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The Implications of a Break-Up of China for Carbon Dioxide Emissions

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Abstract: The transition from autocracy to democracy may lead a country to break-up. The break-ups of the USSR and Yugoslavia led to sharp falls in emissions. If something similar would happen in China, projected emissions would fall by 50% or more. Break-up uncertainty dominates other scenario uncertainty

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Key Words: China, scenarios, carbon dioxide emissions

1. Introduction

History has been bloody. At the time of writing, violent conflict rages in four countries and simmers in more. This is typical. Yet, the scenarios used for the analysis of climate change and climate policy are peaceful. As history ends and projections begin, peace breaks out. This is partly because the analytical community that builds scenarios for climate change has little contact with scholars of war and peace – although the latter have only recently started to consider predictive modeling (Goldstone et al. 2010). It is partly because climate scenarios are politicized enough without getting in to the controversial questions of who might fight whom. This paper studies the implications for carbon dioxide emissions of a potential break-up of China.

China is the largest emitter of carbon dioxide, and one of the fastest growing ones. The future of emissions from China is very important for the future of climate change. China is also an emerging economy with a rapidly growing middle class. Typically, that leads to calls for the indiscriminate application of the rule of law and increased political participation. An erosion of central authority regularly leads to a country's fragmentation. This has happened repeatedly in China's history, and more recently in the Soviet Union and Yugoslavia. It is hard to estimate the probability that it will happen again, but the chance is greater than zero. It is easier to assess the implications should China break-up, and that is the focus of this paper.

This is the second paper with less-than-peaceful scenarios. In (Devitt and Tol 2012), we study the interactions between climate change, civil war, and economic development (finding that climate change is the least important of the three components) but do not consider the impact on emissions. With many countries, it is easier to estimate models, present probabilistic projections, and discuss the results while hiding behind the anonymity of stochasticity. The current paper does not have those advantages.

The paper proceeds as follows. In Section 2, I discuss the date of break-up of China. In Section 3, I discuss the consequences for economic growth and emissions. Section 4 concludes.

2. When might China break-up?

Using non-cooperative game theory, (Alesina and Spolaore 1997;Alesina and Spolaore 2005) propose a theory of nation formation. There are fixed costs to being a country (e.g., head of state, foreign service) and increasing returns to scale (e.g., countries are free trade zones) but scale brings costs too (e.g., mutually exclusive viewpoints, monetary union). Countries can thus be too small as well as too large, and there is an optimum nation size as well as an equilibrium nation size. More interestingly, the theory also predicts what happens to the size of nations when circumstances change. For instance, countries can be smaller if part of a free trade area. We indeed see a revival of secessionist movements in a number of member states of the European Union. Federal states can be larger than centralized states, because diversity is more easily

accommodated. And pertinent to the current paper, autocratic states can be larger than democratic ones, because diversity of opinion is suppressed.

(Alesina and Spolaore 1997) make this relationship precise. If all countries were democratic, the number of nations would equal to (the largest integer greater than) $N_d=\sqrt{(\alpha\gamma/2\kappa)}$. If all countries were autocratic, the number of nations would be $N_a=\sqrt{(\alpha\delta\gamma/2\kappa)}$. The relative change in the number of nations due to democratization is thus $N_d/N_{a=}\sqrt{1/\delta}$. We therefore do not need to concern ourselves with the interpretation of three of the four parameters in the model. The parameter δ is the fraction of people represented by the autocratic regime. According to Wikipedia, 6% of the population in China is a member of the Communist Party. If we take δ=6%, N_d/N_a=4. That is, a democratic China would fall apart into four separate countries – there are ancient rivalries between the Northeast and the Southeast, and alleged splittists in the Southwest and Northwest.

The Polity IV database[1] gathers information on institutionalized features of government in all countries with more than 100,000 inhabitants. Various indicators are aggregated to an overall index, polity2[2], ranging from -10 (total autocracy) to +10 (perfect democracy). I regressed polity2 on per capita income, per capita income lagged, and polity2 lagged, using data for some 150 countries for the period 1960-2010. Table 1 shows the results for three alternative models.

All three models indicate that, compared to other countries with similar income levels, China is remarkably autocratic. Its current score is -7. In the static model, given China's income, its score is 1.4. In the two dynamic models, the equilibrium score with income stationary at its 2010 level, China's polity2 score is 3.6. This suggests that China has a democracy deficit. In the two dynamic models, if China's per capita income would gradually slow down to 3% per year by 2030, China would become an open anocracy[3] (polity2>3) in 2029 and a democracy (polity2>6) by 2041. See Figure 1.

These results suggest that there will be increasing competition for power in China over the next few decades, with currently marginalized forces joining in by the end of the next decade. That would seem to be a time of a heightened risk of disintegration of central power.

3. What would happen if China would break-up?

In recent times, the autocratic regimes of two countries lost control with a break-up as a result. Figure 2 shows per capita income, primary energy intensity of the economy, and carbon intensity

[1] http://www.systemicpeace.org/inscr/inscr.htm
[2] an inferior overall indicator, polity1, continues to be reported for historical reasons
[3] In an anocracy, groups compete for power. In a closed anocracy, competitors are drawn from the elite. In an open anocracy, others compete too. (Cole 2011) finds that closed anocracies are more fragile. This implies that the results below are conservative.

of the energy sector for the Soviet Union and Yugoslavia.[4] In these countries, per capita income dived by 6.4% and 5.9% per year, respectively, for 9 and 8 years, respectively. At the same time, energy efficiency reverted too, by 1.4% and 1.3% per year, respectively. Energy efficiency changes for a number of reasons, including structural change in the economy, behavioural change by economic agents, and technological change in capital goods. I am not aware of a decomposition analysis to determine the relative sizes of these effects, and putting together a consistent data set would be hard. Carbon efficiency improved by 1.7% per year in the Soviet Union and by 2.7% in Yugoslavia. Carbon dioxide emissions therefore fell sharply in both countries.

Figure 3 shows the implications for China, assuming that country breaks-up in 2029, and that it falls midway between the Soviet Union and Yugoslavia. These are the best guess parameters. The pattern is by assumption: China's emissions grow according to a particular scenario – see Table A1 – until 2029, followed by a contraction of 9 years, after which growth is resumed. The numbers are large. In 2038, the first year after the crisis, emissions are less than half in the break-up scenario: 7.5 $GtCO_2$ versus 19 $GtCO_2$. This gap persists over time.

Figure 3 also shows the expected value of the emissions. Only two uncertainties are considered. First, the onset of the break-up is set by the emergence of an open anocracy. The polity2 is increasing over time, so I set the probability of the onset happening in a particular year equal to the polity2=3 in that year, according to the dynamic2 model of Table 1 and Figure 1.

The second uncertainty is the rate of emissions shrink. Figure 2 shows per capita income, energy intensity and carbon intensity for the former USSR and Yugoslavia. I use data for the 15 countries that emerged from the USSR and 6 of the 7 countries that emerged from Yugoslavia[5]. I use data on per capita emissions to account for the correlations between the three indicators. Per capita emissions fell on average by 6.8% per year, with a standard deviation of 3.4%.

These two uncertainties together form the expected value. The mean is higher than the mode. The reasons are as follows. There is a small possibility of faster emissions growth during a break-up. More importantly, in the base scenario, the growth rate of carbon dioxide emissions falls over time. The break-up is (assumed to be) independent of the baseline. Later break-ups are, therefore, less effective in reducing emissions than earlier break-ups. Break-ups shift the baseline, another reasons why earlier break-ups have a bigger impact.

Figure 4 shows the cumulative density functions of emissions in 2030, 2040, and 2050. The CDF consists of three components. The vertical line denotes the probability that no break-up will

[4] Data are from the World Bank http://data.worldbank.org/, BP http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481 and CDIAC http://cdiac.ornl.gov/trends/emis/meth_reg.html. Data for former countries follow from aggregation of the constituent countries. Data for not-yet-independent constituents follow from assuming that the growth rate of the aggregate holds for all constituents.

[5] There are hardly any data on Kosovo.

occur. The break-up date and the rate of emissions shrink are the other components. The uncertainty about the shrink rate is symmetric, and dominated by the uncertainty about the break-up date (see above). The result is a mix of smoothly increasing probabilities interspersed by steps – best visible in the CDF for 2050.

Figure 5 shows the baseline and the expected break-up emissions for five alternative scenarios: FUND (as above; see Table A1) and the four main SRES storylines: A1b, A2, B1 and B2 (Nakicenovic and Swart 2001;IMAGE Team 2001). In all five cases, there is a substantial gap between the emissions with and without break-up. In 2050, the highest of the break-up scenarios equals the lowest of the baseline scenarios. This underlines the importance of the assumption of peaceful development.

4. Discussion and conclusion

Scenarios of future carbon dioxide emissions are based on the implicit assumption of peaceful development. This assumption is not realistic. I investigate the implications of a democratization of China leading to a break-up like the ones of the USSR and Yugoslavia. While speculative, the break-up scenarios show a large reduction in carbon dioxide emissions. In the parameterization used here, a potential break-up of China dominates other scenario uncertainties up to 2050.

War and peace was found to be important in an earlier scenario study (Devitt and Tol 2012). This implies that we should start to include issues of state formation and violent conflict in a more systematic way in scenario analyses of climate change. This requires the development of predictive models, and research to develop confidence in such models.

The model used here makes four crucial assumptions, each of which is debatable. First, I assume that China will follow the historical path of other nations and grow more democratic as it grows richer. I do not consider the idiosyncrasies of China. I do not explore scenarios in which China remains autocratic and economic growth comes to a halt. Second, I assume that a break-up is likely to occur during the transition of a closed to an open anocracy. It could happen sooner, it could happen later. China's elite may seek an external enemy to unite the country, or China may peacefully evolve into a federal state or even a confederation. Third, I assume that a break-up of China would be like the break-up of the USSR and Yugoslavia. This is not implausible, but one can imagine both more benign scenarios (e.g., Czechoslovakia) and more malign ones (e.g., Ethiopia and Eritrea, Sudan and South Sudan). Fourth, I assume that a break-up of China has no implications for emissions elsewhere. It would be plausible to assume that a deep recession in China would cause recessions in other countries. However, the USSR was much less integrated in the world economy, so its demise cannot serve as an analogue. China's economic rise is too recent to estimate VAR (Vector-AutoRegression) models of growth spillovers between China and the rest of the world.

Therefore, the results shown here are speculative. The size of the findings is such that it is worthwhile to turn speculation into sound research.

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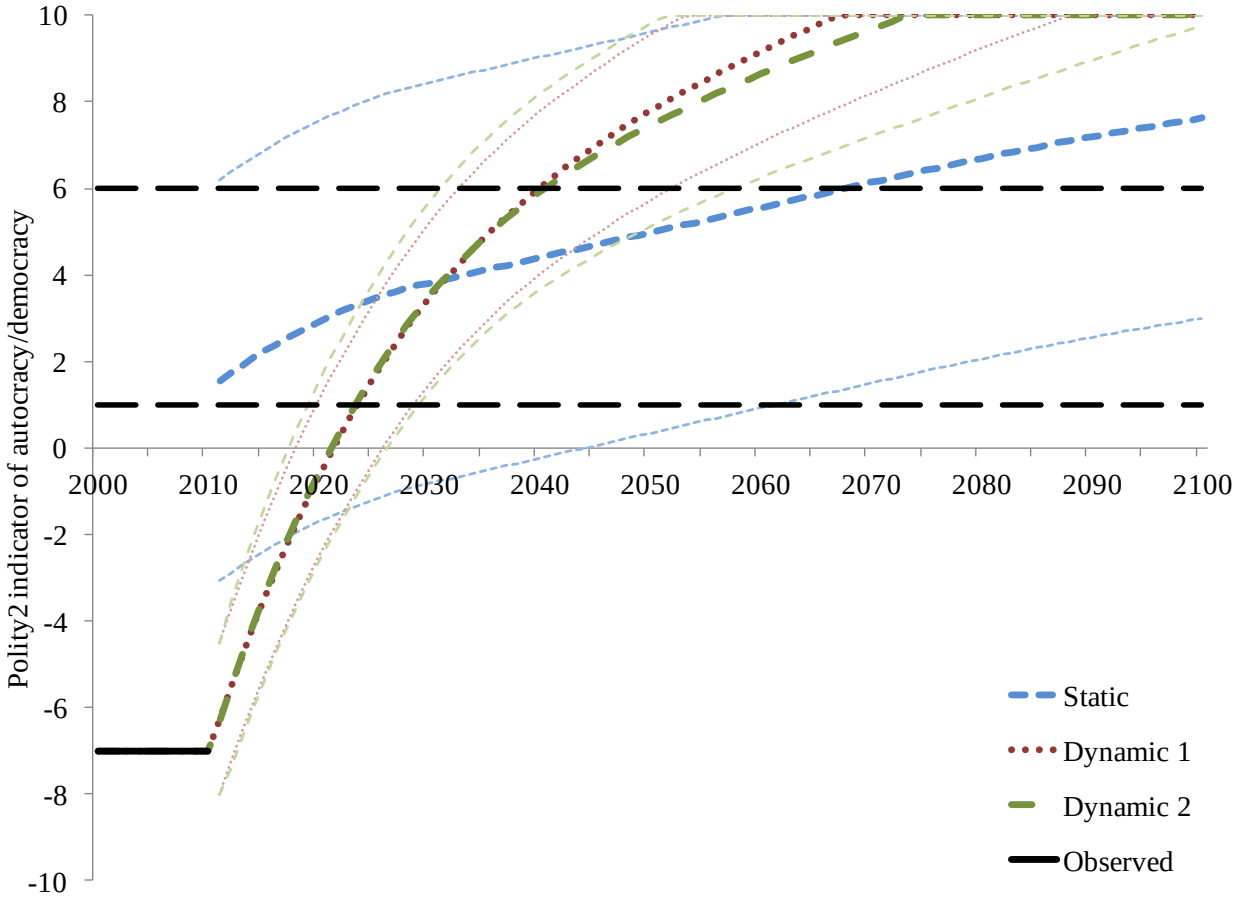
Table 1. Results for a fixed-effect panel data regression with polity2 as dependent variable.

	Static	Dynamic 1	Dynamic 2
Intercept	-14.5 (1.19) ***	-1.64 (0.47) ***	1.66 (0.48) ***
Ln(GDP/capita)	2.03 (0.16) ***	0.243 (0.063) ***	-0.889 (0.376) **
Ln(GDP/capita) (t-1)			1.14 (0.37) ***
Polity2 (t-1)		0.931 (0.005) ***	1.01 (0.01) ***
Polity2 (t-2)			-0.0819 (0.0124) ***
N	6898	6783	6625
S.E. of regression	4.63	1.75	1.74

Figure 1. Polity2 scores for China as observed and as predicted by the three alternative regression models of Table 1; thin lines denote the 67 confidence interval.



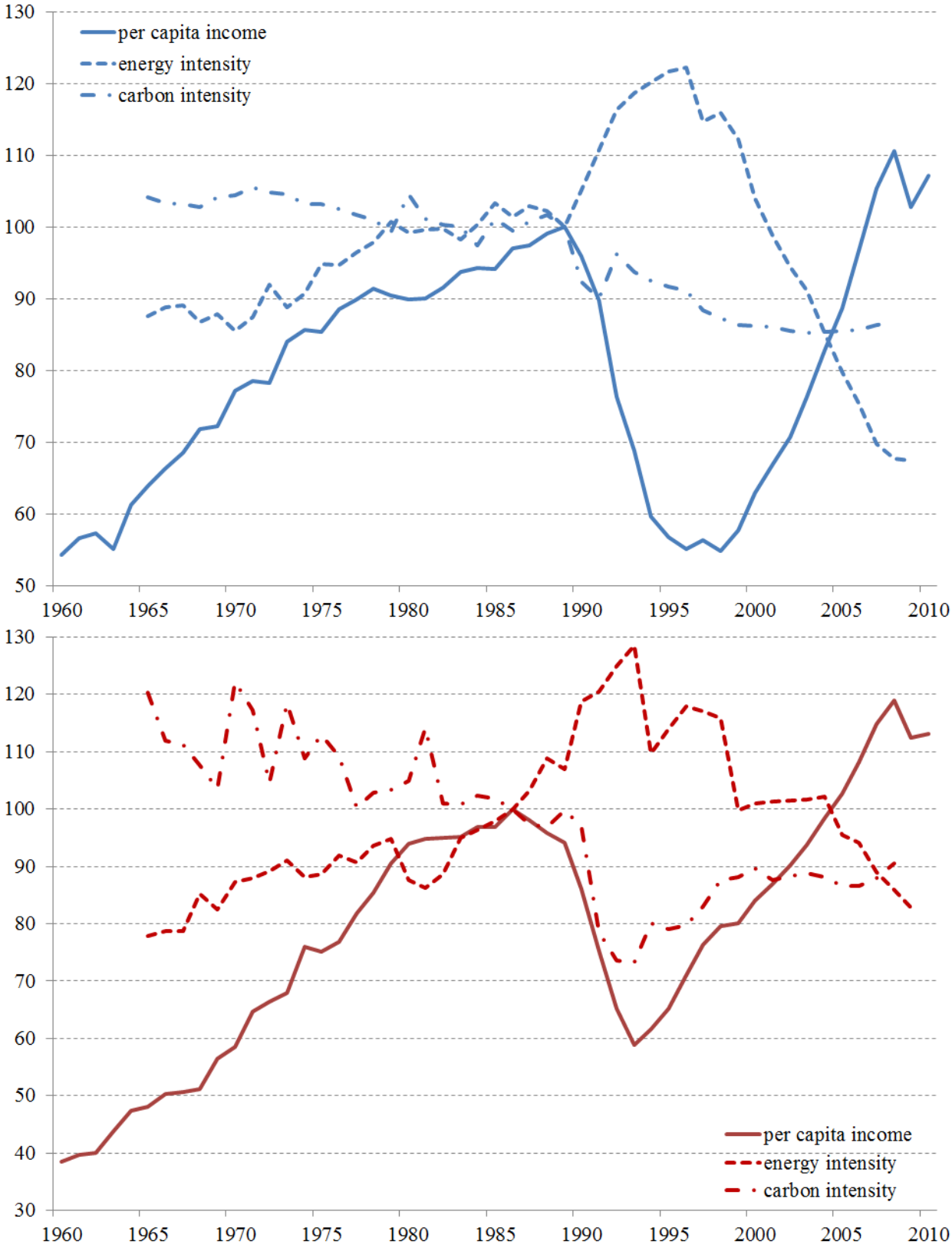


Figure 2. Per capita income, energy intensity and carbon intensity in the former USSR (top panel, 1989=100) and former Yugoslavia (bottom panel, 1986=100).

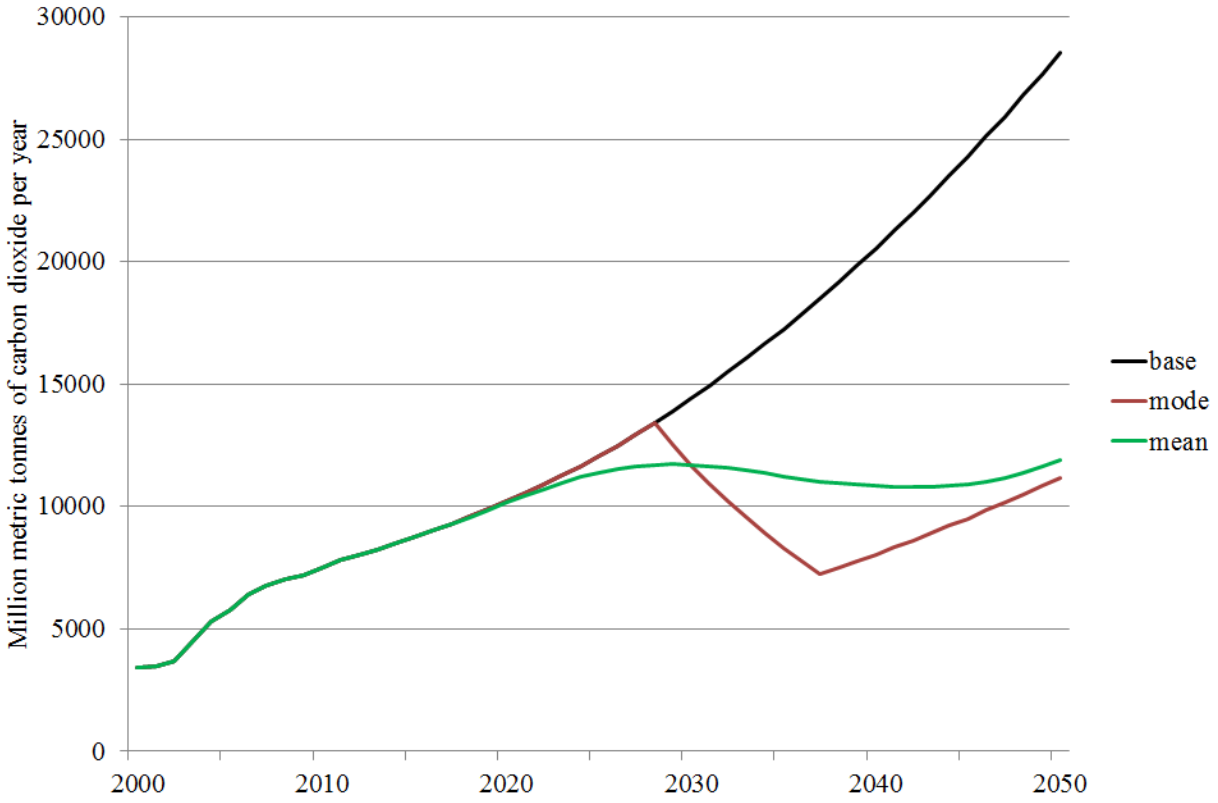


Figure 3. Carbon dioxide emissions from fossil fuel combustion in China as observed and as projected ; base = no break-up ; mode = break-up according to the best guess parameters ; mean = expected value of emissions with uncertainty about the parameters of the break-up model only.

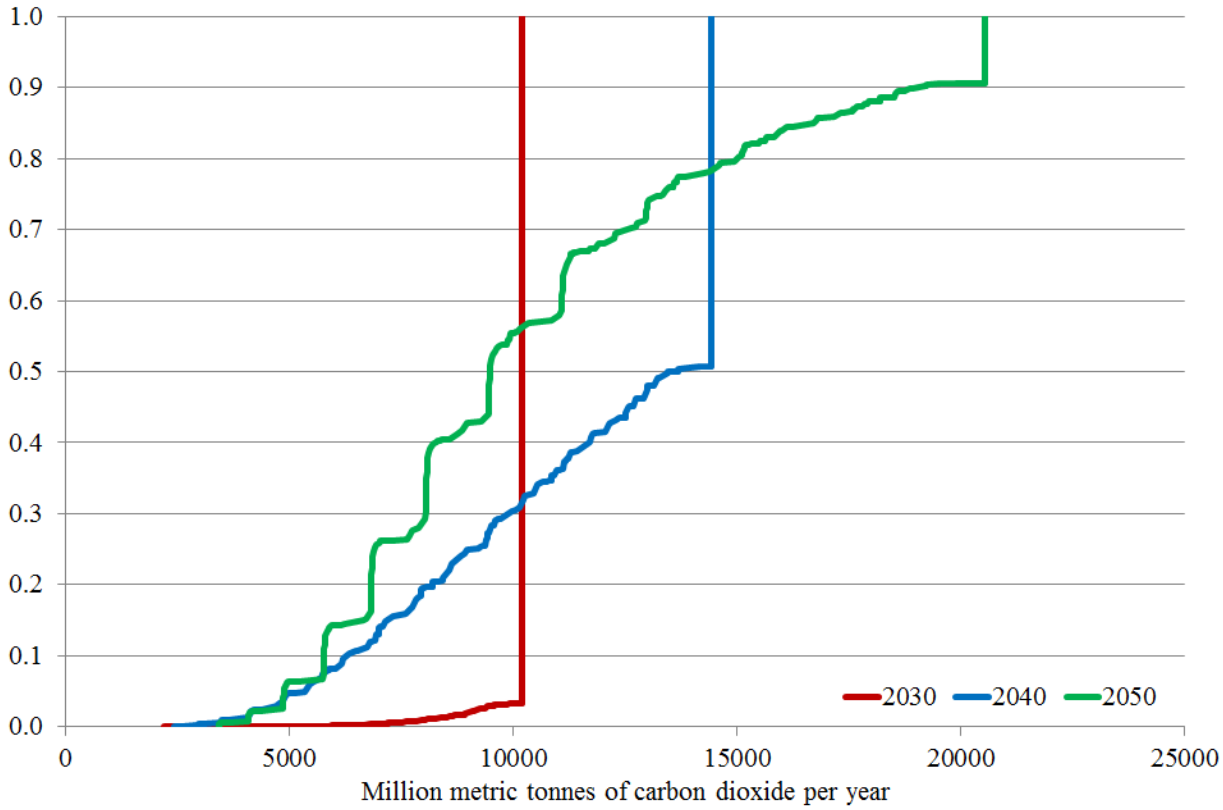


Figure 4. Cumulative density function of carbon dioxide emissions from fossil fuel combustion in China, with uncertainty about the parameters of the break-up model only.

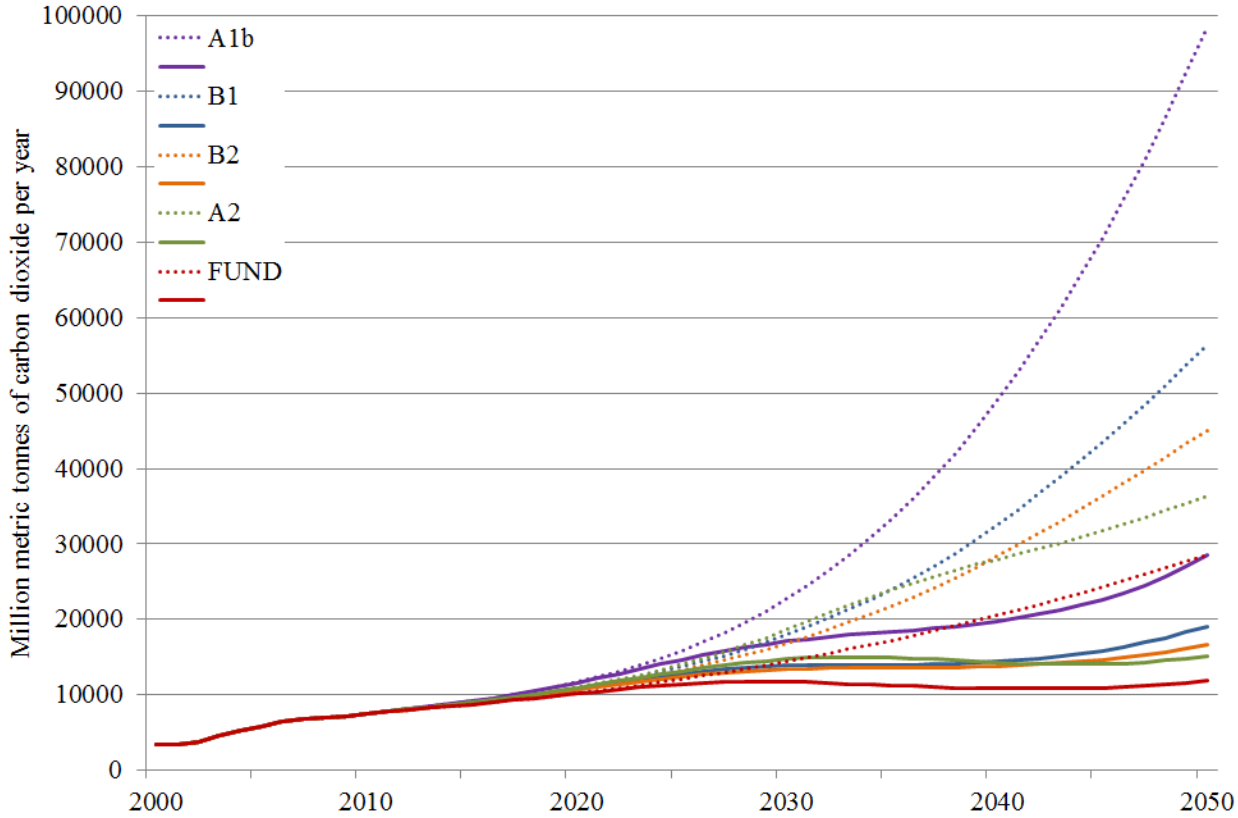


Figure 5. Carbon dioxide emissions from fossil fuel combustion in China as observed and as projected according to five alternative scenarios with and without break-up ; with break-up results are expected values of emissions with uncertainty about the parameters of the break-up model only.

APPENDIX: ADDITIONAL RESULTS

Table A1. Observed and assumed annual growth rates.

Year	Population	Per capita income	Primary energy efficiency	Carbon efficiency
2000	0.79%	7.5%	-7.0%	1.8%
2010	0.52%	9.8%	-2.2%	-3.6%
2020	0.39%	6.4%	-0.68%	-1.1%
2030	0.25%	2.9%	0.88%	0.25%
2040	0.25%	2.9%	0.84%	0.18%
2050	0.10%	2.9%	0.80%	0.10%