

# **Support for a Carbon Tax in China: A Collective Decision-Making Process Simulation Using the KAPSARC Toolkit for Behavioral Analysis**

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## **About KAPSARC**

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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# Key Points

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**C**hina, the world's largest emitter of carbon dioxide, is taking steps to combat the effects of climate change on its environment. The path it takes to mitigate the effects of pollution will have a significant impact on the global carbon reduction agenda. In this study, we focus on the political feasibility of implementing a carbon tax in China within the next five years. We do this using the KAPSARC Toolkit for Behavioral Analysis (KTAB) platform, a model of collective decision-making processes (CDMPs) developed at KAPSARC to assess the expected support in China for, and reactions to, this potential policy choice. Our key findings are as follows:

The majority of Chinese actors are expected to view as positive the application of a weak carbon tax. A tough, clearly articulated and enforceable carbon tax, however, does not appear to be politically feasible in the current Chinese context.

Large energy companies, particularly heavy carbon emitters, may oppose the principle of a carbon tax, but recognize the need to engage in the policy discussion to help shape any potential outcome.

Momentum behind a carbon tax in China is slow but steady. Even if energy companies have substantial political clout and are able to disrupt progress on a carbon tax, this would not be sufficient to derail the weak but growing consensus that favors some form of tax on carbon.

# Executive Summary

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**E**fforts by the Chinese government to reduce carbon dioxide (CO<sub>2</sub>) emissions are of great importance to both the population of the People's Republic of China and the rest of the world. As China is the largest emitter of CO<sub>2</sub> globally, both the precedent that could be set by taking aggressive action and the very real impact of lowering such emissions could represent important steps in advancing a carbon reduction agenda. There are a variety of policy options available to the Chinese government, but each has potential consequences that may vary by industry, geography and income. As a result, each policy option has a different configuration of stakeholders that may benefit or suffer.

The typical approach to policy analysis of a carbon tax or an emissions trading scheme (ETS) is to focus on its economic implications. However, this does not address the question of political feasibility. The economic implications seldom impact everyone in the same way – there will be winners and losers for most policy choices. The expected winners will tend to be the supporters of a policy, and the expected losers will often try to create obstacles that prevent a policy change, or implementation of a policy.

In this study, we focus on the political feasibility of implementing a carbon tax in China within the next five years. In doing so, we use the KAPSARC Toolkit for Behavioral Analysis (KTAB) platform, a model of collective decision-making processes (CDMPs) developed at KAPSARC, to assess the expected support for, and reactions to, this policy choice. The feasibility of this policy, based on this methodological approach and taking this

perspective, is directly related to the expected reaction of constituents and interest groups that will be impacted by a policy change. Our goal is to analyze the value proposition for each stakeholder group – in terms of the model and the actors – and evaluate how they might interact based on their own cost benefit analyses of a carbon tax; and assess the potential for areas of mutual agreement among the specified decision makers and their constituent supporters.

The KTAB model allows the user to simulate the interactions of decision makers and their constituents. Such a simulation allows for the evaluation of the political feasibility of reaching consensus, as well as the type of consensus that is possible. In this paper we simulated the CDMP to assess the appetite for a carbon tax in China. Based on data from subject matter experts, we found that key members of the Politburo Standing Committee (PBSC) modestly support the concept of a carbon tax, but that a broad debate about the form and structure is ongoing. Central and provincial governments are seen as strong advocates for a tax on carbon. However, unsurprisingly, industry, energy companies and major carbon emitters are opposed to the tax.

Our KTAB simulation of the CDMP identifies the possibility of a loose consensus for a modest carbon tax, which implies that any mechanism or implementation of a tax will be similarly modest. Consequently, we find that, within our chosen timeframe, it is not politically feasible to adopt and implement a stringent carbon tax policy in the current Chinese political context.

# Introduction

China is the world's largest consumer of energy. It consumed 2.98 billion metric tons of oil equivalent (TOE) in 2014. In 2015, the country's energy consumption grew by a meagre 1.5 percent, yet China still represents about 23 percent of global energy consumption and 34 percent of net global energy growth. China is also the world's largest emitter of carbon dioxide (CO<sub>2</sub>) – it produces 25 percent of the world's emissions of this greenhouse gas (GHG). Figure 1 shows CO<sub>2</sub> emissions for the world's top five CO<sub>2</sub> emitting countries. It is clear that since 2001 China is one of the leading sources of emissions, both in absolute terms and in the rate of growth, among this group of countries.

Visitors to and residents of heavy industrialized Chinese cities can easily see the smog effect on the skyline. The main domestic political pressure is focused on air quality, which poses an immediate health threat, rather than on the longer-term impacts of GHG emissions. On December 8, 2015, the city of Beijing encountered its first red alert for air pollution – schools were closed and construction work was halted. According to the U.S. Embassy's air pollution monitor in Beijing, the intensity of the particulate matter (PM) concentration at 2.5 microns was 291 micrograms per cubic meter on that day. A maximum of 25 micrograms per cubic meter is the level recommended by the World Health Organization.

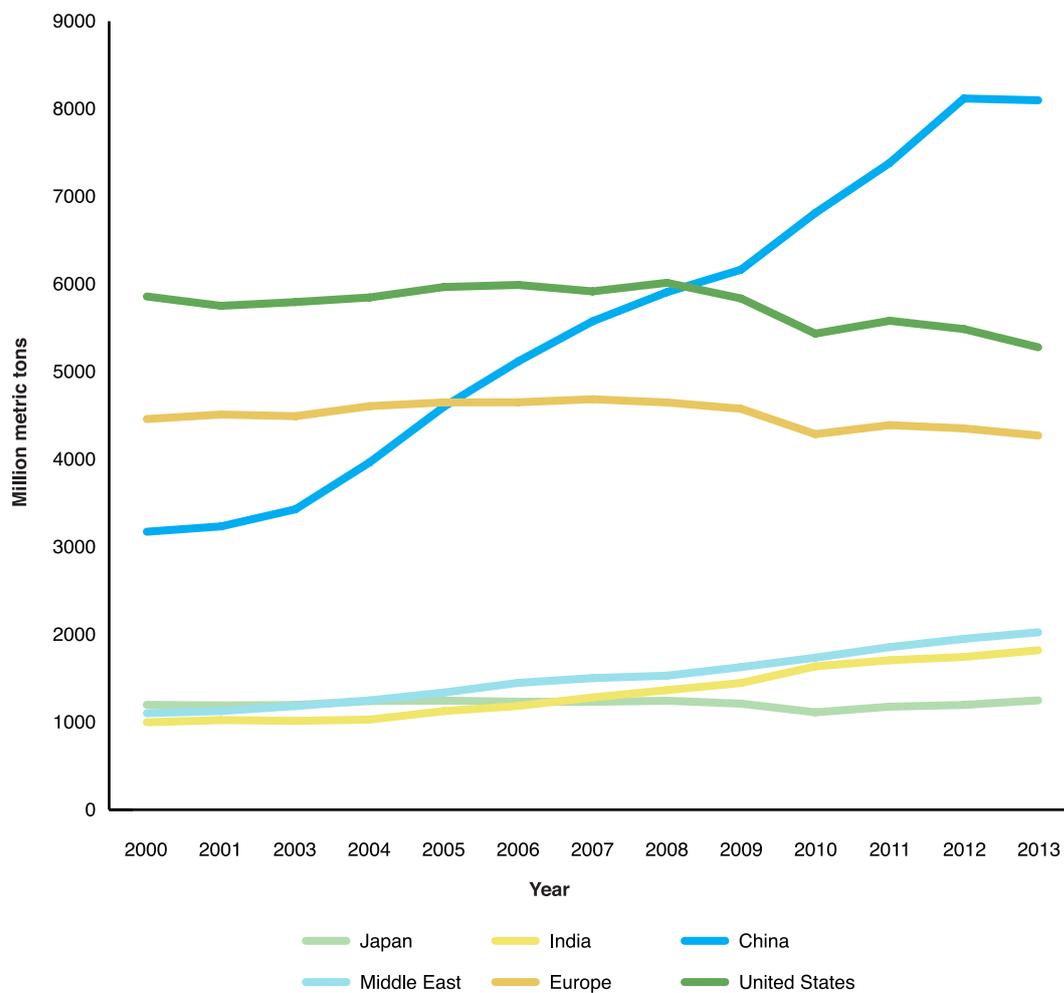


Figure 1. Total CO<sub>2</sub> emission from the consumption of energy.

Source: EIA's International Energy Statistics.

## Introduction

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The Chinese government is aware of the gravity of the issue, particularly as a result of increasing world pressure to focus on carbon reduction, most recently in the COP21 and COP22 meetings. As a result, China has taken an active role in international discussions on CO<sub>2</sub> reduction. After COP15 in 2009 in Copenhagen, China announced its intention to reach a 40 to 45 percent reduction in the production of emissions by 2020. The country renewed its commitment during President Barack Obama's visit to China in 2014. In the Sino-U.S. Joint Statement on Climate Change, Washington pledged to reduce its carbon dioxide emissions by 26 to 28 percent by 2050 based on 2005 output, while Beijing committed to peak carbon emissions by 2030 so as to lower CO<sub>2</sub> emissions per unit of gross domestic product by 60 to 65 percent from 2005 levels.

## China's current energy and climate policies

The Chinese government has undertaken many efforts to address climate change and continues to set out policies to meet its international pledges and domestic targets. The 12th Five-Year Plan (FYP) issued in 2010 is considered a milestone for China's climate change policy. The plan included numerous binding energy and climate targets that were set to be achieved by 2015. These targets include an increase of China's forest coverage to 21.66 percent, a reduction in energy intensity by 16 percent, a reduction in CO<sub>2</sub> emissions intensity by 17 percent and increased use of non-fossil fuels in the primary energy mix to 11.4 percent.

Two of the above targets were included for the first time in China's top economic and social development plan: a reduction in the level of carbon emissions and the addition of non-fossil fuel to the energy mix. In addition, the government has committed to reaching 20 percent non-fossil fuel consumption by 2030.

A recent paper published by the World Resources Institute (WRI) assessed these targets in 2015 and revealed that the country is close to achieving and exceeding those planned targets. In 2013, the forest coverage was 21.63 percent (2015 target set to 21.66 percent) and non-fossil fuel consumption was 11.2 percent in 2014 (2015 target set to 11.4 percent). In addition, coal production and consumption fell significantly for the first time in 14 years.

In response to the worst air pollution crisis faced by the country, nine Chinese provinces adopted a cap on coal consumption in 2013. Moving forward, to direct and monitor the country's climate and energy efforts, the Chinese government announced the National Climate Change Plan and the Energy Development Strategic Action Plan in 2014. In the same year, China also announced its plans to peak CO<sub>2</sub> emissions no later than 2030, as well as to increase the percentage of non-fossil energy consumption to 20 percent by 2030.

In June 2015, Premier Li Keqiang claimed that the country had reduced its energy intensity and CO<sub>2</sub> emissions production in 2014 by 29.9 percent and 33.8 percent, respectively. In addition, China put forward two new targets to be achieved by 2030 compared to 2005 levels: a reduction of 60 to 65 percent in carbon intensity and growing the forest carbon stock volume by approximately 4.5 billion cubic meters.

China has announced an emissions trading scheme (ETS) to achieve its GHG emissions targets. This was introduced in the 12th FYP, which initiated seven pilot projects in Beijing, Shanghai, Tianjin, Chongqing and Shenzhen, Guangdong and Hubei Provinces in 2013. It is planned that this cap-and-trade scheme will be rolled out nationwide in 2017, making it the world's largest. The nationwide system is intended to be effective in 2017 (though there are no concrete plans to execute a nationwide ETS in 2017 at time

of publication of this paper), covering six industries including power, nonferrous metals, iron and steel, cement, paper and chemicals, civil aviation industry and alternative energy vehicles. Setting market prices and putting a price on carbon is a key element to achieving success.

## Future policies and carbon tax

The 13th FYP for 2016-2020 prioritizes the environment and puts an emphasis on ‘Green Development’. It envisions China contributing to global efforts on climate change as well as advancing green technologies. With the recent election of President Trump in the U.S., Chinese President Xi Jinping has staked out a position as the world’s leader on climate change. The 13th FYP includes a number of quantitative targets and policies to reduce CO<sub>2</sub> emissions, promote energy efficiency, increase resource conservation and limit pollution.

Although China’s ETS flagship policy received a lot of support, a carbon tax policy option was also much discussed over the last few years. China’s National Plan for Addressing Climate Change clearly addressed the need to study carbon tax policies. If a carbon tax was to be implemented, then it would fall under the purview of the Ministry of Finance (MOF), while an ETS is the responsibility of the National Development and Reform Commission (NDRC).

There is no carbon tax in China at present, even though studies conducted by leading research centers and think tanks for various Chinese ministries, as well as international cooperative efforts such as the Tsinghua-MIT joint program, have shown that a carbon tax is simpler and perhaps more effective than an ETS. This naturally prompts the question; why does China favor an ETS over a carbon tax?

The typical approach to any policy analysis of a carbon tax or an ETS is to focus on its economic implications and on how best to implement it. However, this does not address the political feasibility of a carbon tax policy, based on the reaction of stakeholders to the impact on their perceived interests. The economic implications will seldom impact everyone in the same way – there will be winners and losers for most policy choices. The expected winners will tend to be the supporters of a policy, and the expected losers will often try to create obstacles that prevent agreement on a policy change, or implementation of a policy. The criteria various stakeholders use to assess the value of winning and losing are based on what they themselves value and on the other considerations that impact their livelihood and priorities.

In this paper we focus on this second, but often unasked, political feasibility question. Government, industrial, social and other stakeholders will all have some view on the efficacy of a carbon tax policy, which informs what we can realistically expect to be agreed. In considering this, we apply a modeling framework that has been developed at KAPSARC to assess collective decision-making processes (CDMPs), and which is known as the KAPSARC Toolkit for Behavioral Analysis (KTAB). For a more detailed description of KTAB, CDMPs and the specific model utilized in this paper, please refer to Wise, Lester and Efird (2015a and 2015b).

Our goal is to analyze the value proposition for each stakeholder group – in the terms of the model, the actors – and evaluate how they might interact based on their own cost benefit analyses of a carbon tax; and assess the potential for areas of mutual agreement among the specified decision makers and their constituent supporters.

# The KAPSARC Toolkit for Behavioral Analysis

**K**TAB is a platform that enables the modeling and analysis of CDMPs. CDMPs can be distinguished from other decision-making processes in that:

They involve more than one actor, be it an individual, institution, or identifiable group or 'bloc'.

A single decision is arrived at as a result of some form of coordinated interaction between a finite set of actors.

The form of this interaction is different in kind to large group decision-making processes such as the market based derivation of a price, which is the result of the uncoordinated actions of countless individuals.

In this paper we will present an analysis of plausible outcomes for the collective decision-making processes that China may currently be engaged in regarding the imposition of a national carbon tax. To do so, we used KTAB to construct a particular model of CDMPs, based on the Spatial Model of Politics (SMP), which we explain below.

Although the results we present are based on a single model, KTAB is a toolkit that enables almost limitless variant models to be implemented, based on different assumptions as to how various CDMPs work. Any and all of the assumptions in this paper can be changed, and new models built through KTAB can test the consequences of these changes.

For this paper we have deliberately chosen to focus on the logic of the analysis and to present a description of the results. What this paper does not contain is a detailed technical description of the underlying model and its calculations. Interested readers are pointed to two related KAPSARC papers for more detail:

An Introduction to the KAPSARC Toolkit for Behavioral Analysis (KTAB) Using One-Dimensional Spatial Models.

Multidimensional Bargaining using KTAB.

Both papers are available from KAPSARC's website, specifically the KTAB portal, as is the program's source code and documentation. Please visit <http://ktab.kapsarc.org> for all related papers, and <http://kapsarc.github.io/KTAB/> for the software.

By separating the technical detail from this applied analysis, we hope to make the discussion more accessible for what is a relatively new field to most readers.

## Approach and assumptions

When analyzing CDMPs, one way to show the preferences of, and differences of opinion between, the various actors is to represent them graphically using a technique referred to as spatial preferences. This approach forms the basis for a model we have implemented in KTAB called the Spatial Model of Politics (SMP). We apply the SMP to the question of a Chinese carbon tax. The SMP is one of the most widely applied and accepted models of CDMPs, both technically and informally. Even outside the field of political science, everyday language is imbued with the implicit assumptions of this model. Political parties may be described as right or left wing; less spatially explicit, we also tend to imply a linear spectrum when describing individuals – or groups, such as political parties – as conservative or liberal, aggressive or passive. Commentators and analysts will often try to uncover the positions held by politicians or other highly placed officials.

For more information on the SMP we again refer readers to the two technical papers cited above. However, a brief description of the logic follows here.

The SMP uses the following terms:

**The Set of Actors.** This comprises all the stakeholders that contribute to the resolution of the CDMP in some way. They can be individuals or aggregates of individuals. Aggregates can be formal, such as a corporation, or informal, such as loose affiliations based on interests, for example young men sharing a love of fast cars. The constraint is that it must be possible to reasonably assume that each actor is a unitary entity, speaking with a single voice.

The following framework can be used to understand the range of viable outcomes rather than to narrow them down to a single ‘most likely’ or expected outcome.

**A Spectrum of Positions.** This is a way of mapping out the possible range of responses and positions actors could give/take to a given question in the form of a linear continuum of possible positions. The extreme ends of the spectrum are associated with extreme positions. In the question of private participation, one end could be ‘extremely limited private sector participation’, the other ‘a policy environment that is open and conducive to private participation.’ These extremes are then labeled as 0 and 100, converting a qualitative spectrum into a numeric one, where each position is given its own score.

The spectrum is a scale where distance measures the change in consequences for the actors: the gap between positions corresponds to the difference in outcome. An implicit assumption is that all actors roughly agree on the order of potential costs implied by the spectrum. The potential cost of moving from position 25 to position 50 would be of roughly the same magnitude as that involved in moving from 50 to 75. In other words, the spectrum requires reasonable calibration.

**The Set of Positions.** With identified actors and a defined spectrum of positions, the position (i.e., the advocacy) of each actor can then be mapped to the spectrum with a number between 0 and 100.

**Measures of Influence.** Not all actors are equally powerful. Influence measures how easily the actor can shape the outcome of the CDMP, if fully motivated. It does not describe how likely the actor's preferred position is to win, nor is it a measure of the actor's motivation to win. It is the actor's clout, or political power, as applied to the question, as z powers.

Influence scores are relative: an influence score of 60 means that an actor is twice as influential as one with a score of 30. Influence scores are also additive: two actors in coalition, each with influence 30, could block an actor with influence 60. The combination of relativity and additivity can make influence the most cumbersome score to collect. Each actor's score needs to be calibrated against that of all the other actors.

Again, influence is scored against a range of 0 to 100. Strictly speaking, if an actor is assigned an influence score of 0 then it would have no power and would not be counted as an actor.

**Measures of Salience.** Regardless of an actor's position and level of influence, different actors will have different levels of interest in the question. Salience quantifies how much an actor cares about the issue in general. How motivated are actors to exert influence to produce their preferred outcome, if and when the issue arises? One way to answer this question is based on the observation that each actor has a portfolio of issues to which it devotes its attention. Salience identifies the importance of the specific issue in that portfolio, recognizing that people have an implicit budget constraint on exerting their influence across their whole portfolio. The salience scores are defined in Table 1 and range from 0 to 100.

**Table 1.** Definition of Saliency Scores.

| Score    | Definition  |
|----------|---|
| 0 – 10   | The actor hardly cares and may not be aware of the issue                                      |
| 10 – 20  | The issue is minor, but the actor is aware of it  |
| 20 – 40  | The issue is one of many issues for this actor  |
| 40 – 60  | The issue is among the top 3 or 4 for this actor  |
| 60 – 80  | The issue is the most important for this actor but there are still others that need attention |
| 80 – 100 | The issue is that actor’s top priority  |

Source: Wise, Lester, and Efirid 2015a.

The saliency score is not the amount of time that an actor will devote to the negotiations but rather its willingness to use whatever influence it has to convince others of the merits of its own preferred position. The saliency score does not represent an actor’s influence, merely its motivation when the issue arises.

Once again, saliency scores are relative among actors. As with influence, a saliency score of 0 would indicate that the actor does not care about the issue, and that it should not be counted as an actor.

**The Calculation of Exercised Power.** This is a derived value, calculated in the model. As previously described, influence is an indication of the actor’s political clout on the particular issue, if fully motivated, while saliency indicates how much the actor actually cares about the issue. Exercised power is a product of these two values and reflects the amount of influence an actor can be expected to apply in support of its position on this issue – using the following equation:

$$\text{Exercised Power} = \text{Influence} * (\text{Saliency} / 100)$$

Note that influence, saliency and exercised power all map the actor’s attitudes toward the overall issue as defined in the question, not individual alternative solutions to the question.

## Model dynamics: turns in the KTAB SMP

KTAB’s SMP provides a simulation of how actor positions change over time. Time is captured in a series of iterations or ‘turns.’ The exact length of time a turn takes is an abstraction: a turn should be thought of as any period of time during which all actors can exchange information and attempt to influence each other. In the examples in this paper, the SMP simulation is run for five turns. (There is a complicated and unresolved debate on how many turns are appropriate for a model like the SMP to run, the details of which are beyond the scope of this paper.) The results of the simulation present the turn-by-turn changes to actors’ positions. These shifts in position are based on several different factors in the model, all operating simultaneously. Generally, the behavior of individual actors can vary quite widely based on the configuration of numeric values in a particular dataset. There is no such thing as a ‘rule of thumb’ regarding how the simulation unfolds. Sometimes actors will move only incrementally as the turns progress, sometimes they may make much larger moves in the simulation. What follows is a brief, non-technical, description of the logic behind the simulation.

There are two stages within each turn of the simulation.

The simulation begins at the end of Turn 0. At the end of each turn, actors generate a series of proposals and counterproposals, ‘voting’ – i.e., lending their influence in support of, not literally taking a sequence of polls – on each until a winning outcome is reached. Actors produce proposals that improve the likelihood of achieving an outcome that is closest to their preferred outcome, while also trying to appeal to others – based on their perspective – until a ‘winning’ position can emerge. The final outcome of the CDMP is not necessarily one with which all actors agree: weak actors might be overruled by strong ones. The probable winning position for each turn can be described through a probability curve.

During the proposal and counterproposal process between each turn, actors can seek to persuade others to shift their position, with the inducement that this may improve the chances of achieving a generally accepted position that is closer to their preferred outcome. These shifts may change the likely outcome of the CDMP. Such attempts at persuasion may or may not succeed: the weaker actors may simply concede, counter with an offer to make limited concessions, or even make their own attempt at persuasion. The changes that are calculated by the SMP to be selected by each actor create a new set of actor positions, on which the proposal process described in the first stage is restarted from this new set of positions. Note that while the initial input data defines the positions in Turn 0, remaining turns are calculated strictly based on the SMP’s assessment of actor interactions.

This second stage can be thought of as containing two distinct phases.

In the first phase, each actor tries to find some other actor to be a counterparty for effective persuasion. If any attractive counterparties are identified – there may be more than one, just one or none at all, for any potential initiator – then the initiator will focus its efforts to exert influence on the target most attractive to it. Weaker actors may be targeted by multiple initiators; stronger actors may not be targeted at all. The actual shift in position made by a counterparty is determined by a calculation that considers the interactions among the entire set of actors.

In the second phase, the assessment of how the counterparty responds may vary slightly as it is based on its perceptions and evaluation of alternative outcomes. The combination of what the initiator chooses to do, and how the counterparty will respond, results in an ‘objective’ calculation of the reaction. Consequently, the objective results of the second phase can differ from the subjective estimates of the first phase.

There are many calculated interactions that lead to a high degree of complexity in the set of potential results that can emerge from each turn. For example, what drives an actor to compromise is not only its view of the options available, but also its assessment of the likelihood of various options ‘winning.’ It is possible to imagine an actor might compromise to lend support to a position that is not its most-favored outcome in order to defeat what it considers an even less desirable option. However, using this model, a detailed narrative can emerge for an individual actor’s behavior in each simulation, itself a source of potential insight generated by the SMP.

In this paper we will focus on the high level outcomes calculated by the KTAB simulation, while trying to provide some explanation for the numeric calculations that result in the most interesting shifts in actor positions.

# Analysis of Support for a Carbon Tax

## Defining the question

This KTAB study addresses the question: what is the level of support for a national carbon tax in China within five years? To analyze this question, we start by defining the spectrum of positions as shown in Figure 2 below. The spectrum reflects the range of positions that actors in this simulation might take. Unlike other SMP studies, the spectrum here does not reflect a series of concrete alternatives, admixtures of policy options, but rather the range of support for, or opposition to, a carbon reform tax. Our intent at this point is not to evaluate the specifics that might be included in a carbon tax, but to assess the political environment and actors' views about whether any sort of carbon tax is a viable option. From this, we can draw inferences about what a carbon tax in China might actually look like, but we first want to assess whether it is even a possibility.

In terms of definition, actors that take a position close to 50 are indifferent to the notion of a carbon tax. Actors taking a position of 0, at the far left of the figure, are extremely opposed to the idea, and actors at a position of 100 at the far right of the figure are unambiguously supportive of a carbon tax. Positions ranging from 50 to 0 reflect

increasing opposition, and positions ranging from 50-100 reflect increasing support.

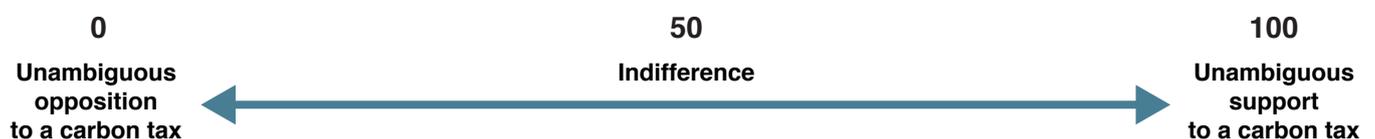
## The KTAB SMP data inputs

In order to collect data for this study, we interviewed 12 experts from Beijing and Shanghai who are knowledgeable about the key players that have the ability to influence the decision to introduce a national carbon tax in China. As with any KTAB study, we identified a comprehensive list of actors, including policymakers and influencers, and gathered three specific quantitative attributes for each actor. Specifically, this included each actor's:

**Position:** the location of an actor on the linear spectrum. In other words, what is its advocacy with respect to support for or opposition to a carbon tax?

**Influence:** the relative degree of political power for each actor. The most powerful actor is assigned a value of 100 and others are weighted relative to the most powerful actor.

**Salience:** the relative priority each actor assigns to the idea of a carbon tax policy as compared with other issues over which it must exert influence.



**Figure 2.** Spectrum of positions.

Note: Illustration shows the desire to have a carbon tax in China within the next five years as described through a range of positions. The actors can adopt any position along the scale of 0 to 100.

We aggregate the data collected during the expert interviews into a single dataset, which we call our baseline dataset. When there are differences of opinion about the assignment of values, particularly for key stakeholders, we make note of this to perform sensitivity analysis. We present our baseline dataset in Table 2. This represents our best guess as to the data, using the collective knowledge of the actors

from our 12 interview subjects to assign the values for position, influence and salience. From these last two properties we calculated the exercised power.

The expert based data for the policy options described above is represented in Table 2. This table presents the cumulative position, influence and salience from all experts in addition to their calculated exercised power.

**Table 2.** Expert-based data regarding support for or opposition to applying a carbon tax in China

| Actor   | Legend | Group                               | Position | Influence | Salience | Exercised Power |
|---|--------|-------------------------------------|----------|-----------|----------|-----------------|
| <b>Academics</b>  | ACD    | Advisors                            | 55       | 15        | 34       | 5               |
| <b>Car companies</b>  | CRC    | Producer of carbon emissions        | 23       | 34        | 35       | 12              |
| <b>Central Bank</b>   | CTB    | Central government                  | 50       | 17        | 10       | 2               |
| <b>China Energy Conservation and Environmental Protection Group</b> | ECE    | Advisors                            | 30       | 26        | 20       | 5               |
| <b>China National Petroleum Corporation (CNPC)</b>                  | CNP    | Producer of carbon emissions        | 18       | 26        | 27       | 7               |
| <b>Environmental NGOs</b>   | ENGO   | Advisors                            | 82       | 11        | 66       | 7               |
| <b>Energy Research Institute (ERI)</b>                              | ERI    | Advisors                            | 66       | 23        | 54       | 13              |
| <b>Heavy industry</b>   | HI     | Producer of carbon emissions        | 12       | 24        | 19       | 5               |
| <b>Li Keqiang</b>   | LK     | Politburo Standing Committee (PBSC) | 63       | 62        | 42       | 26              |
| <b>Liu He</b>   | LH     | Central government                  | 60       | 36        | 50       | 18              |
| <b>Media</b>  | MDI    | Advisors                            | 61       | 22        | 24       | 5               |
| <b>Ministry of Environmental Protection</b>                         | MEP    | Central government                  | 80       | 42        | 66       | 27              |
| <b>Ministry of Foreign Affairs</b>                                  | MFA    | Central government                  | 66       | 19        | 23       | 5               |
| <b>Ministry of Finance</b>  | MOF    | Central government                  | 72       | 39        | 40       | 16              |
| <b>National Experts' Committee on Climate Change</b>                | NCC    | Advisors                            | 86       | 23        | 62       | 14              |
| <b>National Development and Reform Commission (NDRC)</b>            | NDR    | Central government                  | 61       | 47        | 53       | 25              |
| <b>National Energy Administration (NEA)</b>                         | NEA    | Central government                  | 51       | 37        | 45       | 17              |
| <b>Other large energy companies</b>                                 | LEC    | Producer of carbon emissions        | 11       | 23        | 39       | 9               |
| <b>Power generating companies</b>                                   | PGC    | Producer of carbon emissions        | 28       | 29        | 35       | 10              |
| <b>Provincial governments (with resources)</b>                      | PGR    | Provincial government               | 12       | 30        | 40       | 12              |
| <b>Provincial governments (without resources)</b>                   | PGW    | Provincial government               | 63       | 34        | 34       | 12              |

## Analysis of Support for a Carbon Tax

|   |     |                                     |    |     |    |    |
|---|-----|-------------------------------------|----|-----|----|----|
| Public  | PUP | Advisors                            | 65 | 5   | 55 | 3  |
| Related international NGOs  | INO | Advisors                            | 68 | 9   | 40 | 4  |
| State-owned Assets Supervision and Administration Commission of the State Council (SASAC) | SAS | Central government                  | 30 | 29  | 21 | 6  |
| Shandong  | SD  | Provincial government               | 48 | 43  | 30 | 13 |
| Shanghai  | SHG | Provincial government               | 78 | 47  | 60 | 28 |
| Shenhua   | SHH | Producer of carbon emissions        | 11 | 19  | 60 | 12 |
| Sinopec   | SPC | Producer of carbon emissions        | 17 | 22  | 57 | 13 |
| Small-medium industry   | SMI | Producer of carbon emissions        | 23 | 11  | 30 | 3  |
| State Council   | SC  | Central government                  | 40 | 46  | 20 | 9  |
| State Tax Administration  | STA | Central government                  | 74 | 29  | 46 | 13 |
| Xi Jinping  | XJ  | Politburo Standing Committee (PBSC) | 63 | 100 | 34 | 34 |
| Xie Zhenhua (Vice chairman of NDRC)   | XZ  | Central government                  | 40 | 22  | 35 | 8  |
| Zhang Gaoli   | ZG  | Politburo Standing Committee (PBSC) | 55 | 10  | 55 | 6  |

Source: KAPSARC and SASS expert interviews.

With these data, we can simulate the collective decision-making process between and among the actors in this study. That is, we can simulate how the actors interact with, and influence, each other over time, to arrive at an ‘outcome’ for the issue. This reflects a model based view of the expected outcome for the actors’ collective support for – or opposition to – a national carbon tax in China.

The KTAB module used in this paper is the Spatial Model of Politics (SMP). More information about the SMP can be found in Wise, Lester and Efirid (2015a, 2015b).

## Simulation results

The KTAB SMP simulation provides a view on the changing positions of actors over time, as discussed

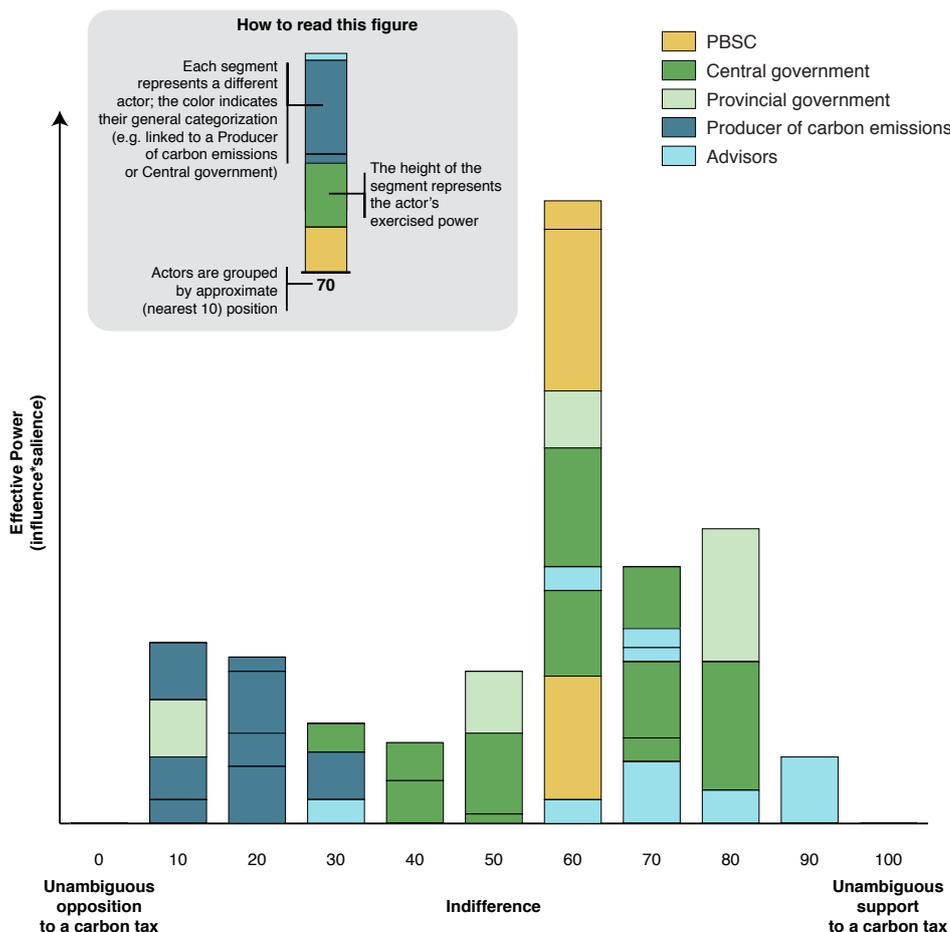
previously in the paper. Time is measured by the model as a series of turns. In this paper, we include two forms of graphical display for the KTAB simulation results: a pair of bar charts (Figures 3 and 4), which include Turn 0 and Turn 5; and a Sankey diagram (Figure 5) that displays the dynamics of the shifts in stakeholder positions over time.

Figures 3 and 4 are bar charts that display the distribution of the actors’ positions over the position spectrum in Turn 0 and Turn 5, respectively. As noted previously, the Turn 0 values are not generated by the KTAB model. They reflect the data collected from the group of experts before any model calculations. Turn 5, in this case, is the final turn in the simulation, so it represents the final position of each actor, after KTAB has calculated the CDMP over five iterations.

Each actor is represented as a segment of a bar on this figure. The location of the bars on the horizontal axis indicates the position that they take. For simplicity, when actors take roughly the same position, they are stacked on top of one another and rounded to the nearest interval. The height of the bars represents exercised power. Exercised power is calculated by multiplying influence and salience, so that the influence applied to the actor's position is discounted by its salience. In other words, if an actor is both very influential and cares a lot about the question – i.e., has high salience – then this will be represented by a much larger bar than for an actor that has the same level of influence but low salience – i.e., cares less and applies less of its influence.

The different segments of the bars represent distinct actors, color coded to reflect groups of similar actors. For example, a Politburo Standing Committee (PBSC) member is colored red, while a producer of carbon emissions is in purple. The height of the different segments reflects the actor's exercised power, with the overall height of the bar showing the power in support of that position from the collection of actors that are advocating that position.

In Figure 3, the distribution of actors' positions, weighted by their exercised power, is dominated by one large cluster at position 60, with a spread of other, much smaller clusters of actors – which might be referred to as coalitions – distributed from positions ranging from 10 to 90.



**Figure 3.** Distribution of actors' positions and exercised power at Turn 0.

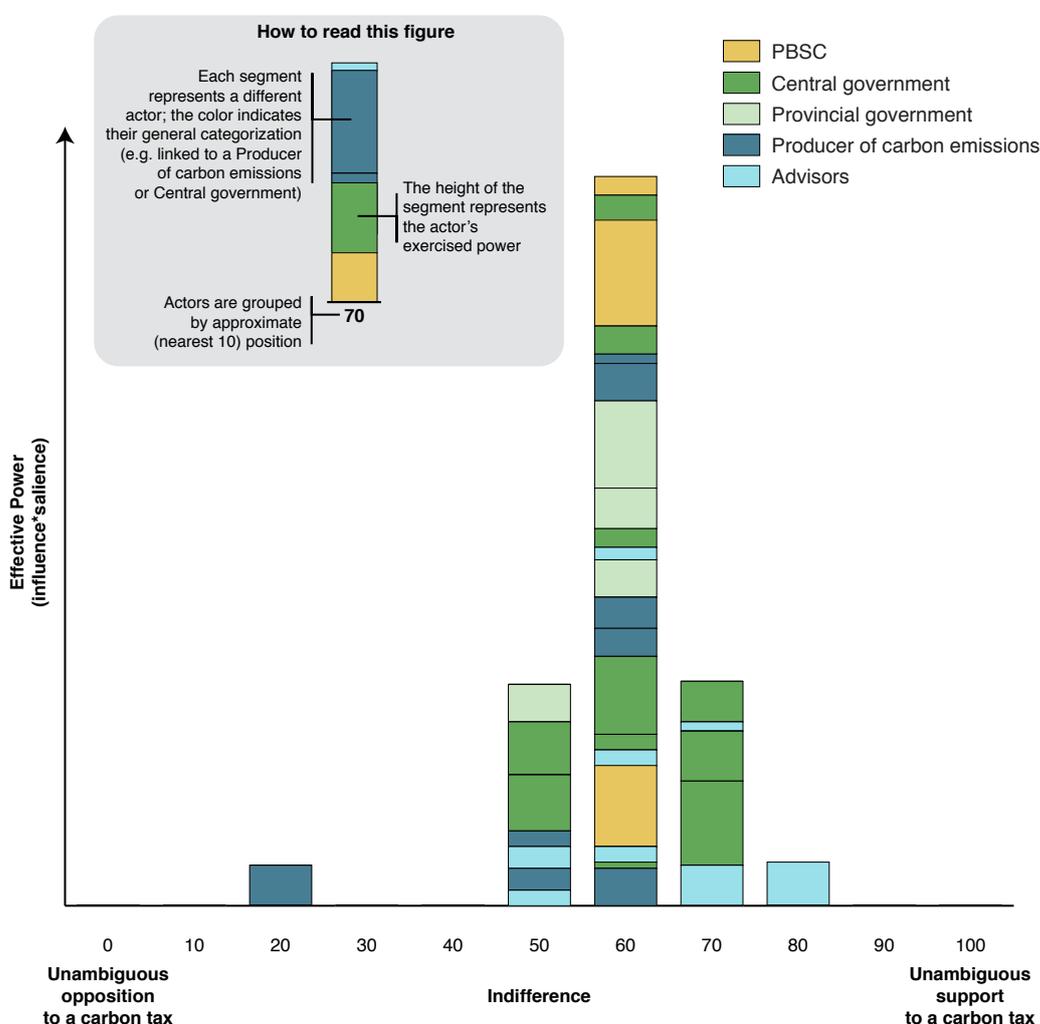
Source: KAPSARC analysis.

## Analysis of Support for a Carbon Tax

All three modeled members of the Politburo Standing Committee (PBSC, shaded yellow in the figure), Xi Jinping (XJ), Li Keqiang (LK) and Zhang Gaoli (ZG), take a position of 60, slightly in favor of the tax. Not surprisingly, the producer of carbon emissions, shaded blue, are skewed toward the left on this spectrum and comprise the bulk of the influence of the actors at positions 10-30. Central government actors, shaded green, generally take a more favorable view of the tax. This set of actors, at positions 60-80, is at, and to the right of, President Xi's position, which reflects mild support for a

carbon tax. The National Experts' Committee on Climate Change (NCC) actor adopts a position very supportive of the tax of 90, but its political clout (exercised power) is limited. President Xi has the most exercised power.

Figure 4 shows how the actors' positions have changed after five turns of simulated interaction. The SMP calculates that actors will settle on the new positions reflected in this figure. Again, for simplicity, actors whose positions are very similar are rounded to the nearest 10-point interval.



**Figure 4.** Distribution of actors' positions and exercised power at Turn 5.

Source: KAPSARC analysis.

The strength of President Xi's position – where all of the modeled PBSC members now cluster – along with a few more advocates in clusters of actors, suggest that there will be much more consensus in favor of a carbon tax after actors are allowed to negotiate with and influence each other. However, the consensus is weakly in favor of a carbon tax. We might infer from this that the result is, consequently, likely to be a weak carbon tax. If the bulk of influential actors strongly supported a carbon tax – i.e., assuming a position much closer to 100 – then they would probably be bolder in drawing up a law, so that it had clearer standards and enforcement mechanisms. With only weak support for a carbon tax, it is probably the case that they will not expend much effort in pushing through an all-encompassing and stringent carbon tax law. It is more likely to be a symbolic law than a tough one.

Two of the modeled representatives of the central government were, among the list of actors, assigned very high influence by our experts. The experts who provided the data for our analysis assessed the Ministry of Environmental Protection (MEP) and the National Development and Reform Commission (NDRC) as having an influence of 42 and 47, respectively. In the baseline dataset, the NDRC held a position of 60, and the simulation indicates that this is a position to which the Commission held firm over the course of five turns. Similarly, the MEP was given a position of 80, and it moved down slightly to a position of 70 in the final turn. This provides support for the idea that there is growing consensus around the position of 60.

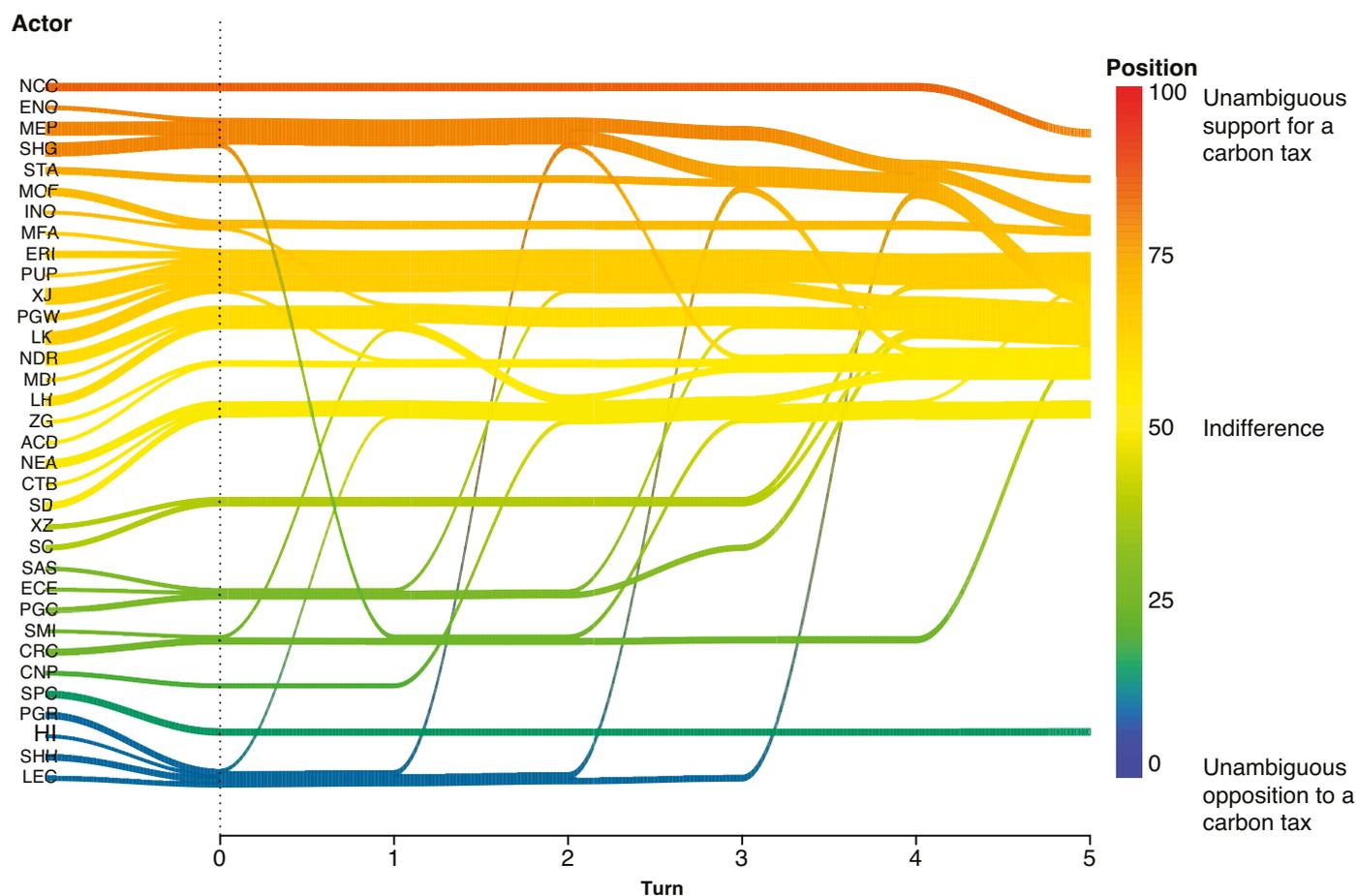
In addition, those actors that opposed a carbon tax in Figure 3 have almost all shifted to a position of 50 or more in Figure 4. Of those actors that took a position opposing a carbon tax in Turn 0, only Sinopec (SPC) remains opposed to a carbon tax at the end of the simulation. Others were willing to

express indifference or weak support for a carbon tax by the end of the simulation. As noted above, this is probably because they would rather see a weakly supported, and weakly constructed, carbon tax law than one with teeth and clear penalties that would lead to economic costs for their businesses. As the consensus emerging is weakly in favor of a carbon tax, implying a similarly weak carbon tax law, then it is better for these actors to be part of, and able to have input to, a solution than risk any consensus that might form in support of a stronger carbon tax.

Thus, from Figure 4 we can say at the conclusion of the simulation that there is weak support for a carbon tax in China, but there are also a variety of opposing views as to this outcome. As the PBSC comprise the primary advocates of a weak carbon tax, this seems to be the most likely outcome – though this outcome is not universally agreed upon.

We can also view actors' changing positions, as simulated by KTAB, in a more dynamic way. Figure 5 provides a visualization of these dynamics from Turn 0 through Turn 5. This illustration, known as a Sankey diagram, allows us to observe the simulation results of all actors in the dataset (identified in Table 2) as they shift their positions from one turn to the next. Turn 0 reflects the initial condition – data collected from experts – as also shown in Figure 3. The remaining turns are simulated results from the KTAB SMP module. When an actor shifts a position from one turn to the next, it has been influenced by some other actor to adjust its position, i.e., through advocacy, because it sees a change in position as in its best interest. Actors are balancing their desire to achieve their preferred outcome against building consensus for an outcome – a position on the spectrum – that is close to their preferred outcome. As such, simulated changes in position capture the give-and-take that happens during a negotiation process.

## Analysis of Support for a Carbon Tax



**Figure 5.** Simulated changes in actor positions by turn regarding support for a carbon tax.

Source: KAPSARC analysis.

The range of positions from 0 to 100 is shown on a color gradient, ranging from blue to green to yellow to red, as shown in the key on the right hand side of the figure. The vertical axis loosely corresponds to the color gradient in terms of spatial distance for positions, but the color shading is a more precise indication of the positional location of actors.

This figure clusters actors that hold the same position, after rounding position to the nearest 5, into a single weighted line, the thickness of which reflects the exercised power – the combination of the collective influence and salience – of actors holding that position in a particular turn or turns.

Individual actors are marked on the left hand side of the figure with a short naming legend consistent with Table 2.

The diagram allows the reader to track the changing levels of support for particular positions as the CDMP simulation is run for five turns. The color of lines shows the position being advocated while the thickness of each line denotes the weight of the influence, i.e., the support. The legend translates the color of the line into numerical and qualitative policy descriptions. Where two lines merge, one actor is now advocating the same

position as another. Where lines split, a particular position is losing the support of a particular actor. The simulation leads to a narrowed range of positions. These are the plausible outcomes of the CDMP. More detail on the intuition of the progression of turns in the SMP simulation is provided earlier in this paper, in the “Approach and assumptions” section.

Four rough groupings of actors are apparent in Turn 0. These are:

- A clusters of actors in the orange gradient, roughly covering a position of 80.

- Two closely proximate clusters of actors in the light orange to slightly lighter orange gradient, roughly covering positions of 60-70.

- A cluster of actors in the yellow gradient covering a position of 50.

- Another two closely proximate clusters in the blue to dark green gradient, roughly covering positions 10-20.

President Xi Jinping (XJ in the figure) anchors the second clusters of actors, along with Premier Li Keqiang (LK). Shanghai province (SHG) and the Ministry of Environmental Protection (MEP) anchor the top cluster of actors, the National Energy Administration (NEA) anchors the third cluster and Shenhua (SHH), together with Sinopec (SPC), anchors the lowest cluster.

Consistent with Figure 4, by Turn 5 the majority of actors have converged on a narrowed range along the position spectrum. The vast majority of positions and exercised power are shaded yellow-to-orange, indicating that most of the powerful actors support a position greater than 50, i.e.,

they are in favor of some form of carbon tax. The simulation results are not sufficiently nuanced to provide the exact reasons for the rise and fall of coalitions, but it can be instructive to explain the individual movement of a few actors to give a sense of the underlying dynamics.

Both large energy companies (LEC) and Shenhua (SHH) changed their position during the simulation, starting at a position of 11 and ending at a position of 60. This prompts the question, why would major carbon emissions producers shift from strongly opposing a carbon tax to weakly supporting the implementation of a carbon tax?

One way to interpret this shift is as follows: A rough consensus seems to be emerging in favor of a carbon tax around the position of 60. Indeed, the members of the Politburo Standing Committee all support this position at the end of the simulation. However, this is a relatively weak support for a carbon tax, given the range of positions that actors could take. We can infer from this that the kind of carbon tax that would be implemented with support of around position 60 will probably not be one with clearly enforceable standards that would have a substantive impact. Such a tax would more likely emerge if actors converge on positions closer to 90-100. Thus, a carbon tax with this kind of support (around 60) would probably be weaker in its language and enforcement clauses. Carbon producers would rather be seen as part of the solution, particularly if that solution is not a threat to their business, as a relatively undemanding carbon tax would be. It is better, from their perspective, to be part of the coalition that supports a carbon tax, so long as it is not likely to be very costly for their business or other interests, and so to be seen as a part of the solution rather than as opposing something that is inevitable.

Another interesting shift in position is observed at the upper end of the scale: the environmental nongovernmental organization (ENGO) shifted to a lower position after only one turn. In the simulation, the ENGO goes through a dramatic shift from being one of the most extreme advocates of the carbon tax to a relatively strong opponent. This may reflect dissatisfaction with the kind of carbon tax it observes being proposed. If only a weak carbon tax law is weakly supported by decision makers, then strong advocates of a carbon tax might oppose this potential outcome, hoping that a tougher carbon tax might still emerge. In the end, this actor shifts to a more neutral position – indicating that it sees something as better than nothing, even if this is not its ideal outcome.

As the simulation progresses, the set of actors that mildly advocates for the carbon tax, closer to a position of 60, consolidates in its range of positions. The actors in the least supportive cluster, starting around position 10-20, adjust their advocacy of the tax upward as the simulation progresses, and by the final turn support a position very close to the President Xi-led grouping. Overall, the simulation indicates an emerging consensus that weakly favors a carbon tax in China. The KTAB simulation results thus suggest that such an outcome is politically feasible.

### Sensitivity analysis

The KTAB simulation depends on a set of data provided by interviews with subject matter experts. The intent of the modeling is to provide insights into a complex decision-making process. The results in the previous section are the logical conclusion of the expert values assigned, according to the mathematical composition of the SMP model in KTAB. However, given that certain actors are generally believed to play a disproportionate role

in the policymaking process, it is often instructive to assess the impact of variations in the expert-assigned data. Such sensitivity analysis allows us to see how robust the initial results are, subject to different assumptions about the actors' position, influence or salience.

Furthermore, SMP-style data capture a set of singular numeric values for each actor. This represents a specific moment in time, even though the 'moment' may in fact endure with some half-life. In reality, the influence of actors changes over longer periods of time as their roles, responsibilities and power base change, as the result of any number of factors. The salience they assign to any one question will also change, based on what else is happening globally. Even their position may change, with enough churn around their world and with the passage of time, based on purely exogenous factors.

In other words, the data collected for SMP are a snapshot in time. In order to simulate outcomes, we have to assume that no fundamental and drastic changes to the actors' descriptive parameters are likely because of some external or exogenous source of causality. Small changes to the political landscape are not likely to alter these parameters meaningfully. The fluidity of daily events does not fundamentally affect the priority of issues for an actor or modify its political power base. However, with enough time and shocks to the system, the data will certainly change.

In this paper we have attempted to mitigate the impact of exogenous changes on the analysis by performing sensitivity analyses (considering alternative scenarios, or starting parameters) on the positions of the most critical actors in the data set. This analysis is by no means exhaustive, and

thus the outcomes of the simulations should be treated with appropriate caution.

In this section, we construct a series of scenarios to evaluate the analytic differences that would result from variation in data input. In particular, we allow the influence of the NDRC and Shenhua Energy Company to vary over a range between 1 and 100. The NDRC is the central planning authority for the Chinese government and Shenhua is the largest coal mining company in China. Both could be viewed as critical actors in this simulation, either supporting or opposing the introduction of a carbon tax. In this section, we will present the results of a sensitivity analysis, where we assess how the overall simulation performs if either of these two specified actors is assumed to be less influential, if either of the actors has more power, or anywhere in between. Figures 6 and 7 display the range of simulation results with these varied assumptions for the NDRC's and Shenhua's initial influence.

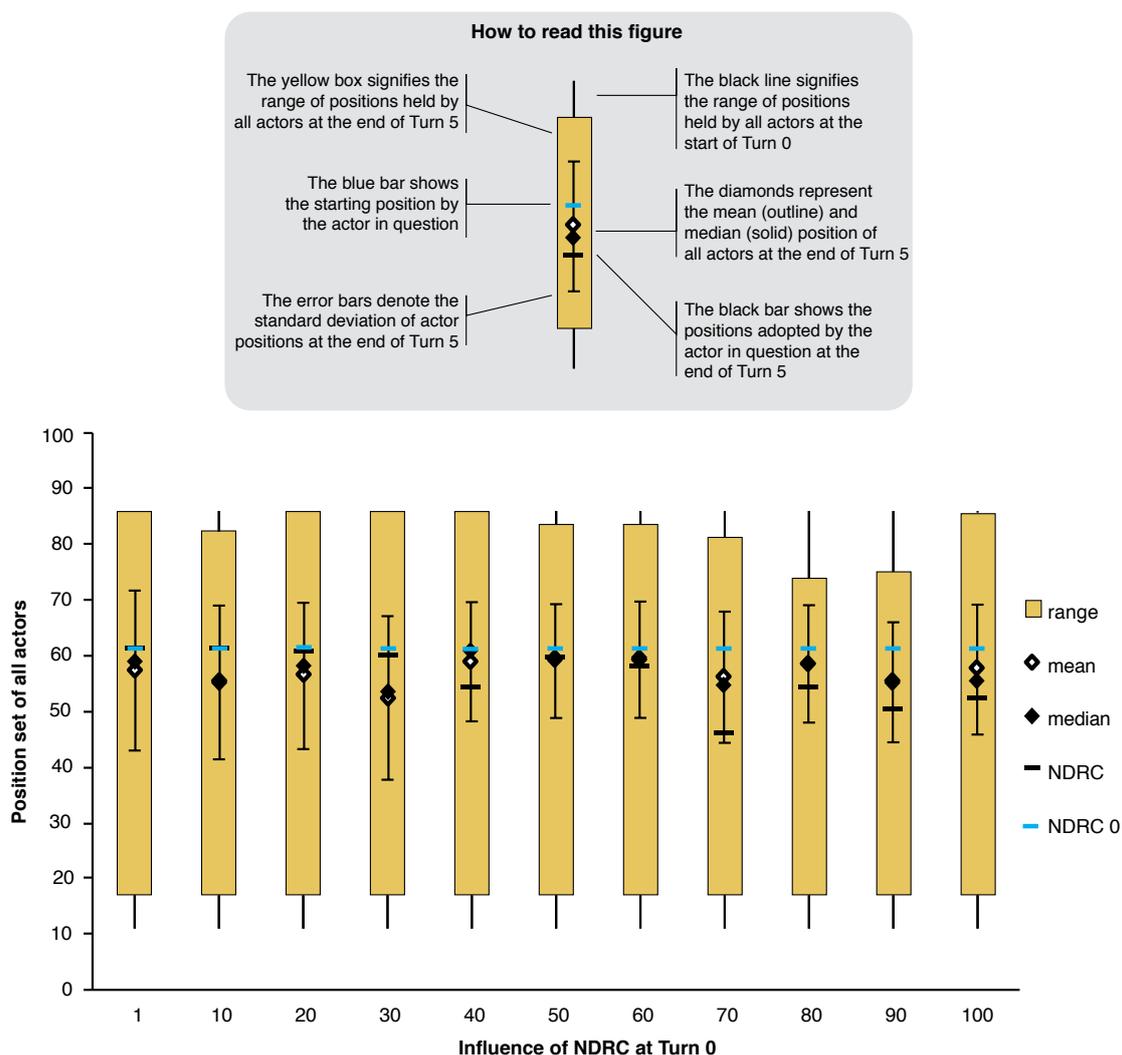
For each actor, 11 simulations were completed, with five turns each, holding constant the starting position for each of these two actors but varying the influence of one actor from 1 to 100 in 10 point intervals. Figure 6 presents the results for varying the influence of the NDRC, whereas Figure 7 presents the results for varying the influence of Shenhua.

Each of these two figures displays five pieces of information for Turn 5 of each of the respective simulations. The black bar mark indicates the actors' position at the end of the fifth turn of the

simulation. The blue bar shows the actor's starting position at Turn 0. The black, solid diamond indicates the median position of all the actors, i.e., that position which has an equal distribution of exercised power on each side of it. The outline diamond indicates the mean position of all the actors, while the error bars show the standard deviation. Finally, the red block indicates the range, from low to high, of positions for all actors in Turn 5 of the simulation. Each of the 11 simulations is displayed from left to right, with the actor's initial (Turn 0) influence increasing by 10 points along the x-axis. The thin blue lines show the range of positions for all actors at Turn 0.

Figure 6 reveals an interesting shift in the NDRC's final Turn 5 position. Again, this is based only on varying its influence for that particular simulation. When NDRC is assigned an influence score of 60 and more, its Turn 5 position ends up lower on the scale, ranging from 45-55. Even when the NDRC is assigned the highest potential influence, a score of 100, it completes the simulation with a view of indifference to the imposition of a carbon tax in China. In other words, as the NDRC is treated as an increasingly more influential actor, its final advocacy shifts from moderately favoring a carbon tax (a position of 60) to one of indifference toward a carbon tax (a position of 50). This reinforces the notion that any carbon tax will be weakly implemented, at best. Consequently, even if the NDRC is more powerful than estimated by our experts, this does not imply a stronger construction of the carbon tax law. If anything, it may be a weaker law than we anticipate.

## Analysis of Support for a Carbon Tax



**Figure 6.** Sensitivity analysis to vary the influence of NDRC.

Source: KAPSARC analysis.

On the other hand, what if one of the largest opponents of a carbon tax law, Shenhua Energy Company, is assigned a higher influence? Figure 7 presents the results of varying this company's influence from 1-100 in 10 point intervals, keeping all other data constant.

The results from these simulations indicate that an increasingly powerful Shenhua will not appreciably impact overall support for a carbon tax, but a more powerful Shenhua will find itself continuing to oppose the carbon tax at the end of the simulation. When Shenhua is assigned very low influence – e.g., in

the 1-10 range – then it acquiesces to the pressure imposed by supporters of a carbon tax. However, when its influence is greater than 10, it retains a position that strongly opposes a carbon tax. Note, however, that its opposition to the carbon tax in these other scenarios does not change the overall set of conclusions from the simulated negotiations. In other words, a more powerful Shenhua is likely to abstain from supporting a carbon tax, but even a very powerful Shenhua does not undermine the overall political feasibility of aligning support for a carbon tax among the majority of actors.

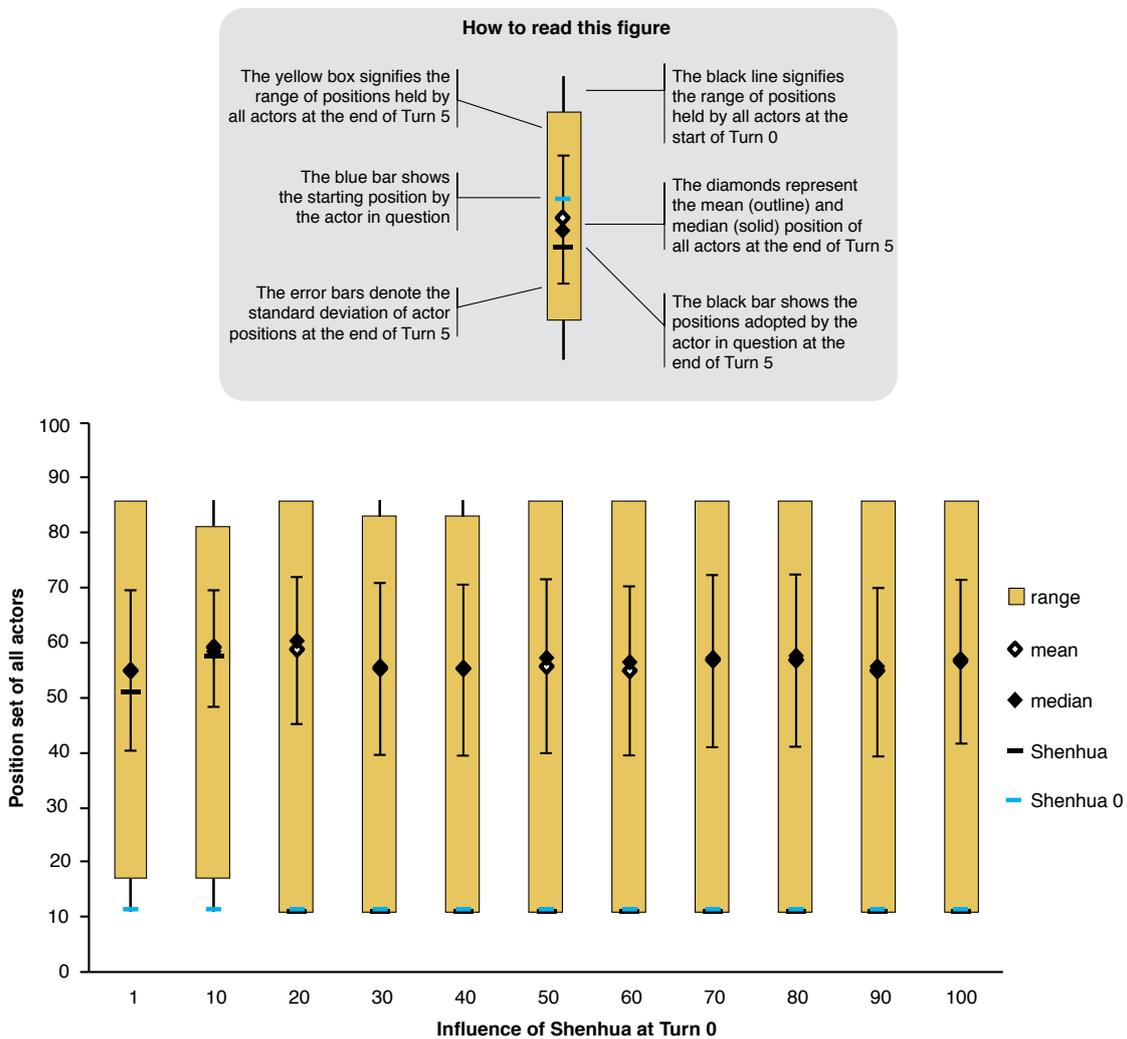


Figure 7. Sensitivity analysis to vary the influence of shenhua.

Source: KAPSARC analysis.

## Limitations in interpreting KTAB output

Beyond those already mentioned that were involved in the input data, it is important to note a few caveats that will help put the strengths and limitations of KTAB output into perspective.

In this case, we are focusing on simulation results that were derived using the SMP. This is a modeling approach with a good track record,

but it is ultimately still a simplification of the world captured in a mathematical structure. This ensures that logically consistent results flow from the variety of inputs we provide, assuming the mathematics are correct, but it does not result in a perfect prediction capability. Rather, with no comments on the accuracy of the input data, we use KTAB as a tool to facilitate discussion about the plausible alternative outcomes suggested by a CDMP that is based on the insights of experts who are knowledgeable about Chinese carbon tax.

This prompts a question about the process used to construct models. In a scientific approach that attempts to validate models against empirical data, the KTAB framework faces several challenges. Nevertheless, the theories underpinning KTAB have been used successfully in the past and we are working to mitigate the risks that emerge from validation issues in order to build greater confidence in KTAB simulations, both our own and those of users outside KAPSARC.

First, for the SMP simulations, a perfect validation process would replicate the position data over time *ex ante*, and check the turn-by-turn output of the simulation against the empirical data *ex post*. Given the difficulty in generating data for a single baseline dataset, this approach would quickly become overly cumbersome and impractical. KAPSARC is exploring several methods to automate or semi-automate the data collection process through natural language processing techniques. If a computational approach could rapidly collect data, then a validation exercise would be feasible. However, this process remains at an early stage.

An alternative approach to validation might identify an ‘outcome’ that can be inferred from the simulation results. The outcome would need to be concrete and observable, with some degree of specificity. This outcome would be shared *ex ante*, and then compared with actual observed events *ex post*. There have been thousands of initiatives by researchers in the commercial, government and academic communities to validate models like SMP using this approach. The main challenge is that both the judgment of a simulation modeled outcome, as well as the observed outcome, are often the products of a subjective interpretation. This interpretative element introduces bias and can easily be skewed – though not necessarily on purpose – to produce false positives, which reinforce the belief that the model is valid. That said, it can be a useful exercise to gain confidence in these types of models. KAPSARC is using KTAB models to identify plausible outcomes, not iron-clad predictions. Gaining some confidence that the simulation results ‘seem right’ and having some level of validity reinforces the notion of plausibility in this approach.

# Conclusion

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China has committed to meeting 20 percent of its energy consumption from non-fossil energy by 2030. However, for China as well as other major emitters of CO<sub>2</sub>, the pathway to agreeing a set of policies to reduce carbon dioxide emissions is particularly lengthy because climate change is more than an economic and environmental concern. There is a political bargaining dimension that must be addressed within the domestic political context.

Accordingly, we conducted a CDMP study by using our KTAB model to assess the appetite for a carbon tax in China. Our initial analysis based on expert input suggested weak support for a carbon tax among the modeled members of the Politburo Standing Committee (PBSC). The majority of actors took a similar position to the PBSC. Central and provincial governments are seen as strong advocates for the tax. However, major producers of emissions are, predictably, opposed to the tax.

The KTAB simulation results indicate an emerging consensus on carbon tax, albeit a weak one. This implies that any mechanism or implementation of a carbon tax law will, likewise, be weak. When there is strong political will to legislate a policy, strong implementation of the principles will follow. Our analysis finds that it is not politically feasible currently for China to adopt and implement a strong carbon tax policy, because the proposal has weak political support. This result opens up the possibility for alternative solutions, such as a carbon emissions trading scheme.

In addition, we performed sensitivity analysis to validate the impact of inaccurate data in our study,

and to evaluate whether assessing two key actors as more or less influential would affect the overall simulation. A sensitivity analysis was conducted for the NDRC, the body that would be responsible for drafting any carbon tax law, and for Shenhua Energy Company, an energy major that clearly opposes a carbon tax, by varying their influence. Even if the NDRC is assessed as more influential than anticipated by the experts interviewed, our simulation indicates it is not politically feasible to adopt any toughening of the potential carbon tax law. On the other hand, when Shenhua is assigned relatively substantial influence, it will remain opposed to any form of a carbon tax, though it is unable to disrupt the emerging consensus around weak support for a carbon tax.

Our findings are validated by recent announcements from China on the subject. Officials have said that a carbon tax is not an option in the near term, as China's entire tax system would have to be reconsidered to take account of the potential knock-on effect of introducing a new carbon tax. However, the door appears not to be closed: the deputy director of NDRC's climate change department, Jiang Zhaoli, stated that a carbon tax could be adopted closer to 2020 as a way to increase controls on carbon emissions. And on March 20, 2016, Lou Jiwei, the Finance Minister, said at the China Development Forum that the country will not introduce a standalone direct carbon tax, but it will probably incorporate a tax on carbon into its environmental protection tax or resource tax. So there does appear to be weak support for the idea of a carbon tax, and it remains to be seen whether this will grow over time as the political climate around emissions reduction schemes continues to evolve.

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## About the Project

KAPSARC is developing the KAPSARC Toolkit for Behavioral Analysis (KTAB), an open source software platform, to support modeling and analysis of collective decision-making processes (CDMPs). KTAB is intended to be the standard platform for analyzing bargaining problems, generalized voting models and policy decision-making. It is our intent to use KTAB to assemble the building blocks for a broad class of CDMPs. Typical models in KTAB will draw on the insights of subject matter experts regarding decision makers and influencers in a methodical, consistent manner; and then assist researchers to identify feasible outcomes that are the result of CDMPs.



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