the spatial clustering of SRB became more pronounced from 2000 to 2010 (Shi & Sun, 2014).

Under the current social environment with increasingly convenient transportation and faster information transmission in China, fertility concept will continuously spread to neighboring areas, which will further affect people's sex selection and SRB (Shi & Sun, 2014). With the influence of economic, social, cultural and policy factors in neighboring regions, SRB may also converge in neighboring regions, resulting in spatial dependence (Tang et al., 2011; Liu et al., 2014). Thus, the traditional statistical method will be unable to capture the scientific and reliable results, and the spatial analysis method should be employed to take the spatial dependence of SRB into consideration.

Objective

Employing the spatial Durbin model, this study aims to consider the spatial dependence and examine the influence of economic, social, cultural and policy factors on SRB.

Data and Method

Data

Adopted the province-level data from 1982, 1990, 1995, 2000, 2010 and 2015 in China (except

Hong Kong, Macao, and Taiwan), we investigated the determinants of SRB from the perspective of spatial analysis. Provincial SRB was derived from the corresponding year's censuses data or the 1 Percent Population Sample Surveys. Other data were from the corresponding year China Statistical Yearbook, Almanac of China`s Population, China Population Statistics Yearbook (renamed China Population & Employment Statistics Yearbook after 2007) and Censuses or the 1 Percent Population Sample Surveys. Table 1 shows the definition and depressive statistics of SRB and explanatory variables

Table 1 Descriptive statistics for SRB and explanatory variables

Variable	Description	Mean	SD	Observation
Dependent variable				
SRB	The ratio of live male births to 100 live female births	114.172	8.030	217
Explanatory variables				
GDP	Natural log of gross domestic product per capita	8.810	1.555	217
URB	Percentage of people live in the cities or towns	39.913	18.753	217
EDU	Percentage of people with high school education or above	18.844	10.486	186
STE	Percentage of people sterilized during birth control	38.432	19.816	183

Note: The largest VIF value of explanatory variables was less than 10.

Method

The model we employed was Dynamic Spatial Durbin Model (Dynamic-SDM), which taking SRB lagged in time, endogenous interaction effects and exogenous interaction effects into consideration. The formula of Dynamic-SDM can be expressed as follows:

$$Y_t = \tau Y_{t-1} + \rho W Y_t + X_t \beta + W X_t \theta + \mu + \alpha_t + \nu_t \quad (1)$$

Where Yt denotes an N × 1 vector that consists of one observation of SRB for every province (i = 1,…, N) at time t (t = 1,…, T); $Yt\text{-}1$ denotes the observation of SRB for every province at time t-1

Xt is an $N \times K$ matrix of exogenous explanatory variables. The $N \times N$ matrix W is a nonnegative matrix of known constants that describe the spatial arrangement of the economies in the sample. WYt represents endogenous interaction effects, which refers to the mutual influence of SRB of each province through spatial weight matrix W. WXt represents exogenous interaction effects, which refers to the influence of explanatory variables of one province on the SRB of neighbouring provinces through spatial weight matrix W. The parameters τ, ρ, β and θ are the response parameters of, respectively, SRB lagged in time Yt-1, endogenous interaction effects(WYt),

explanatory variables and exogenous interaction effects(WXt). The $N \times 1$ vector μ control for all spatial-specific, time-invariant variables, namely spatial-specific effects; the $N \times 1$ vector αt control for all time-specific, unit-invariant variables, namely time-specific effects. The $N \times 1$ vector Vt consists of i.i.d. disturbance terms, which have zero mean and finite variance σ^2.

Results

Table 2 provides the Global Moran`s I Index of SRB and explanatory variables from 1982-2015. It indicated that SRB and explanatory variables all had spatial correlation, and spatial effects should be considered when analyzing the change of SRB.

Table 2 Global Moran`s I Index of SRB and explanatory variables since 1982

Year	SRB	GDP	URB	EDU	STE
1982	0.362***	0.173**	0.348***	0.279***	-
1990	0.105	0.261**	0.307***	0.291***	0.221**
1995	0.361***	0.304***	0.236**	-	0.256**
2000	0.520***	0.365***	0.310***	0.328***	0.310***
2005	0.253***	0.320***	0.380***	0.318***	0.304***
2010	0.499***	0.438***	0.403***	0.327***	0.303***
2015	0.004	0.395***	0.406***	0.301***	0.263***

Note: "-" refers to a missing value.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 shows the results of the regression. Firstly, the results of OLS regression indicated that EDU and STE had a significant effect on SRB, whereas GDP and URB were insignificantly associated with SRB.

Secondly, the direction four explanatory variables` influence on SRB did not change in SEM, SAR, and SDM, only the significance of parameters was different (see the Main part in Table 3). Based on the results of the tests $\theta = 0$ (F=3.19, P =0.013) and $\theta + \rho\beta = 0$ (F =4.06, P = 0.003), SDM cannot be reduced to SEM and SAR.

Finally, SRB lagged in time was introduced to SDM. The SRB lagged in time was significantly positive, indicating that there was inertia in the change of SRB, and other potential factors also have significant positive effects on the change of birth sex ratio. Concerning spatial autoregression coefficient (ρ), SDM overestimated spatial correlation (ρ=0.360 in SDM Vs. ρ=0.338 in Dynamic-SDM). Overall, our results indicated that the Dynamic-SDM fist our data best.

Table 3 Estimation of the regression of SRB on OLS and spatial panel modelings from 1982-2015

Variable	OLS	SEM	SAR	SDM	Dynamic-SDM
SRB lagged in time					
Y*t-1*					0.182**
Main					
GDP	1.660	4.837***	3.591***	0.540	-0.725
URB	-0.039	-0.179*	-0.080	-0.178*	-0.278***
EDU	-0.285*	-0.218	-0.273**	-0.210	-0.219
STE	0.173***	0.140***	0.144***	0.129***	0.184***
Spatial effect					
Lambda		0.473***			
ρ			0.441***	0.360***	0.338***
W*GDP				3.405	5.069**
W*URB				0.357**	0.387**
W*EDU				-0.552**	-0.574**
W*STE				0.011	-0.007

Note: OLS, ordinary least squares; SEM, Spatial Error Model; SAR, Spatial Autoregressive Model; SDM, spatial Durbin model; All models were fixed with spatial and time effects except the Dynamic-SDM modeling.

*** p<0.01, ** p<0.05, * p<0.1

Lesage & Pace (2009) suggested that in the spatial econometric model, the regression coefficient of the explanatory variable could no longer be used to measure the influence and significance of the variable. The influence of the independent variable on the dependent variable should be decomposed into direct effect and indirect effect according to the source, and then interpret the model based on these effects. Table 4 shows the direct, indirect, and total effects of Dynamic-SDM in the short- and long-term effects.

(1) First of all, the direct effect of GDP was not significant, but the indirect effect was significantly positive, indicating that the economic development in one region would increase the SRB in neighbouring regions.

(2) Secondly, URB had the significant negative direct effect and positive indirect effect on SRB, meaning that the improvement of URB in one region could lower the SRB locally, which was consistent with previous findings (Yang, 2008; Hu and Yuan, 2012; Li et al., 2014), and increase the SRB of neighbouring regions.

(3) Thirdly, EDU had significant negative direct and indirect influence on SRB. The negative direct effect indicated that the improvement of people's education level in a region could significantly reduce the SRB in that region, which was consistent with many studies (Das Gupta, 1987; Behrman & Rosenzweig, 2002; Lavely & Cai, 2004), and indirectly proved the conclusion of Yang & Li (2009) that education can inhibit the SRB when the average education attainment was 9 years or more. The negative indirect effect suggested that the improvement of people's education level in one area lowered

the SRB in others.

(4) Finally, STE had a significant positive direct effect on SRB, while the indirect was insignificant. The positive direct effect indicated that the stricter birth control policy was implemented in a region, the higher SRB in that region was, which was consistent with the prior research (Hull, 1990; Bignami-Van Assche, 2004; Li et al., 2010).

(5) By comparing the direct, indirect and total effects of different variables, it can be found that the improvement of a region's economic and social development level (GDP and URB) would restrain the increase of SRB in the local area, but not conducive to the governance of SRB in the surrounding areas. The improvement of people's education level in a region was not only beneficial to the governance of the region's SRB but also could inhibit the SRB in the surrounding areas. The one-child policy would only affect SRB locally.

Table 4 The direct, indirect and total effects of Dynamic-SDM in the short- and long-term effects

Variable	Short-term effects			Long-term effects		
	Direct	**Spillover**	**Total**	**Direct**	**Spillover**	**Total**
GDP	-0.306	6.828***	6.522***	-0.233	9.303***	9.070***
URB	-0.249**	0.421**	0.172	-0.298**	0.538*	0.239
EDU	-0.282*	-0.929***	-1.211***	-0.368**	-1.317***	-1.685***
STE	0.191***	0.071	0.263*	0.238***	0.129	0.367

*** p<0.01, ** p<0.05, * p<0.1

Conclusion

1. SRB and its influencing factors were spatially correlated at the provincial level;
2. The development of per capita GDP increased the SRB in the surrounding regions;
3. The improvement of urbanization level significantly lowered the SRB locally, while increasing the SRB of the neighbouring regions;
4. Improved education attainment significantly lowered the SRB both in and around the region;
5. Birth control policy increased the SRB locally, but the indirect effects were not significant.