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Individualism and nationally determined contributions to climate change

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HIGHLIGHTS

- This study explains why NDCs are formulated as they were from cultural perspectives.
- Countries with more individualism tend to submit higher mitigation targets for NDCs.
- Both a conceptual framework and empirical evidence are provided in this article.
- Tailored strategies to distinct cultural identities are promising in enhancing NDCs.

GRAPHICAL ABSTRACT
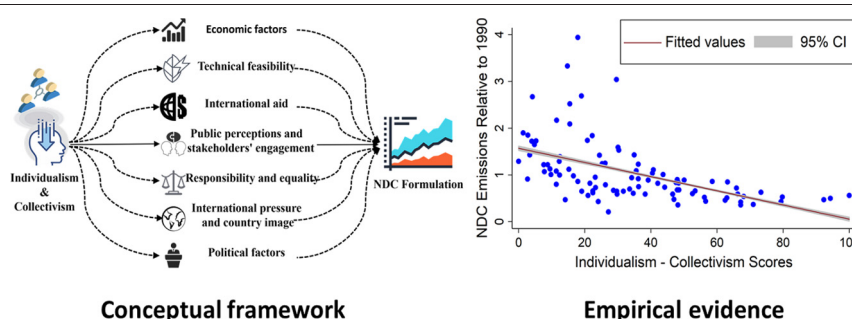
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ABSTRACT

Ratcheting up the Nationally Determined Contributions (NDCs) to achieve the Paris Agreement goals requires a better understanding of the enablers and barriers behind NDC formulation. However, existing quantitative analyses on the drivers of NDCs from an anthropological perspective are elusive. This study proposes both a conceptual framework and empirical analysis of how cultural values link with the pledged NDCs. The findings show that individualism (IDV) is a significant and robust predictor for the mitigation levels of NDCs, after controlling for affluence level, renewable energy proportion, democracy and other socioeconomic factors. For every 10-point increase in the IDV score (say from the score of Canada to Australia or from the score of Vietnam to Mexico), the committed per-capita emission in 2030 relative to 1990 levels decrease by 14%–22%. However, such a correlation is absent when assessing the mitigation ambitions using various fair benchmarks. This study underscores the necessity of considering more cultural context and nuances in tackling common climate problems, and advocates for developing tailored climate communication strategies to enhance the NDCs.

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1. Introduction

The Paris Agreement established a landmark framework that invites countries to determine voluntary contributions to climate change based on their own circumstances. Although climate actions have sped up since the agreement, the collective efforts of Nationally Determined Contributions (NDCs) are insufficient to achieve the goal of keeping global mean temperature increase well below 2 °C or 1.5 °C (Rogelj et al., 2016) by the end of the century. To bridge the emissions gap, it is necessary to motivate countries to enhance their NDCs. Such efforts are especially crucial in 2020–2021 when the first opportunity for ratcheting up the fight against climate change is approaching.

A critical step to strengthen ambitions is to identify factors that influence NDC formulation. It is well acknowledged that NDC formulation is influenced by multiple factors, including development stages, considerations of equity and responsibilities, mitigation capacity, domestic costs

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and benefits of mitigation, politicians' viewpoints and public perceptions, climate change vulnerabilities, and the possibilities of gaining international supports (Dash and Gim, 2019; Sælen et al., 2019). However, few studies investigate the driving factors of NDC formulation from a socio-cultural perspective.

There is an increasing awareness that culture plays a critical role in climate change mitigation and adaptation (Adger et al., 2012; Barnes et al., 2013; Corner et al., 2014; Hălbac-Cotoară-Zamfir et al., 2019). Culture, which is defined as "the shared values, beliefs, and norms of a society" (Hofstede et al., 2010), guides behaviors and decisions by providing a dominant logic. By such definitions, culture mediates the risk perceptions regarding climate change, and affects the decision making and public acceptance of climate policies (Crona et al., 2013; Zheng et al., 2021). For instance, it is observed that hierarchical individualists – individuals showing a strong belief in authority and self-reliance – are less concerned with climate change risks than egalitarian communitarians – one favoring egalitarian and communitarian values (Kahan et al., 2012). A case study from Northern Burkina Faso indicates that culture is a significant barrier to some climate adaptation activities (Nielsen and Reenberg, 2010). In light of these existing theories and evidence, it is conjectured that cultural values also play a role in national climate discourse, such as NDC formulation.

To investigate whether, and if so, how cultural values play a role in NDC formulation, this study proposes both a conceptual framework and empirical analysis. The conceptual framework connects cultural values with the potential drivers of NDCs and the empirical analysis bridges the cultural dimension model in socio-cultural sciences and the first round of NDCs. We specifically focus on the individualism-collectivism culture, which is widely considered as a fundamental dimension of cultural variation across countries and individuals (Oishi and Kisling, 2009; Triandis, 2001). Individualism-collectivism culture describes the relationships between the individual and the group (Hofstede, 2001). Societies with more individualistic culture have a loosely-knit social framework, in which societal members are autonomous individualists and less dependent on their groups. They are prone to choose the universal norms independently rather than being imposed to take the in-group ones. By contrast, in societies with more collectivistic culture, societal members are more likely to take the norms and duties prevalent in the group and put high values on the relationships among in-group members. Both the conceptual framework and empirical evidence show that countries with more individualistic culture pledge higher mitigation levels of NDCs. The correlation is robust when the affluence level, renewable energy proportion, democracy and other socioeconomic variables are controlled. The findings lay a foundation for incorporating anthropological considerations in NDC enhancement and developing culturally tailored strategies to motivate higher ambitions in climate change mitigation.

2. Literature review and conceptual framework

2.1. Potential NDC drivers

2.1.1. Economic factors

Costs and benefits of mitigation are main factors influencing NDC formulation. On the one hand, high level of abatement cost hinders the ambitions of emission reduction (Hof et al., 2017). For instance, although there are substantial potentials of carbon emissions reduction through exploiting the abundant renewable energy resources in Kenya, the high cost of renewable energy installation (approximately 0.5%–2% of GDP in 2050) is a realistic challenge (Dalla Longa and van der Zwaan, 2017). Chunark et al. (2017) found that the economic cost of renewable energy utilization can be as much as 3.1% of GDP loss in stringent emission targets. In addition to the implementation cost, the pledged countries also care about the macroeconomic influence of mitigation, such as the impact on personal revenues and job opportunities (Orlov and Aaheim, 2017; Vona, 2019).

On the other hand, mitigation efforts also bring economic benefits through avoiding loss from climate disasters or stimulating economic growth alongside industrial chains. In countries that are vulnerable to climate change, the benefits from avoiding loss will exceed the negative economic impacts; hence it is understandable that they show more ambitions in NDCs (Kim et al., 2020). Moreover, some mitigation strategies, such as large-scale implementation of renewable energy or shift of economic structure to a service-oriented economy, can stimulate the development of upstream industries and create more job opportunities, bringing benefits that offset the implementation cost (Bastidas and Mc Isaac, 2019; Dai et al., 2016). For example, Mittal et al. (2016) and Tran et al. (2017) found that increasing the penetration of renewable energy can decrease the economic loss in China, India and Vietnam.

Climate mitigation can also bring environmental and social co-benefits for air pollution improvement and public health (Dovie, 2019). According to Cai et al. (2018), reducing particulate matter ($PM_{2.5}$) pollution associated with China's electricity industry under the pledged NDC target would decrease premature deaths by 20,000 by 2030, which offsets 18–62% of the abatement cost. Another study on the USA obtained similar findings that the co-benefits of its NDC commitment will reduce emissions of SO_2 and NO_x by 25%, approximately avoiding 3500 premature deaths annually by 2020 (Driscoll et al., 2015). The findings that health co-benefits noticeably offset the abatement cost will enhance the ambitions in NDC formulation.

2.1.2. Technical feasibility

Technical barriers can also explain the lack of ambition in the NDCs. There are two principle strategies for climate change mitigation: renewable energy development and energy efficiency improvement (He, 2015). Moreover, some end-of-pipe technologies, such as carbon capture and storage (CCS), also help control the greenhouse gas (GHG) emission level (Miyagawa et al., 2011). The development level of these technologies in the countries partially determines the potentials of emission reduction in their NDC formulation (Michalena et al., 2018).

2.1.3. International aid

Some countries' mitigation commitments are conditional on foreign financial support, technology transfers, and capability assistance. Chen et al. (2018) synthesized 164 submitted Intended Nationally Determined Contributions and found that 77% of the documents mentioned the need for financial assistance and 70% of the documents addressed the need for technology support. Pauw et al. (2019) pointed out that 63% of the emerging countries and 83% of the least developed countries and small island developing states claim that the implementation of their NDC largely depends on the capacity assistance they receive. The conditionality of NDCs can influence the mitigation ambitions of countries. Developing countries tend to be more ambitious when external aid is available. Meanwhile, developed countries might take credit from providing support for developing countries and therefore reduce their own mitigation targets.

2.1.4. Responsibility and equality

The mitigation targets are supposed to be "fair," implying each country takes its responsibility for emission reduction. Within the United Nations Framework Convention on Climate Change (UNFCCC), countries agreed on the principle of 'Common but differentiated Responsibilities and Respective Capabilities" (CBDR-RC). CBDR-RC recognizes that climate change is a common concern of all countries and acknowledges the different capabilities and differing responsibilities of individual countries in combatting climate change. However, the concept of fairness is controversial for decades (Kartha et al., 2018; Pan et al., 2017; Robiou du Pont et al., 2016). Some countries advocate that prior emissions increase future emission entitlements (namely the principle of grandfathering). Other arguments stress that a country's responsibility for climate change should incorporate its historical emissions (i.e., the principle of historical responsibility) or that every person has equal

carbon emission development right (i.e., the principle of egalitarianism) (Robiou du Pont et al., 2016). Such divergence of the fairness principle might be reflected in the NDCs, although few countries justify the fairness of their contributions in the documents (Swingle, 2016).

2.1.5. Public perceptions and stakeholders' engagement

The consciousness regarding climate change of policymakers, stakeholders, and the public can influence the decision making progress of NDCs. Day et al. (2015) found that 86% of countries invited stakeholders to participate in the preparation of the INDC. Stakeholders, including scientists and representatives from the government, environmental non-governmental organizations (NGOs), and private sectors, are supposed to be knowledgeable in specific fields and able to suggest feasible mitigation actions or to contribute data (Dash and Gim, 2019).

Meanwhile, public awareness and risk perception of climate change also have effects on governments' decision on emission reduction targets. Drummond et al. (2018) found a positive association between the proportion of people who are aware of climate change and the unconditional mitigation targets. When people believe climate change will threaten their lives, income, and welfare, they are more likely to support ambitious mitigation strategies and actions (Alvi et al., 2020). Moreover, personal knowledge (Shi et al., 2016) and experience, especially those of direct exposure to climate-related disasters (Rudman et al., 2013) and physical evidence of climate change (Arctic Climate Impact Assessment, 2004), may alter opinions and attitudes towards climate change. For instance, the perception of local temperature change is one of the strongest predictors for risk perception of climate change (Lee et al., 2015).

2.1.6. International pressure and country image

Pressures from the international community and concerns for country image constitute another factor influencing NDC formulation. Preserving a favorable country image in the eyes of the international community is important for foreign policy goals, which involve safeguarding national sovereignty and elevating international stature (Harris, 2004). The achievement of these goals determines the cost-benefit analysis of international climate change cooperation and mitigation efforts.

2.1.7. Political factors

NDC formulation is a political process by nature. The political institutions and pre-existing legislation will affect the mitigation ambitions significantly by influencing the agenda setting, policy coordination and political support (Röser et al., 2019). In particular, political partisanship and ideology are essential predictors of political support for climate change. For example, in the United States, there is a long-lasting political divide on the perceptions of climate change between the Liberals and Democrats and Conservatives and Republicans. A similar left-right ideological divide is also found in the public of the European Union (EU) and Australia: left-wing politicians and the general public on the left (progressive parties) reported stronger belief and concerns about climate change than fight-wing ones (conservative parties) (Fielding et al., 2012; McCright et al., 2016). Politicians do not respond to climate change in a straightforward way. They shape and construct arguments that are aligned with their outlooks and political ideals, as well as those of their supporters, to increase the possibility of being re-elected (Willis, 2017).

2.2. Hypothesis and conceptual framework

The main tenets of how individualistic culture influences NDC formulation are as follows. First, individualistic culture can influence NDC formulation through public perceptions, which are critical components of the socio-political context within which policy makers operate. Public perceptions can fundamentally compel or constrain political action to address climate change (Leiserowitz, 2005). People with more

individualistic culture don't necessarily comply with the norms of the collective, but choose the impartial and universal ones independently (Beugelsdijk and Welzel, 2018). As such, people who think alike are more likely to get together and fight for climate change mitigation. A typical example to support this argument is that kids in Canada, a typical individualistic country, get together and sue the government over climate change (Tollefson, 2019). In these cases, governments are pressured and motivated to take active actions to develop and implement positive climate policies. By contrast, societies with more collectivist culture address obligations and subordinating to the collective's interest. It is hypothesized that such societies show greater acceptance of low mitigation ambitions, if they are the governments' decisions.

Moreover, although the NDC formulation is a political decision, politicians seldom generate mitigation targets by themselves. They rely on stakeholders' suggestions and contributions to make decisions. In collectivist countries, scientists are more likely to consider policymakers' preferences and national interests, and therefore tend to propose low-ambition targets. By contrast, scientists in individualistic countries would probably assert suggestions in line with the universal norms which emphasize more on climate change mitigation. Thus, we conjecture that the mitigation level and ambition of a country's NDC is positively related to its level of individualism.

Apart from the two influencing mechanisms mentioned above, other socio-political factors can also lead to the observation of the positive correlations between individualistic culture and the pledged NDCs (Fig. 1). For example, countries with more individualistic culture usually have higher levels of affluence (Gorodnichenko and Roland, 2011). According to the principles of "Common but Differentiated Responsibilities" within the UNFCCC, developed countries are supposed to pledge higher emission cuts. Thus, the correlation between individualism and affluence levels and the correlation between affluence and emission reduction can lead to an observation of the correlation between individualism and emission cuts. Besides, it is found that individualism is associated with greater levels of clean technology adoption (Ang et al., 2020). This linkage can also lead to an observation of the positive correlation between individualism and emission reduction, as more clean technology adoption associates with more ambitions on emission reduction. Moreover, the relations between individualistic culture and NDC formulation can also act through national political institutions, given the positive relation between individualism and democracy (Davis and Abdurazokzoda, 2016). Although these influencing channels support our hypothesis that the mitigation level of a country's NDC is positively related to its level of individualism, they are not the direct effect of individualistic culture on NDC formulation. Thus, we rule out the effects of these influencing channels through controlling for more socio-economic variables and employing instrumental variable analysis.

3. Methods and data

3.1. Variables and data

3.1.1. Independent variables

To empirically examine the potential links between individualism and NDC formulation, we perform the regression analysis using the variables indicated in Fig. 2. Specifically, to what extent a society has individualistic culture is measured by a set of scores obtained from the aggregation of value surveys on individual societal members. This approach of measurement is in line with one specific tradition of cultural analysis – the societal cultural value dimension (SCVD) scholarship – that reduces cultural characteristics to several dimensions and assumes the university of cultural dimensions (Peterson and Barreto, 2018). In the SCVD approach, a wide range of survey questions were used to collect personal cultural values, and factor analysis was applied to summarize the data and characterize the cultural characteristics of the society. In most cases, the societies are predetermined according to geo-political boundaries, e.g., by countries, and the culture of a country is named as
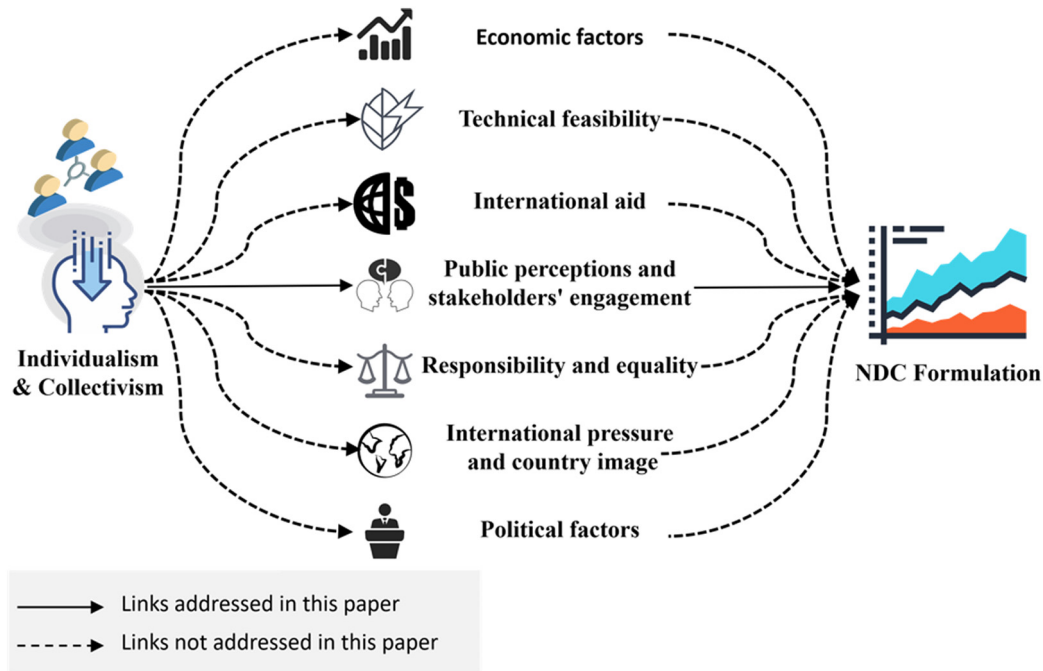
Fig. 1. Conceptual framework linking individualism and NDC formulation.

Fig. 2. Variables used in the regression model.

national culture (Beugelsdijk and Welzel, 2018; Gelfand et al., 2011; Hofstede et al., 2010; House et al., 2004; Schwartz, 2004). Although countries are not governed by monolithic values and the value heterogeneity within countries is even larger than that between countries (Fischer and Schwartz, 2011), averaging the values of individuals still provides a window into the prevailing culture in the society (Schwartz, 2013).

The most widely used cultural dimension framework is developed by Dutch social psychologist Geert Hofstede (Hofstede et al., 2010). Hofstede initially constructed four cultural dimensions – power distance, individualism versus collectivism, masculinity versus femininity, and uncertainty avoidance – based on surveys of IBM employees across 30 countries in the 1970s. The framework has been updated by extending the survey samples to other professions and to more than 80 countries. Later he added another two dimensions – long term orientation versus short term orientation and indulgence versus restraint – using the data of the World Value Surveys (WVS). The scores on Individualism–Collectivism were collected through a series of questions on job orientations. Countries that score higher on this dimension have more individualistic culture, which indicates that people in these countries are autonomous and less dependent on collective norms and duties. The other end of the continuum is collectivistic culture, in which people tend to behave in accordance with the expectation of social norms and be loyal to the cohesive group. We use Hofstede's measurement of individualism and collectivism to capture the cultural variations across countries on this dimension. Although the temporal stability of Hofstede's framework has been criticized as outdated, it is proved to be still representative of contemporary globalized societies, as countries have moved along the same path, with persistent relative changes between countries (Beugelsdijk et al., 2015).

To eliminate the concerns for mismeasurement of cultural dimensions, we also use the most recent framework developed by Beugelsdijk and Welzel (2018) for robustness check. In contrast to Hofstede's measurements (Hofstede et al., 2010) based on surveys on IBM employee forty years ago, Beugelsdijk and Welzel's cultural dimension framework (Beugelsdijk and Welzel, 2018) provides us with a more updated cultural framework based on the samples of the World Value Surveys and European Values Studies (EVS), comprising over

495,011 individual surveys from 110 nations between 1981 and 2014. Beugelsdijk and Welzel reframe Hofstede's six cultural dimensions to three, including Collectivism–Individualism, Duty–Joy, and Distrust–Trust. Survey questions on Collectivism–Individualism in this framework consist of broader elements, including religious beliefs, attitudes towards obedience, tradition, and responsibility, as well as their job preference. Higher scores on this dimension also mean more individualism. Although the measurement of individualism in the two frameworks are based on various samples and procedures, they have significant correlations, the coefficient of which is between 0.47–0.84 (Beugelsdijk and Welzel, 2018).

3.1.2. Dependent variables

The dependent variable is the first round of NDCs. The variations of the submitted NDCs across countries can be assessed in various ways (Höhne et al., 2017). One of the approaches is to compare the per-capita GHG emissions pledged in the NDCs relative to a reference year. This way of measurement enables a cross-national comparison of emission levels but fails to reflect the ambitions since it is highly dependent on the development stage of the country. According to the principle of "Common but Differentiated Responsibilities" within the UNFCCC, developed countries in most cases pledged higher level of mitigation compared to developing countries. Another way widely used to assess NDC is to compare GHG emissions pledged in the NDCs with the "fair" effort-sharing benchmarks that comply with a global "least-cost" 2 °C or 1.5 °C pathway. This way of measurement is controversial since the fair benchmarks are divergent under various equity principles and approaches. Other approaches of the NDC assessment include comparing the NDCs with the baseline emissions in "no policies" baselines or "current policies" scenario. These approaches have limitations as the information of baseline scenarios provided in the NDC documents is elusive, which hinders the cross-national comparison. In this study we chose the former two approaches to assess the cross-national variations in NDC commitments.

The emission level of NDCs depends on which target years and reference years are selected. We use the per-capita GHG emissions (excl. LULUCF) in 2020, 2025, and 2030 relative to 1990, 2000, 2005, and 2010, respectively. The per-capita emission in the target years and reference years are sourced from Meinshausen & Alexander's work (Meinshausen and Alexander, 2017). Regarding the mitigation ambition of NDCs, the assessment is sensitive to what benchmarks of fair share are selected. We reference to Robiou du Pont et al.'s work (Robiou du Pont et al., 2016), which compared the submitted NDCs with the fair shares under five equality approaches, i.e., Capacity (CAP), Equal per capita (EPC), Greenhouse development rights (GDR), Equal cumulative per capita (CPC), and Constant emissions ratio (CER). Although Robiou du Pont et al.'s work has been criticized on the ground of cascading biases against poorer countries (Kartha et al., 2018), it provides multiple choices for NDC comparison, which fits the purpose of our regression analysis.

3.1.3. Control variables

Many factors would potentially affect the observation of the relationship between the NDCs and cultural values. We control for them to eliminate the bias of omitted variables. The Control variables can be classified into four categories. The first category refers to a country's economic factors, including affluence level (denoted by the log form of per capita GDP), development stage (denoted by whether the country is one of the Organization for Economic Co-operation and Development (OECD) countries), and GDP growth rate between the reference year and the NDC target year. The second category reflects on a country's technical change related to carbon emission. The variables of this category include per capita energy use (in log form), proportion of renewable energy, and carbon emission per GDP (in log form). The third group of variables is historical GHG emissions during 1850–2010, which describe the responsibility of the countries. The fourth group of

control variables represents a country's other characteristics, including its political regime, geographical position and party grouping within the climate change negotiations. Specifically, the political regime is denoted by the indicators of democracy (measured by the Polity 2 score from the Polity IV dataset) (Marshall, 2014) and governance (measured by Worldwide Governance Indicators) (Kaufmann et al., 2010). The effect of geographical position and negotiating blocks is captured by the dummy variables of region and the dummy variables of party groupings, respectively.

3.1.4. Samples

The baseline test is based on a sample of 82 countries (for the full name of the sample countries, please kindly refer to Table A1 in the Appendix). The decision of whether or not to include a country is anchored by the data accessibility. Countries with both cultural trait scores and submitted NDCs are selected for comparison. From the geographical perspective, the sample includes 8 countries from Africa, 25 countries from Asia, 33 countries from Europe, 12 countries from Latin America and the Caribbean, 2 countries from the North America, and 2 countries from the Oceania. From the perspective of the Party groupings within the climate change negotiation, the sample includes 4 countries from the BASIC Group (Brazil, South Africa, China and India), 4 countries from the Environmental Integrity Group (EIG), 25 countries from the European Union, 3 countries from the Least Developed Countries (LDCs), 7 countries from the Organization of Petroleum Exporting Countries (OPEC), 3 countries from the Small Island Developing States (SIDS), 10 countries from the Umbrella Group, and 26 countries from the Other States.

3.2. Regression model

The basic empirical model for measuring the effect of cultural factors on the NDCs is:

$$NDC_i = \theta IND_i + \eta Controls_i + a + e_i \tag{1}$$

where the dependent variable NDC_i denotes the levels of first NDCs (percentage change relative to a reference year) or the ambition of first NDCs (percentage change relative to fair benchmarks) proposed by each country i. The explanatory variable IND_i denotes the cultural traits of individualism and collectivism in a country i. We also control for other socioeconomic factors which could affect the NDCs, denoted as $Controls_i$. The Control variables are as described in the Variables and Data section. θ and η are the respective elasticity coefficients of $Culture_i$ and $Controls_i$. a is the constant term and e_i is the disturbance term unique to each country.

3.3. Estimation methods

In the baseline estimation, we run a regression of the model given in Eq. (1) using the method of between estimator (BE). BE performs a cross-sectional regression on the average value of each country's time series data. Compared to other estimators, BE performs better in providing consistent estimates of long-term correlations (Stern, 2010), which suits the circumstances here since cultural evolution is an extremely slow process.

To mitigate the possible omitted variable bias, we further perform a between estimator two-stage instrumental variable (IV) regression. The IV analysis deals with potential endogeneity problems, including omitted variable bias, mismeasurement and mutual influences. Specifically, we use historical pathogen prevalence (Fincher et al., 2008) as an IV for individualism. We choose this IV because it is a strong predictor of individualism but does not necessarily relate to the commitment of climate change mitigation. Fincher et al. (Fincher et al., 2008) present evidence of a robust relation between the regional prevalence of pathogens and the cultural indicator of individualism and collectivism.

Meanwhile, it is hard to think of the channels through which the NDC of a country is affected by their historical pathogen prevalence. Thus, the regional prevalence of pathogens can only influence NDC formulation through individualism-collectivism culture and the influence of other confounding factors can be ruled out.

4. Empirical findings

4.1. Individualism and the emission levels of NDCs

The empirical analysis links the Individualism scores of the sample countries with their first NDCs (Fig. 3). Based on the BE test (Table 1), we find that at the confidential level of 99%, individualism (IDV) is a significant predictor of the relative emission levels pledged in the NDCs, which are measured as the per-capita GHG emission in 2030 relative to 1990 levels. The results are consistent with our hypothesis and robust when controlling for other cultural characteristics, affluence levels, renewable energy proportions, democracy and other socioeconomic variables. More specifically, countries with more individualistic culture pledged higher levels of mitigation targets (i.e., lower levels of per-capita GHG emissions relative to 1990) than countries with collectivistic culture. Though the size of the coefficient seems relatively small, the practical meaning is significant. The estimated coefficient on IDV ($-0.022 \sim -0.014$) indicates that for every 10-point increase in the IDV score (say from the score of Canada to Australia or from the score of Vietnam to Mexico), the committed per-capita emission in 2030 relative to 1990 levels decrease by 14%–22%.

Similar significant correlations are confirmed when the NDCs are indicated as per-capita GHG emission in the lower mitigation target relative to 2000, 2005, and 2010. However, the correlations are not robustly significant when higher mitigation targets relative to these reference years are used as dependent variables. There are two possible explanations for this phenomenon. One explanation is that the correlation doesn't exist and the observation of the significance is just regression noise. Another explanation is that, compared to the year 1990, the other three years (i.e., 2000, 2005, and 2010) are less widely referenced when countries formulate their NDCs, leading to the effect of national culture unveiled. Considering the solid theoretical basis and consistent results obtained from the empirical analysis using both of the individualism indicators (i.e., Hofstede's measurement and Beugelsdijk & Welzel's measurement), we are leaning towards the second explanation, rather than regression noise.

However, it might be the case that individualism correlates with NDC mitigation levels through other channels than cultural influence. To address these concerns, we control for a set of variables and perform an instrumental variable analysis to rule out the confounding influence of other factors (Table A2). First, the positive correlation between individualism and mitigation levels of NDCs might be because individualistic countries are more affluent, and affluent countries pledged higher levels of mitigation. We rule out the effect of this influencing channel by showing that the correlation between individualism and NDC levels
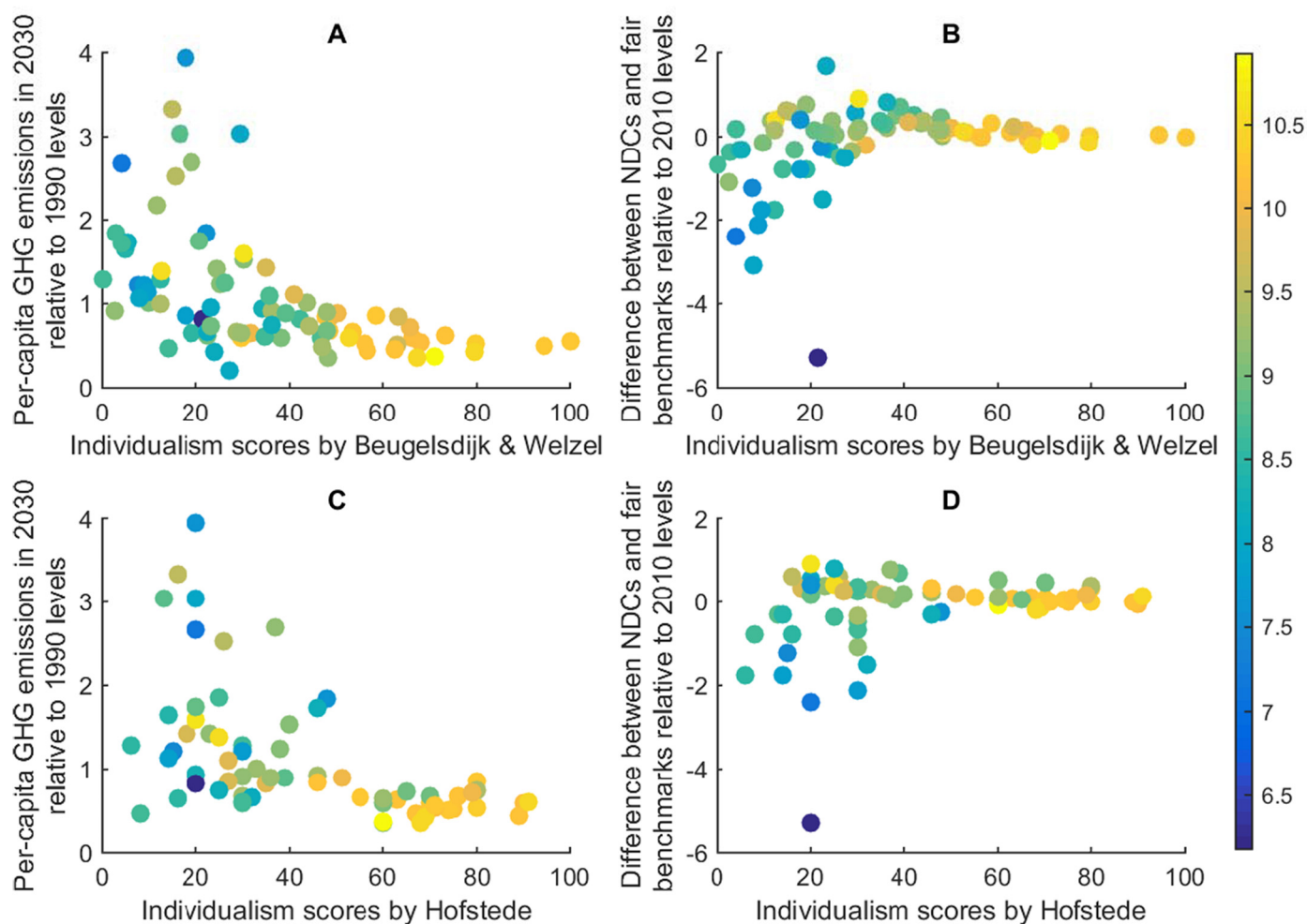

Fig. 3. Individualism and the pledged NDCs. The color of the scatter points shows the affluence level of countries, indicated by the logarithmic form of Gross Domestic Product per capita (at purchasing power parity).

Table 1

The correlations between individualism and the relative emission levels of NDCs using between estimator.

Reference year	Low NDC emission levels in 2030 relative to				High NDC emission levels in 2030 relative to			
	1990	2000	2005	2010	1990	2000	2005	2010
Panel A: Beugelsdijk & Welzel's cultural dimension model								
Individualism	−0.0221[***]	−0.0104[**]	−0.00901[**]	−0.00843[**]	−0.0167[***]	−0.00639	−0.00519	−0.00455
	[0.00546]	[0.00445]	[0.00393]	[0.00371]	[0.00468]	[0.00418]	[0.00362]	[0.00338]
Observations	1991	1991	1991	1991	1991	1991	1991	1991
Adj. R^2	0.548	0.486	0.418	0.351	0.501	0.402	0.309	0.228
Panel B: Hofstede's cultural dimension model								
Individualism	−0.0165[***]	−0.00285	−0.00167	−0.00107	−0.0142[***]	−0.00213	−0.0013	−0.000811
	[0.00555]	[0.00314]	[0.00268]	[0.00244]	[0.00485]	[0.00297]	[0.00246]	[0.00218]
Observations	1585	1585	1585	1585	1585	1585	1585	1585
Adj. R^2	0.625	0.732	0.677	0.599	0.572	0.665	0.588	0.485

Notes: (1) The dependent variables in the regression (i.e., the column names) are the low/high NDC levels, indicated by the per-capita GHG emissions (excl. LULUCF) in 2030 relative to 1990, 2000, 2005 and 2010, respectively. The per-capita emissions in the target years and reference years are sourced from Meinshausen & Alexander's work (Meinshausen and Alexander, 2017). The independent variables in Panel A are Beugelsdijk & Welzel's measurement of Individualism (Beugelsdijk and Welzel, 2018), and those in Panel B are Hofstede's measurement of Individualism (Hofstede et al., 2010). (2) Robust standard errors in the parentheses; [***]$p < 0.01$, [**]$p < 0.05$, [*]$p < 0.1$. (3) Coefficients of controlling variables and constants were included in the model but not reported.

are still robustly significant when we control for affluence level, development stage, historical GHG emissions, and even if we instrument individualism with the regional prevalence of pathogens. Second, one may argue that individualism positively associates with democracy and countries showing higher levels of democracy set higher mitigation levels of NDCs. We found that this explanation stands as the correlations are indeed supported by our sample. However, the effect of individualism on NDC levels holds when the indicators of democracy and governance are controlled and when the individualism is instrumented. Likewise, other possible channels, such as the argument that individualism correlates with more renewable energy adoption which allows for higher mitigation levels, were ruled out as the results show that the effect of individualism on NDC mitigation levels (relative to 1990) is robust or even stronger with controlled variables or instrumental analysis.

4.2. Individualism and the mitigation ambition of NDCs

To evaluate the potential influence of individualism on the mitigation ambition of NDCs, we use the percentage differences between the NDCs and the "fair" shares of per capita emissions allowances under various equity principles as the dependent variables. Using the between estimators (Table 2), we didn't find a robust correlation between individualism and the ambitions in the submitted NDCs. Only when CER and the average five approaches are referenced as benchmarks are the ambitions of NDCs significantly associated with individualism.

In other cases, the correlations are not significant. Through instrumenting the cultural variable of individualism, we didn't find significant or robust evidence to support the effect of culture on NDC ambitions either (Table A3).

It is worth noting that insignificant coefficients don't necessarily indicate the absence of correlations. One possible reason hindering the observation of the correlation between individualistic culture and the NDC ambitions is that the countries have not yet achieved a consensus on the fair benchmarks, which the NDC assessment highly depends on. Another interesting conjecture behind this finding is that most of the countries take into consideration of the historical carbon emission (especially that in 1990) in the process of NDC formulation while few considered the fair shares which align with the Paris goals. That is why we observe a significant correlation when the NDC is indicated as the target relative to a reference year, but no significant evidence when the NDC is indexed as the changes relative to fair benchmarks.

4.3. Discussion and policy implications

Despite the wide discussion on the factors that influence climate change mitigation ambitions, most researchers and politicians consider the lack of ambitions as a technical and financial problem (Willis, 2017). This study provides an exploratory analysis of why the NDCs are formulated as they were from a cross-cultural perspective. It implies a new pathway to enhance the ambitions of climate action from the cultural

Table 2

The correlations between individualism and the mitigation ambition of NDCs using between estimator.

Equity principles	Average	Capacity (CAP)	Constant emissions ratio (CER)	Equal cumulative per capita (CPC)	Equal per capita (EPC)	Greenhouse development rights (GDR)
Panel A: Beugelsdijk & Welzel's cultural dimension model						
Individualism	−0.00714[*]	−0.00159	−0.00831[**]	−0.00014	−0.00493	−0.0201
	[0.00387]	[0.00731]	[0.00382]	[0.00460]	[0.00398]	[0.0292]
Observations	1970	1970	1970	1970	1970	1970
Adj. R^2	0.461	0.413	0.303	0.516	0.484	0.04
Panel B: Hofstede's cultural dimension model						
Individualism	−0.00601	−0.00381	−0.00099	0.00364	−0.00284	−0.0747[**]
	[0.00374]	[0.00594]	[0.00239]	[0.00451]	[0.00343]	[0.0312]
Observations	1574	1574	1574	1574	1574	1574
Adj. R^2	0.445	0.509	0.55	0.541	0.586	0.105

Notes: (1) The dependent variables in the regression are the mitigation ambition of NDCs referenced from Robiou du Pont et al.'s work (Robiou du Pont et al., 2016), which compared the submitted NDCs with the fair shares under five equality approaches (i.e., the column names) and presented the average value (i.e., the "Average" column) of these comparisons. The independent variables in Panel A are Beugelsdijk & Welzel's measurement of Individualism (Beugelsdijk and Welzel, 2018), and those in Panel B are Hofstede's measurement of Individualism (Hofstede et al., 2010). (2) Robust standard errors in the parentheses; [***]$p < 0.01$, [**]$p < 0.05$, [*]$p < 0.1$. (3) Coefficients of controlling variables and constants were included in the model but not reported.

perspective. Besides climate change, solutions to other global environmental issues can also incorporate cultural considerations. Specifically, the study generates three policy implications.

First, it is necessary to incorporate national culture into the development of climate change strategies. For example, how to develop effective strategies to downscale the NDCs within the country and motivate sub-national mitigation actions is one of the critical questions that all country need to consider. Either a top-down emission allocation scheme that aligns with the national mitigation target or bottom-up mitigation commitments that adequately consider local realities can be utilized to accelerate climate actions. The finding of individualistic culture shows more advantages in bottom-up commitment and therefore implies that bottom-up downscaling strategy might be more suitable for such culture. Communities with such culture might prefer independent choice over an imposed mitigation quota. They set their own goals rather than fulfilling the expectation of the collective. By contrast, in countries with collectivist culture, local governments at the sub-national level may underestimate their contributions in the bottom-up commitment to eliminate risks of failing to achieve the goals. However, they have more motivation to enforce a top-down administrative quota as they view it as collective duties.

Second, the paper underscores the need for a tailored NDC enhancement approach that is in line with the country's cultural context. In specific, choice of target audience can be culturally dependent when increasing climate mitigation efforts is being advocated. For countries with collectivistic culture, it is critical to convince the political leaders of the importance and urgency of tackling climate change. This is because, in such countries, political leaders' preference has a more significant influence than scientists' or public perceived norms and values. For countries with individualistic culture, improving climate literacy and public understanding of anthropogenic causes of climate change is as crucial as the awareness of policymakers.

Third, it is necessary to contextualize the content of the advocates. In light of the findings in the present study, we suggest advocates in countries with a collectivistic culture should link the risks of climate change and the merits of mitigation with the in-group interests, such as the co-benefits of mitigation on local air pollution, human health and enhancing international reputation. If the public is informed that tackling climate change can strengthen their collective interests, they are more likely to oblige to the in-group mitigation target and thus take active actions.

5. Conclusion

It is fascinating to study and try to understand culture's role in policy decisions on climate change, especially when the second round of nationally determined commission is approaching. This study reports the theoretical and empirical analysis on the influence of individualism-collectivism culture on NDC formulation. It is found that individualism is a significant and robust predictor of the mitigation level of the submitted NDCs, although the countries have no intentions to consider it or not even realize it. The correlations can be explained by two influencing channels. First, the public in countries with more individualistic culture put more value on the impartial and universal norms over the collective norms within a group. They are more likely to fight for climate change mitigation and exert more pressure on the governments' policy decision. Second, although the NDC formulation is a political process, policy makers usually rely on stakeholders, who are supposed to be knowledgeable and contribute proposals, to make decisions. Stakeholders in individualistic societies are more independent while those in collectivistic societies tend to consider policymakers' preferences and national interests, which therefore understate the mitigation levels in NDCs.

The effects of culture on climate change actions are complicated, mediating or being mediated by multiple other factors. This study doesn't intend to advocate or criticize any specific culture, but hope to enhance a better understanding of culture's role in climate policy decisions. This study contributes to the literature not only by responding to the advocates on incorporating anthropological knowledge into tackling climate commons but also by providing new insights on how to motivate NDC enhancement by incorporating cultural engagement. Such contribution is explorative and serves to lay the groundwork for further quantitative empirical research bridging cultural values and climate change.

CRediT authorship contribution statement

Xinzhu Zheng: Supervision, Methodology, Writing – original draft, Formal analysis, Data curation. **Kaidi Guo:** Writing – review & editing, Formal analysis, Data curation. **Huilin Luo:** Writing – review & editing, Formal analysis, Data curation. **Xunzhang Pan:** Investigation, Formal analysis, Data curation. **Edgar Hertwich:** Investigation, Formal analysis, Data curation. **Lei Jin:** Investigation, Formal analysis, Data curation. **Can Wang:** Supervision, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declared that they have no conflicts of interest to this work.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scitotenv.2021.146076.

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