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Turning the carbon supertanker: Sectoral feasibility of climate change mitigation in China

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ABSTRACT

Whether China can slow the growth of emissions of greenhouse gases and ultimately reduce them has become a central question for climate mitigation. In previous research on India, we developed a theoretical framework to assess the structural characteristics of different sectors and identify which ones were most amenable to mitigation. In this article, we extend that approach to China and review the nine sectors responsible for most of the country's emissions. These include electricity (disaggregating renewables, nuclear, and coal), road transportation, four disaggregated industry sub-sectors (steel, cement, fertilizers, and oil refining), and buildings. We identify two sets of attributes, what we called political/organizational feasibility and techno-economic feasibility, that together shape the possibilities for emissions mitigation. Our central intuition is that fragmentation – on the government or market side or both – makes collective action more difficult. Cement, steel, and oil refining possess favorable characteristics on both political/organizational feasibility and techno-economic feasibility, while fertilizers and renewables pose the most difficult challenges on both dimensions. Buildings and road transport are mixed cases, where techno-economic feasibility is high while political/organizational dynamics are more challenging. Finally, coal and nuclear are mixed cases where political/organizational feasibility is high but techno-economic aspects are more challenging.

1. Introduction

In the mid-2000s, China became the world's largest emitter of greenhouse gases (GHGs). By 2015, China's share of global CO_2 emissions was 29%, nearly double those of the second largest emitter, the United States [1]. In 2015, countries, including China, committed in Paris to an ambitious set of commitments to reduce global GHGs. While these Nationally Determined Contributions were voluntary, the inclusion of developed and developing countries in the Paris Agreement broke the logjam that had bedeviled previous efforts like the Kyoto Protocol. Whether China can restrain the growth and ultimately reduce its emissions of greenhouse gases has become one if not the central question for climate mitigation going forward. The 2016 election of Donald Trump to the presidency of the United States and his subsequent repudiation of the Paris Agreement has elevated China's importance to mitigation efforts.

China's Paris commitment included a peak in CO_2 emissions around 2030; a significant reduction of CO_2 emissions per unit of GDP; an increase in the share of non-fossil energy; and an increase in forest stock volume [2]. While concerns about air pollution and efforts to rebalance the economy have reinforced the country's resolve to address climate change and will deliver climate co-benefits, whether China is capable of achieving these goals is uncertain.

Reaching these targets has implications for different sectors of the Chinese economy. Previous research focused on technology options and economic feasibility [3,4]. However, efforts to reduce greenhouse gases also hinge on political and organizational attributes of the Chinese system. GHG mitigation requires collective action by both governmental and market actors. Sectors, however, possess different structural features that may facilitate or impede collective action. While preferences are important, abstracting from what actors want reveals attributes of systems that may make it hard to achieve objectives or potentially facilitate emissions mitigation.

In our previous research on India, we developed a theoretical framework to assess the structural characteristics of different sectors of the economy and identify which ones were most amenable to climate mitigation [5]. We noted that this framework helps answers a number of foundational questions including what kinds of political systems facilitate energy transitions, governance processes that produce optimal outcomes in the energy space, and reconciling challenges of energy security and environmental protection [6].

We identified two sets of attributes that we called *political/*

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organizational feasibility and *techno-economic feasibility*, which together shape the possibilities for emissions mitigation. The former captures the degree of fragmentation in governance and markets while the latter captures the scope for and cost of efficiency gains and emissions reductions in a sector. Some sectors possess favorable characteristics on both, some face unfavorable conditions, while others are mixed cases (favorable on one dimension and not the other).

Our primary contribution is on the political/organizational side, where we code the prospects for collective action by government actors and market actors separately and then together. For the *techno-economic feasibility* assessment, we mostly rely on existing studies to evaluate each sector's distance from the best available technology on the market and the costs of bringing that sector up to global efficiency standards. Our research is based on a review of policy documents, including Chinese language sources and about 18 interviews with government officials, academics, think tanks, and international donors that were carried out in Beijing in September 2016 (see Appendix F in the Supplementary file for an anonymized list). We sought to interview diverse sources, cover all the major sectors, and fill in details about the policy process that could not be answered with the existing literature or data. While more interviews would undoubtedly be welcome, we have been as thorough and comprehensive as possible, given available resources.

2. Collective action, governance in China, and sectoral emissions

Our central intuition is that fragmentation − either on the government or market side or both − makes collective action more difficult through higher transaction costs of organizing and developing a coherent approach [7–10]. On the government side, fragmentation is defined as situations where many government actors − namely more than two − possess rule-making authority in a given sector. Fragmentation can involve divisions between administrative departments in the central government and/or shared rule-making authority between the central government and provincial/local governments. On the market side, fragmentation, as we operationalize below, reflects many market actors being responsible for production and emissions in a sector.

While this observation about the impediments to collective action from large groups is not new, we offer a synthetic account of the combination of political and market structures on the prospects for emissions mitigation. Collective action may still be possible in the face of either market or government fragmentation, but it will be more challenging and costly. Structurally, where one side is fragmented, collective action may be possible when the power distribution favors the concentrated side, what Stirling calls "asymmetric agency" [11].

Previous landmark studies of the policy process in China from the reform period of the late 1980s evoked the notion of "fragmented authoritarianism." Models of fragmented authoritarianism captured the diffusion of power away from the central state to provincial and local governments and private actors in a country still governed by a non-democratic system [12]. This approach depicted the "functional division of authority among various bureaucracies to produce a situation in which it is often necessary to achieve agreement among an array of bodies, where no single body has authority over the others" [13].

As Elizabeth Economy argued, fragmentation made collective action on the environment more challenging as local authorities faced contradictory signals from the central government and often privileged economic growth [14]. However, contemporary scholarship has suggested re-centralization of policy has occurred in some domains, motivated by the need for economic rebalancing and to control corruption [15]. The center's effort to claw back authority has seen stronger impetus under the leadership of President Xi. Recent studies suggest sectoral variation in re-centralization. While the Chinese state retains control over top-tier sectors such as state-owned enterprises in heavy industry, the state leaves more room for local and private sector actors in the middle-tiers (such as steel, automobiles, and alternative energy) and bottom-tiers (such as personal services) [16,pp.32–35].

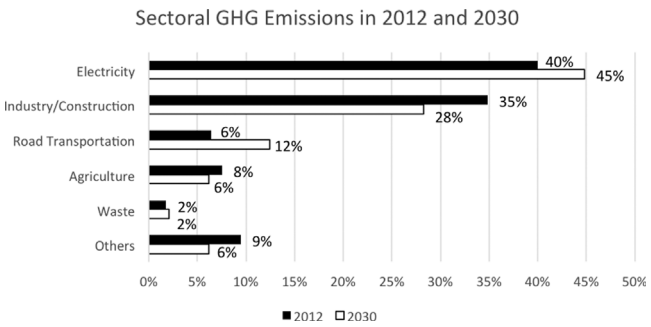

Fig. 1. Sector-wise breakdown of contributions to GHG emissions in China.
Source: 2012 data comes from CAIT; 2030 data comes from McKinsey & Company.

These observations suggest a single model of fragmentation or centralization is inadequate to capture the complexity of Chinese governance. We provide an empirically grounded and theoretically informed assessment of sectoral variation in governance in China. We include the nine most important sectors responsible for most of the country's emissions, both now and projected. The sectors include electricity (disaggregating coal, renewables, and nuclear), road transportation, four disaggregated industry sub-sectors (steel, cement, fertilizers, and oil refining), and buildings. These sectors were responsible for more than 70% of total GHG emissions in China in 2005 and their share of GHG emissions will increase to about 85% in 2030 [17] (see Fig. 1[1] and Appendix Table A1 in the Supplementary file for industry sub-sectors). While buildings is a demand-side sub-sector, it is an important sector in its own right, both as a source of direct emissions of GHGs as well as indirect emissions from its use of electricity.

Three sectors − cement, steel, and oil refining − possess favorable characteristics in terms of political/organizational and techno-economic feasibility. We find that fertilizers and renewables pose the most difficult challenge on both dimensions, though a determined Chinese state may be able to overcome these obstacles through government reorganization. Buildings and road transport are mixed cases, where techno-economic feasibility is high while political/organizational dynamics are more challenging. Finally, coal and nuclear are mixed cases where political/organizational feasibility is high but techno-economic aspects are more challenging (see Fig. 7's sectoral coding and Appendix E's in the Supplementary file disaggregated breakdown for each sub-dimension).

3. Coding rules

Our argument is based on political/organizational and techno-economic feasibility. Each has two sub-dimensions where we code high or low feasibility. This yields an overall two-by-two matrix and two nested sub-matrices. Fig. 2 displays our overall feasibility coding. Cell A shows hard cases where feasibility is low on both dimensions. Cell C includes the most feasible cases, where feasibility is high on both dimensions. Cells B and D are mixed cases that possess high feasibility on one dimension and low on another. Cell B has low political/organizational feasibility but high techno-economic feasibility while Cell D has low techno-economic feasibility but high political/organizational feasibility.

[1] We combined some sub-categories in order to match the 2030 data.