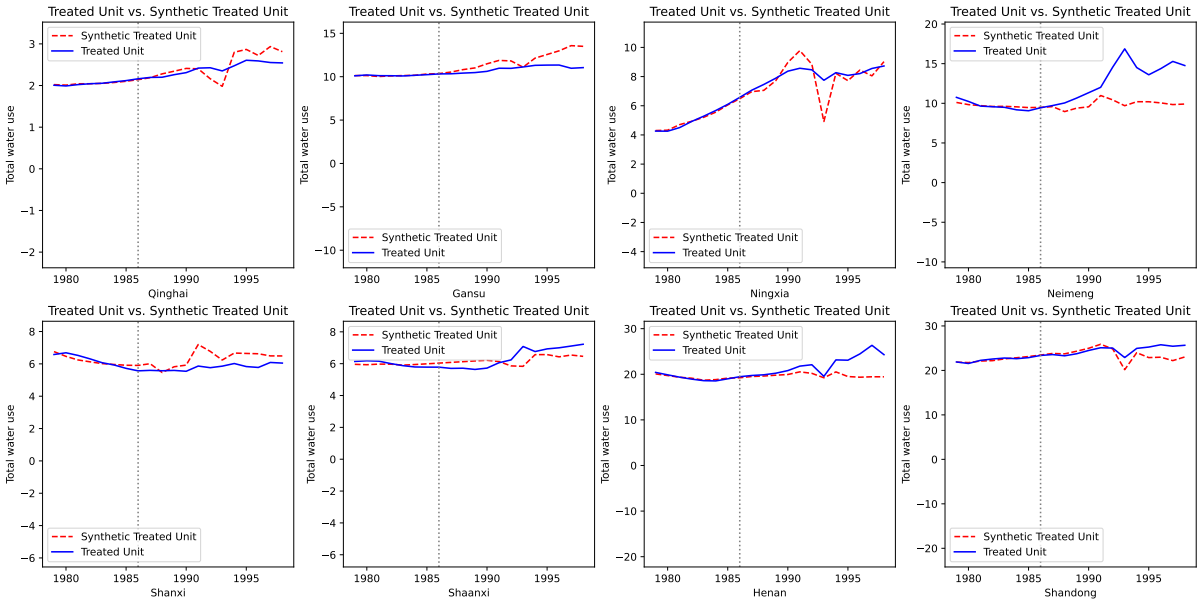
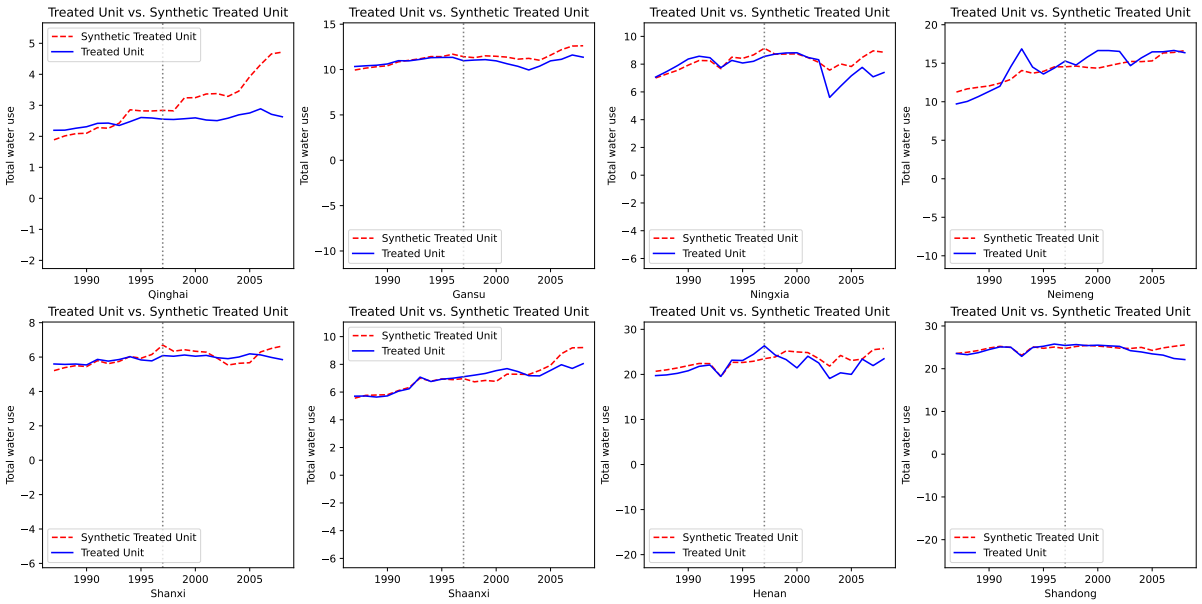
Appendix B: Robustness of DSC method

Explanatory variables are the key to constructing a robust synthetic control method. We used a total of 24 variables related to water consumption Table B1, which datasets have been used in previous studies to explain changes in water use in China [1]. In addition, we selected 5 principal components as input by the elbow method because selection in autocorrelated variables reduces dimensions and then enhances the robustness of the DSC (Figure B5).

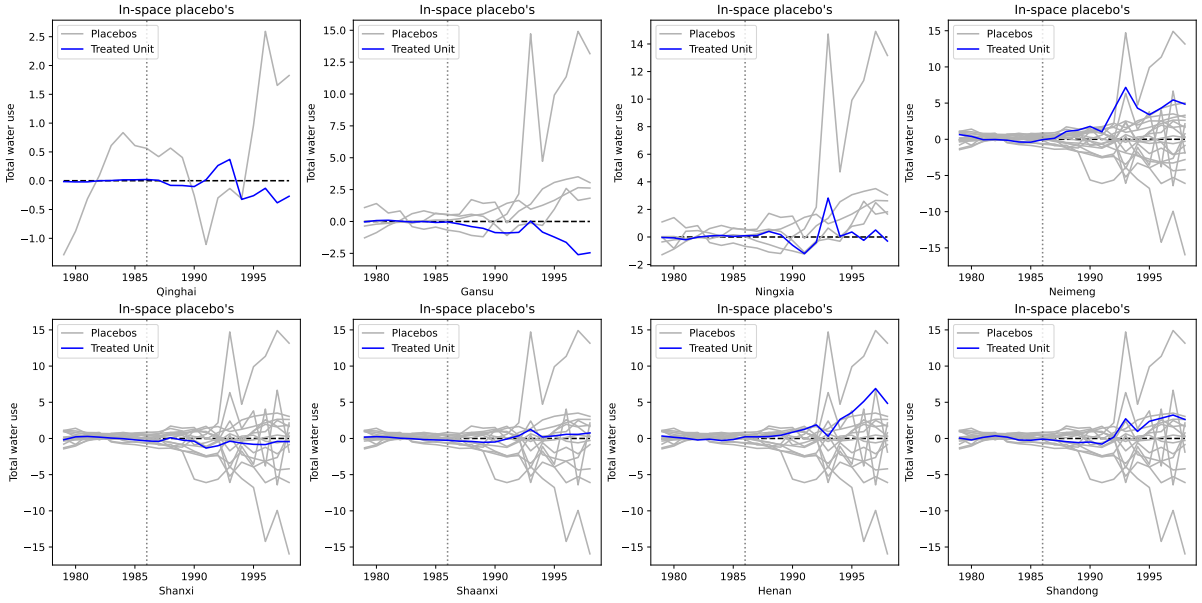
There are two approaches to validity testing of the DSC: (1) comparing the post-treated and pre-treated reconstructions and (2) testing robustness through placebo analysis. For (1), differences between each province and their synthetic are significant in post-treated periods and small in pre-treated periods (Figure B1 and figure B2), which show good reconstructions of their water use changes' estimation. For (2), we applied the in-place placebo analysis described by [2]. In most provinces, ratios of post-MSPE to pre-MSPE are higher than the median of other placebo units, which suggests the institutional shifts in treated time (1987 and 1998 here) influenced them more than most of the other provinces (figure B3, figure B4, Table B2).



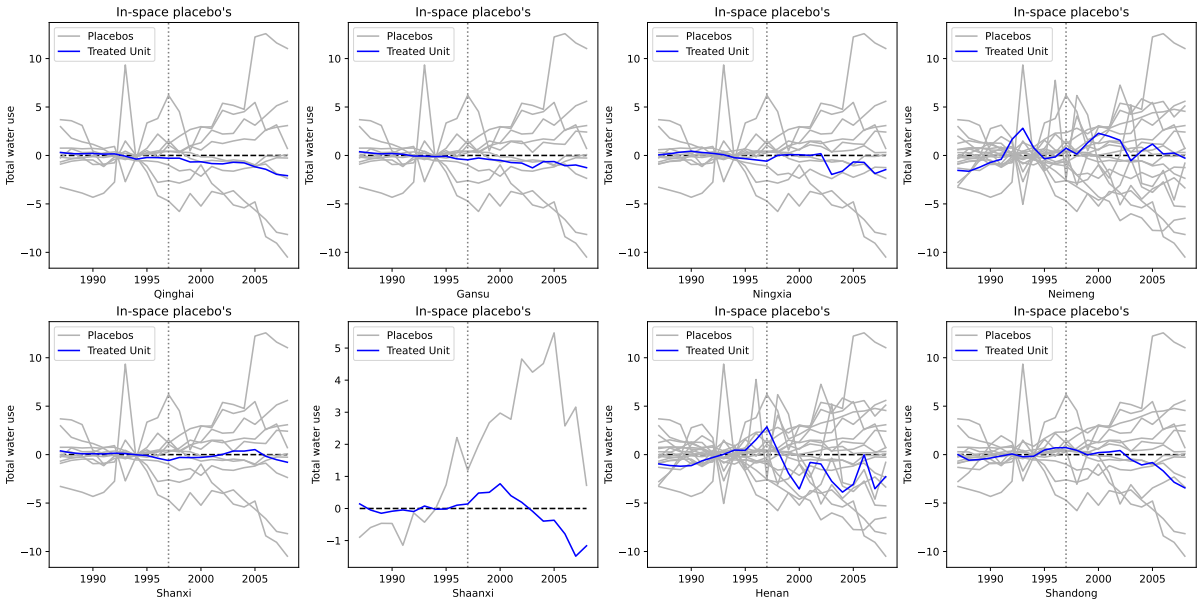
Supplementary Figure B1 Comparations between YRB' provinces and their synthetic controls around the 87-WAS.



Supplementary Figure B2 Comparations between YRB' provinces and their synthetic controls around the 98-UBR.



Supplementary Figure B3 Gaps in change in water use between provinces outside the YRB and their synthetic control, around the 87-WAS, excluding the provinces with high pre-treatment RMSPE (more than 3 times of treated units' RMSPE).



Supplementary Figure B4 Gaps in change in water use between provinces outside the YRB and their synthetic control, around the 98-UBR, excluding the provinces with high pre-treatment RMSPE (more than 3 times of treated units' RMSPE)

References

[1] Zhou, F. *et al.* Deceleration of China's human water use and its key drivers **117** (14), 7702–7711. https://doi.org/10.1073/pnas.1909902117 .

[2] Abadie, A., Diamond, A. & Hainmueller, J. Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program **105** (490), 493–505. https://doi.org/10.1198/jasa.2009.ap08746 .

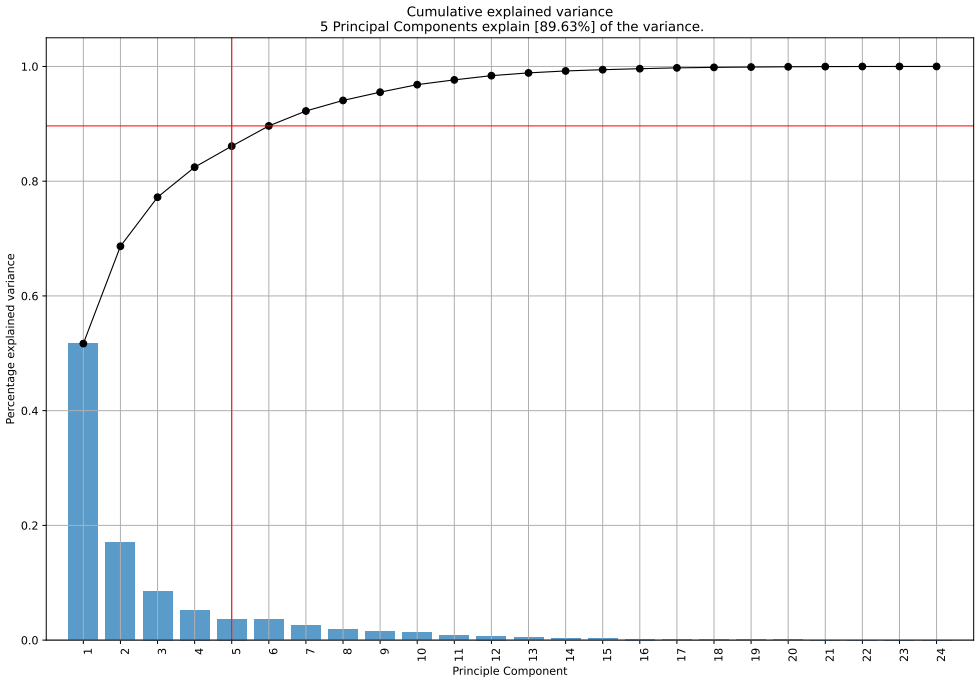
Table B1 Variables and their categories for water use predictions

Sector	Category	Unit	Description	Variables
Agriculture	Irrigation Area	thousand ha	Area equipped for irrgiation by different crop:	Rice, Wheat, Maize, Fruits, Others.
Industry	Industrial gross value added	Billion Yuan	Industrial GVA by industries	Textile, Papermaking, Petrochemicals, Metallurgy, Mining, Food, Cements, Machinery, Electronics, Thermal electrivity, Others.
	Industrial water use efficiency	%	The ratio of recycled water and evaporated water to total industrial water use	Ratio of industrial water recycling, Ratio of industrial water evaporated.
Services	Services gross value added	Billion Yuan	GVA of service activities	Services GVA
Domestic	Urban population	Million Capita	Population living in urban regions.	Urban pop
	Rural population	Million Capita	Population living in rural regions.	Rural pop
	Livestock population	Billion KJ	Livestock commodity calories summed from 7 types of animal.	Livestock
Environment	Temperature	K	Near surface air temperature	Temperature
	Precipitation	mm	Annual accumulated precipitation	Precipitation

Table B2 Pre and post treatment root mean squared prediction error (RMSPE) for YRB's provinces

	1987-WAS				1998-UBR			
Provinces	Pre-RMSPE	Post-RMSPE	Ratio	Significant[a]	Pre-RMSPE	Post-RMSPE	Ratio	Significant[a]
Qinghai	0.016	0.231	14.606	True	0.230	1.170	5.096	True
Gansu	0.056	1.307	23.265	True	0.244	0.841	3.448	True
Ningxia	0.097	0.944	9.697	True	0.332	1.091	3.284	True
Neimeng	0.335	3.846	11.479	True	1.320	1.183	0.896	False
Shanxi	0.208	0.675	3.241	False	0.264	0.401	1.520	False
Shaanxi	0.181	0.572	3.164	False	0.096	0.724	7.579	True
Henan	0.210	3.207	15.292	True	1.222	2.479	2.029	False
Shandong	0.209	1.840	8.785	True	0.431	1.517	3.516	True

[a]Larger post/pre RMSPE than the median of the placebos.



Supplementary Figure B5 Choose number of pricipal components by Elbow method, 5 pricipal components already capture 89.63% explained variance.