Article:
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Supplementary Materials

Fig. S1. Classification of regions and city group

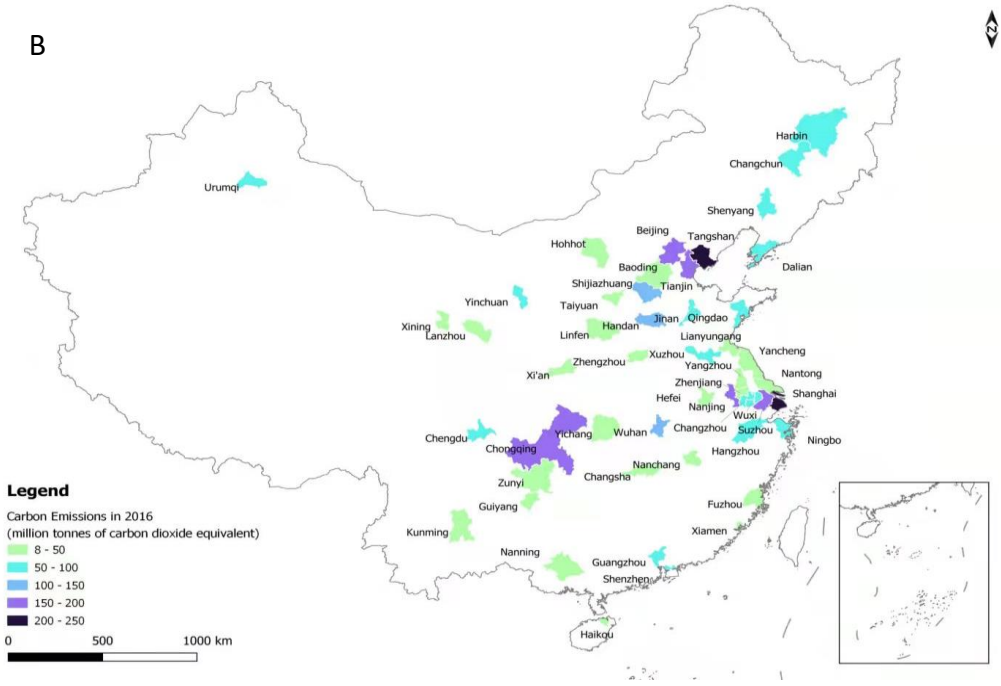

Fig. S2. Total carbon emissions changes during 2000 and 2016. (A) Total carbon emissions changes in percentage from 2000 to 2016; (B) Total carbon emissions for 50 cities in 2016.

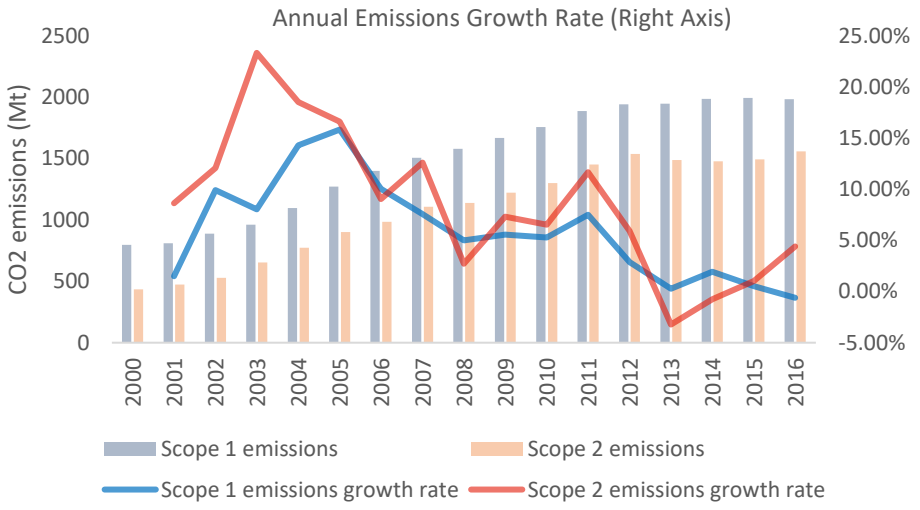

Fig. S3. Carbon emissions trends for 50 cities from 2000-2016

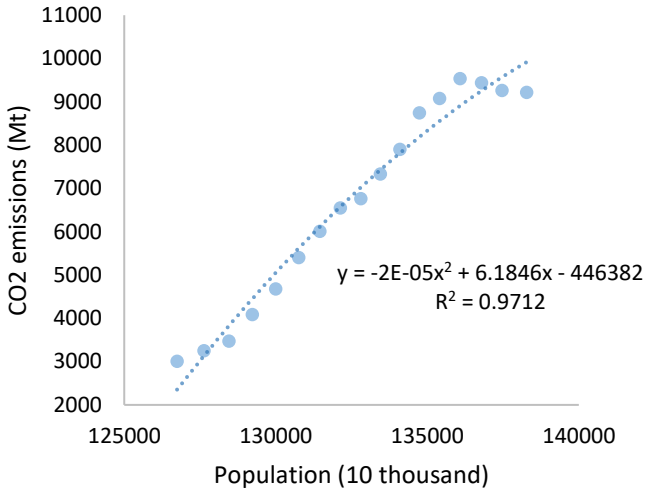

Fig. S4. Trajectory of carbon emissions and population size for China from 2000 to 2016

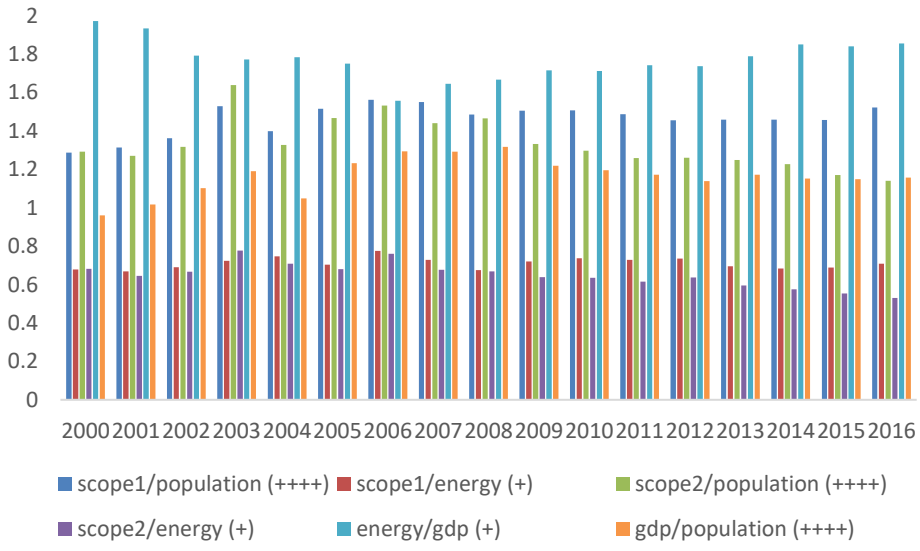

Fig. S5. Scaling exponent and urban Kaya relation for large cities

Notes: The nonparametric bootstrap method is employed to test the credibility of coefficients obtained from the RMA regression method. For each scaling exponent, we conducted 999 times random sampling with replacement, and then calculated each sample and recorded the results. The results are summarized as follows: ++++ represents at least 90% of the replications lead to exponents larger than 1; +++ represents 60%-90% of the estimates are larger than 1; ++ represents 30%-60% of the estimates are larger than 1; + represents less than 30% are larger than 1.

Table S1 Statistical description of variables

Variable	Definition	Obs	Mean	Min	Max	Unit
scope1	scope1 emissions	818	3079.60	135.11	18273.43	10 thousand tons
scope2	scope2 emissions	818	2241.17	50.00	10970.00	10 thousand tons
energy	energy consumption	818	2563.88	16.20	15317.55	10 thousand tce
population	population size	818	690.95	57.34	3392.00	10 thousand people
GDP	GDP	818	92.20	4.06	64.60	billion dollars

Table S2 Classification of regions and city group

Cities	Province	Regions	City Group
Shenzhen	Guangdong	East	Megalopolis
Guangzhou	Guangdong		Megalopolis
Beijing	Beijing		Megalopolis
Shanghai	Shanghai		Megalopolis
Hangzhou	Zhejiang		Metropolis
Tianjin	Tianjin		Metropolis
Nanjing	Jiangsu		Metropolis
Haikou	Hainan		Large Cities
Baoding	Hebei		Large Cities
Nantong	Jiangsu		Large Cities
Xiamen	Fujian		Large Cities
Fuzhou	Fujian		Large Cities
Yangzhou	Jiangsu		Large Cities
Xuzhou	Jiangsu		Large Cities
Qingdao	Shandong		Large Cities
Jinan	Shandong		Large Cities
Handan	Hebei		Large Cities

Ningbo	Zhejiang		Large Cities
Shijiazhuang	Hebei		Large Cities
Wuxi	Jiangsu		Large Cities
Changzhou	Jiangsu		Large Cities
Suzhou	Jiangsu		Large Cities
Tangshan	Hebei		Large Cities
Yancheng	Jiangsu		Medium and Small Cities
Lianyungang	Jiangsu		Medium and Small Cities
Zhenjiang	Jiangsu		Medium and Small Cities
Shenyang	Liaoning		Metropolis
Dalian	Liaoning		Large Cities
Wuhan	Hubei	Middle	Metropolis
Nanchang	Jiangxi		Large Cities
Changsha	Hunan		Large Cities
Hefei	Anhui		Large Cities
Zhengzhou	Henan		Large Cities
Taiyuan	Shanxi		Large Cities
Linfen	Shanxi		Large Cities
Yichang	Hubei		Medium and Small Cities
Harbin	Heilongjiang		Large Cities
Changchun	Jilin		Large Cities
Xi’an	Shanxi	West	Metropolis
Chengdu	Sichuan		Metropolis
Chongqing	Chongqing		Metropolis
Nanning	Guangxi		Large Cities
Kunming	Yunnan		Large Cities
Xining	Qinghai		Large Cities

Guiyang	Guizhou		Large Cities
Hohhot	Inner Mongolia		Large Cities
Lanzhou	Gansu		Large Cities
Urumqi	Xinjiang		Large Cities
Yinchuan	Ningxia		Large Cities
Zunyi	Guizhou		Medium and Small Cities

Table S3 Scaling exponent and urban Kaya relation for megalopolises

	$\frac{\text{scope1}_i}{\text{population}_i}$	$\frac{\text{scope1}_i}{\text{energy}_i}$	$\frac{\text{scope2}_i}{\text{population}_i}$	$\frac{\text{scope2}_i}{\text{energy}_i}$	$\frac{\text{energy}_i}{GDP_i}$	$\frac{GDP_i}{\text{population}_i}$	$\phi_1 - \partial_1\delta\gamma$ or $\phi_2 - \partial_2\delta\gamma$
	ϕ_1	α_1	ϕ_2	α_2	δ	γ	
	++++	+++	++++	+	+	++++	
2000	1.255	0.724	0.666	0.384	4.478	0.387	0.000
2001	1.325	1.339	0.654	0.660	2.705	0.366	0.000
2002	1.285	1.459	0.615	0.699	2.498	0.353	0.000
2003	1.100	1.368	0.584	0.726	2.434	0.331	0.000
2004	1.187	1.437	0.540	0.654	2.365	0.349	0.000
2005	1.100	1.316	0.559	0.669	2.684	0.312	0.000
2006	1.185	1.398	0.535	0.631	2.810	0.302	0.000
2007	1.212	1.396	0.524	0.604	2.740	0.317	0.000
2008	1.089	1.278	0.642	0.753	2.767	0.308	0.000
2009	1.173	1.060	0.667	0.603	3.192	0.347	0.000
2010	1.262	1.342	0.695	0.740	2.752	0.341	0.000
2011	1.173	1.157	0.653	0.644	3.256	0.311	0.000
2012	1.237	1.175	0.802	0.762	3.598	0.293	0.000

2013	1.167	1.133	0.770	0.748	3.819	0.270	0.000
2014	1.167	1.188	0.738	0.751	3.529	0.278	0.000
2015	1.189	1.156	0.763	0.742	3.732	0.276	0.000
2016	1.205	1.068	0.828	0.734	3.654	0.309	0.000

Notes: a) The nonparametric bootstrap method is employed to test the credibility of coefficients obtained from the RMA regression method. For each scaling exponent, we conducted 999 times random sampling with replacement, and then calculated each sample and recorded the results. The results are summarized as follows: ++++ represents at least 90% of the replications lead to exponents larger than 1; +++ represents 60%-90% of the estimates are larger than 1; ++ represents 30%-60% of the estimates are larger than 1; + represents less than 30% are larger than 1; b) For readability, only three decimal places are reserved for the results in the table. The original results obtained by the RMA regression method are available from the corresponding author upon reasonable request; c) The results in the last column are calculated based on the original results.

Table S4 Scaling exponent and urban Kaya relation for metropolises

	$\frac{\text{scope1}_i}{\text{population}_i}$	$\frac{\text{scope1}_i}{\text{energy}_i}$	$\frac{\text{scope2}_i}{\text{population}_i}$	$\frac{\text{scope2}_i}{\text{energy}_i}$	$\frac{\text{energy}_i}{GDP_i}$	$\frac{GDP_i}{\text{population}_i}$	$\phi_1 - \partial_1\delta\gamma$ or $\phi_2 - \partial_2\delta\gamma$
	ϕ_1	α_1	ϕ_2	α_2	δ	γ	
	++++	++	+	+	+	++++	
2000	1.311	0.865	0.990	0.653	2.980	0.509	0.000
2001	1.221	0.860	0.962	0.678	2.639	0.538	0.000
2002	1.294	0.919	0.942	0.669	2.609	0.540	0.000
2003	1.249	0.883	0.955	0.676	2.566	0.551	0.000
2004	1.367	1.004	0.954	0.701	2.403	0.567	0.000
2005	1.311	0.895	0.996	0.680	2.439	0.600	0.000
2006	1.316	0.943	1.036	0.742	2.324	0.601	0.000
2007	1.292	0.845	0.934	0.611	2.629	0.581	0.000
2008	1.396	0.910	0.966	0.629	2.638	0.582	0.000
2009	1.356	0.874	0.939	0.605	2.694	0.576	0.000

2010	1.317	0.812	0.931	0.575	2.752	0.589	0.000
2011	1.375	0.814	0.930	0.551	2.743	0.616	0.000
2012	1.377	0.800	0.977	0.568	2.777	0.620	0.000
2013	1.375	0.736	0.909	0.487	2.998	0.623	0.000
2014	1.423	0.748	0.891	0.468	2.972	0.640	0.000
2015	1.497	0.728	0.884	0.430	3.118	0.660	0.000
2016	1.547	0.724	0.810	0.379	2.701	0.791	0.000

Notes: a) The nonparametric bootstrap method is employed to test the credibility of coefficients obtained from the RMA regression method. For each scaling exponent, we conducted 999 times random sampling with replacement, and then calculated each sample and recorded the results. The results are summarized as follows: ++++ represents at least 90% of the replications lead to exponents larger than 1; +++ represents 60%-90% of the estimates are larger than 1; ++ represents 30%-60% of the estimates are larger than 1; + represents less than 30% are larger than 1; b) For readability, only three decimal places are reserved for the results in the table. The original results obtained by the RMA regression method are available from the corresponding author upon reasonable request; c) The results in the last column are calculated based on the original results.