Supplementary materials

Table S1. Moran's *I* of lnIH and lnNH in spill-over and influx risk perspectives.

Variables	Spillover risk perspective	Influx risk perspective
lnIH2013	0.2097***	0.2169***
lnIH2014	0.2564***	0.2644***
lnIH2015	0.2962***	0.3025***
lnIH2016	0.3455***	0.3501***
lnIH2017	0.3173***	0.3189***
lnIH2018	0.3699***	0.3745***
lnIH2019	0.3463***	0.3473***
lnIH2020	0.4317***	0.4339***
lnIH2021	0.3463***	0.3474***
lnIH2022	0.3815***	0.3828***
lnNH2013	0.2000***	0.2136***
lnNH2014	0.2073***	0.2212***
lnNH2015	0.2210***	0.2345***
lnNH2016	0.2335***	0.2455***
lnNH2017	0.1931***	0.2019***
lnNH2018	0.2061***	0.2166***
lnNH2019	0.1899***	0.1982***
lnNH2020	0.2393***	0.2486***
lnNH2021	0.2122***	0.2213***
lnNH2022	0.2285***	0.2371***

*p<0.1; **p<0.05; ***p<0.001.

Table S2. The cross-sectional dependency test and panel unit root analysis.

Variables	lnIH	lnNH	lnSF	lnPD	lnHRF	lnEL
Pesaran cross-sectional dependency test						
CD test	30.4380***	34.9850***	26.5400***	9.8440***	13.3240***	8.8600***
Pesaran panel unit root analysis						
CIPS test	-2.1950***	-2.3240***	-1.7150**	-1.6310**	-2.1160***	-1.5040*
CADF test	-2.4940***	-2.6030***	-2.2580***	-1.9720*	-2.1040**	-2.4770***

*p<0.1; **p<0.05; ***p<0.001.

Table S3. Model selection test results of panel data models.

	Spillover risk perspective		Influx risk perspective	
	HIV incidence model	HIV prevalence model	HIV incidence model	HIV prevalence model
Spatial error				
LM	97.4139***	202.6266***	97.1859***	48.7751***
Robust LM	0.7977	157.9871***	0.6254	2.6210
Spatial lag				
LM	114.3922***	47.6669***	114.4569***	208.7125***
Robust LM	17.7760***	3.0273***	17.8964***	162.5584***

*p<0.1; **p<0.05; ***p<0.001.

Table S4. Decomposition of spatial effects.

Spillover risk perspective						
	HIV incidence model			HIV prevalence model		
Variables	Direct	Indirect	Total	Direct	Indirect	Total
lnSF	0.0238	0.0567	0.0805	0.0873	0.2295	0.3168
	(0.0969)	(0.2184)	(0.3138)	(0.0986)	(0.2694)	(0.3653)
lnPD	0.1361***	0.2950**	0.4312***	0.1724***	0.4358***	0.6082***
	(0.0451)	(0.1229)	(0.1619)	(0.0455)	(0.1620)	(0.2002)
lnHRF	0.3539***	0.7690***	1.1228***	0.3734***	0.9404***	1.3138***
	(0.0523)	(0.2207)	(0.2562)	(0.0530)	(0.2607)	(0.2971)
lnEL	-	-	-	-	-	-
	0.1905***	0.4116***	0.6021***	0.1898***	0.4748***	0.6646***
	(0.0642)	(0.1745)	(0.2298)	(0.0646)	(0.1918)	(0.2479)
Influx risk perspective						
	HIV incidence model			HIV prevalence model		
Variables	Direct	Indirect	Total	Direct	Indirect	Total
lnSF	0.0287	0.0655	0.0943	0.0956	0.2431	0.3388
	(0.0964)	(0.2115)	(0.3065)	(0.0981)	(0.2613)	(0.3566)
lnPD	0.1367***	0.2883**	0.4249***	0.1734***	0.4255***	0.5989***
	(0.0448)	(0.1179)	(0.1569)	(0.0452)	(0.1548)	(0.1929)
lnHRF	0.3533***	0.7471***	1.1004***	0.3731***	0.9124***	1.2855***
	(0.0520)	(0.2093)	(0.2449)	(0.0526)	(0.2469)	(0.2832)
lnEL	-	-0.3830**	-	-	-0.4326**	-
	0.1822***	(0.1643)	0.5652***	0.1782***	(0.1795)	0.6108***
	(0.0639)		(0.2202)	(0.0642)		(0.2363)

Number in parentheses represents standard error; *p<0.1; **p<0.05; ***p<0.001.

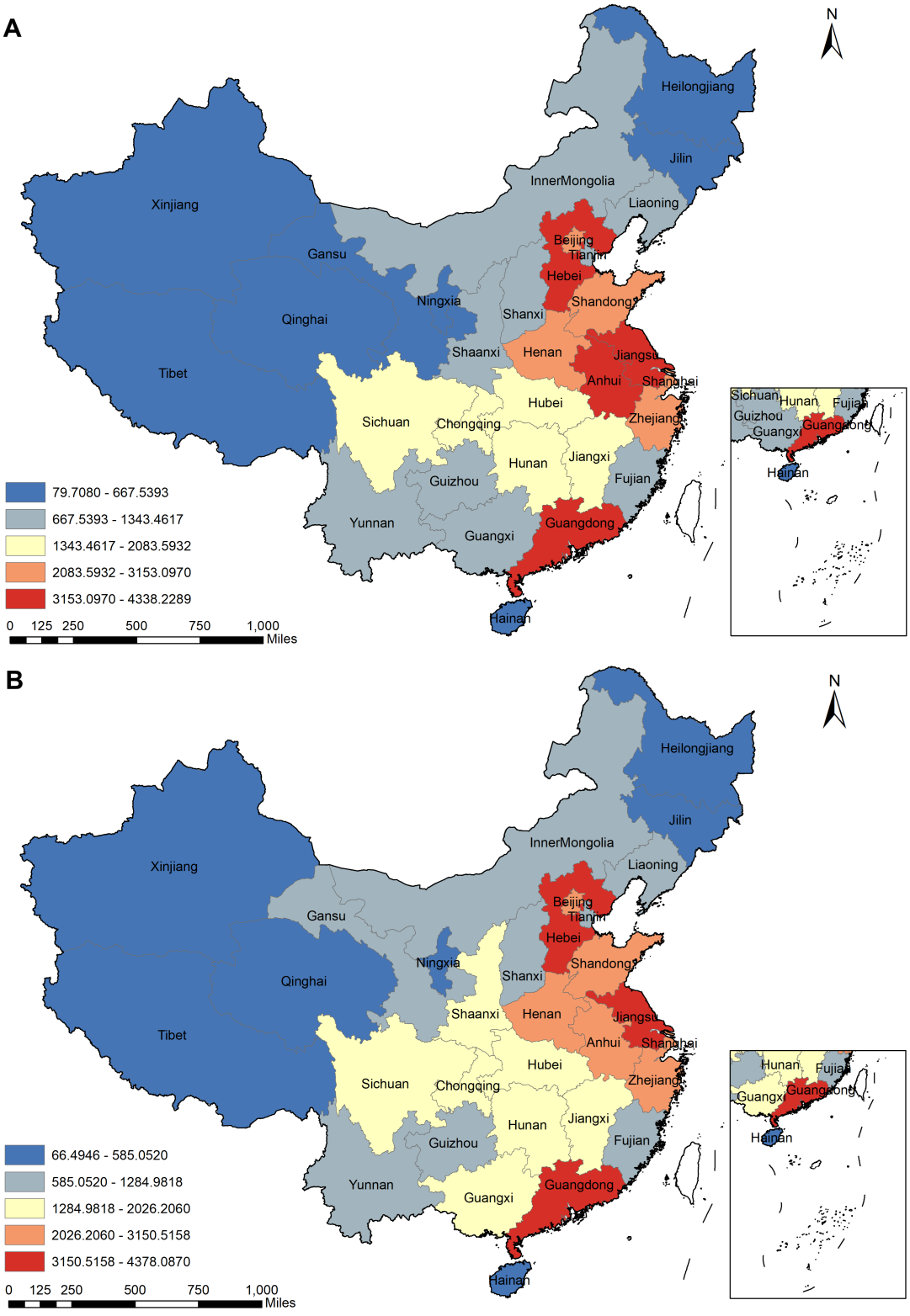

Figure S1. The spatial distribution of average population mobility indexes. A) population outflow indexes; B) population inflow indexes.

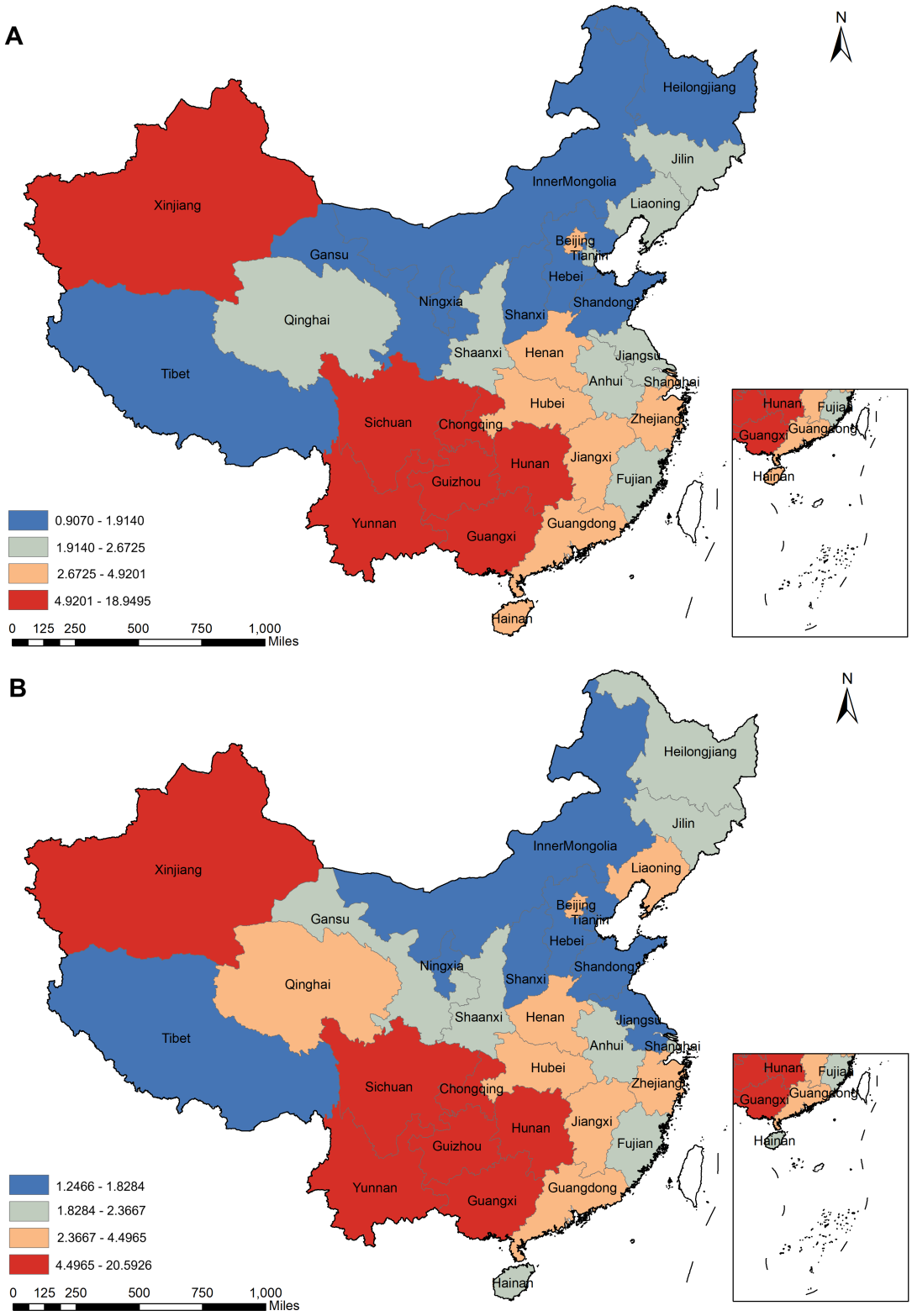

Figure S2. The spatial distribution of HIV incidence.
A) 2013; B) 2022.

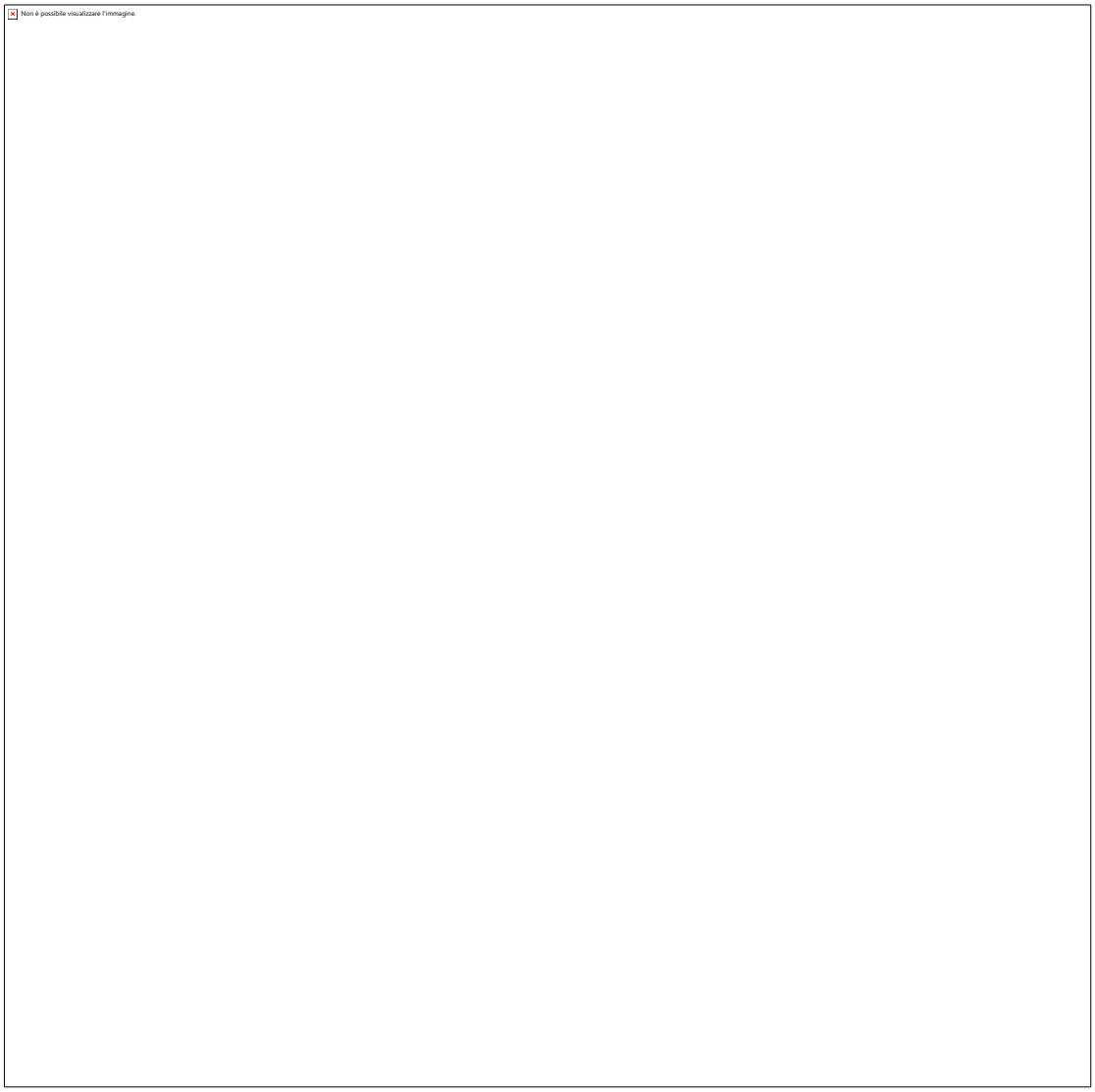

Figure S 3.Moran's I scatterplot in spillover risk perspective.

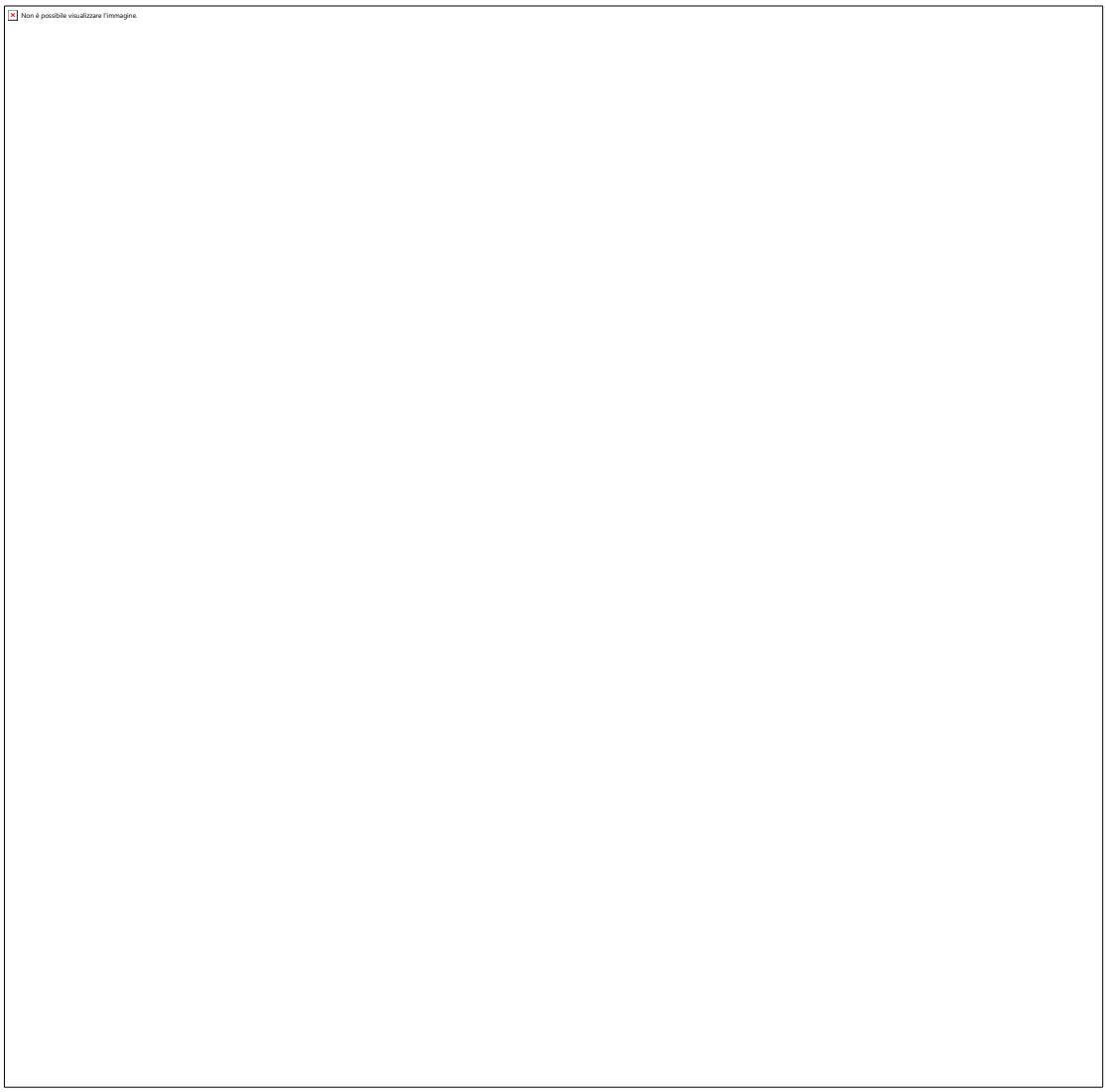

Figure S 4.Moran's I scatterplot in influx risk perspective.