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# Designing a virtuous cycle: Quality of governance, effective climate change mitigation, and just outcomes support each other

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ABSTRACT

Climate change mitigation is mostly assessed through the lens of technologies and policy instruments. However, governance and social capital are crucial factors in complex social systems and may be relevant in the formation of effective climate policies. Here, we investigate the role of quality of governance (QoG), social capital, and equality as preconditions for enacting climate policies. Relying on indicators of social systems at nation state level, we investigate relationships with Qualitative Comparative Analysis (QCA) and Structural Equation Models (SEM). We find that quality of governance, measured as impartiality, underpins social capital and interpersonal trust, equality and effective climate mitigation policies, indicated by the level of carbon pricing. Impartiality and social capital are necessary conditions for climate policies. Socio-economic inequalities reduce trust and political engagement, and thus compromise the overarching goal of climate change mitigation. Evidence from complementary literature indicates that fairly implemented climate policies could foster a virtuous cycle that further improves quality of governance, and thus the capacity for implementing strong climate policies. Our results demonstrate that impartial governance and resulting social capital form the underpinnings of effective climate policies.

## 1. Introduction

Research and assessment of climate change mitigation has mostly focused on technological options and policy instruments (Edenhofer et al., 2014). But there is a wider role of social systems that is increasingly acknowledged. For example, the psychology of underlying lifestyle changes has been studied for years (Swim et al., 2011), and climate change mitigation is increasingly investigated from the perspective of the demand side and lifestyles (Creutzig et al., 2016, 2018). In addition, recent advances in understanding the social and institutional challenges for climate change mitigation have provided valuable insights (Brutschin et al., 2021). However, the role of social dimensions like social capital, governance and social equality for effective climate policy remains insufficiently investigated.

The Green New Deal of the European Union and the Inflation Reduction Act in the United States put new emphasis on the importance of social justice associated with climate change mitigation. Supporters of such legislation argue that reducing GHG emissions must be more than a technological feat, and assert that it should also address poverty, income inequality and racial discrimination. Detractors see the expansion of goals beyond GHG emissions reduction as an expensive and potentially misleading add-on to decarbonization. Proponents, however, see green social policy as a strategic lever to decrease emissions while expanding the coalition for decarbonization. Indeed, dynamic system models demonstrate that a low-carbon transition in conjunction with social sustainability is possible (D'Alessandro et al., 2020; Grubler et al., 2018; Huang et al., 2019). As climate policies progress slowly, and carbon pricing is kept on hold in the US at the federal level, a more comprehensive approach that also addresses equity and justice is gaining momentum (Bloomfield & Steward, 2020; Konisky & Carley, 2021). There

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is little doubt that environmental and social injustice are of high relevance both globally as well as locally and deserve policy attention, as enshrined in the United Nation's Sustainable Development Goals. What is less well understood is how addressing these concerns interacts with more narrowly focused climate change mitigation policies and under which conditions the two agendas mutually support or hinder each other.

In this study we investigate the relationship between governance, effective climate policies, social capital and equality. We first utilize qualitative comparative analysis (QCA) to show that both high levels of impartiality (a principle of justice that governs decisions based on objective criteria, rather than on the grounds of bias, prejudice, or favouritism) and social capital are necessary conditions for the successful implementation of carbon prices, which we use as a proxy for climate policy. Then we employ a structural equation model (SEM) to demonstrate that quality of government measured as impartiality has a positive impact on equality, social capital and carbon prices. Furthermore, our investigation also reveals that the design of climate policy, in particular the distribution of carbon pricing revenues, matters for producing a virtuous loop between impartiality, social capital and effective climate policies.

We draw on both an extensive literature analysis and the best available data from the World Values Survey, the World Income Inequality Database and other data sources, covering 43 countries at different stages of economic development (see Data and Methods, and Appendix Table A1). First, we discuss theories on the relationship between governance and trust, which underpin our empirical approach. In our statistical analyses we use country-level indicators of impartiality, equality and social capital to explore the associations between climate policies and its social dimensions. We then contextualize these relationships with the help of a literature analysis, evaluating each of the links included in the empirical SEM model.

## 2. The theoretical background: Social capital and impartiality as the key enabling factors of environmental governance

In the last three decades, social capital and impartiality have gained recognition as important variables in democratic governance (Hetherington & Hetherington, 2018; Putnam & Leonardi, 1993). Social capital especially has also drawn some interest because it strongly correlates with other socially desirable variables, such as happiness, an optimistic view of options to influence one's own life, more tolerance, a positive view on democratic institutions, and more active participation in civic organizations (Putnam & Leonardi, 1993)'(Uslaner, 2002).

Social capital is often perceived as the "glue of society" (Delhey & Newton, 2004). As the concept of capital implies, social capital is a stock variable of accumulated institutional knowledge and practices, which stem from a network of interpersonal relationships and shared norms, especially of reciprocity, making it possible for people to cooperate with each other to solve societal problems. A straight-forward measure of social capital is trust in other people, or interpersonal trust. However, it is relevant to distinguish between bonding and bridging forms of trust. While bonding trust takes shape in close relationships of homogenous groups of people with strong ties, bridging trust appears in open networks of heterogeneous groups of people with weak ties (Putnam, 2015; Rothstein, 2005). In a narrow sense only bridging trust qualifies as social capital, as only that form of trust helps to overcome social dilemmas at a larger scale (Putnam, 2015; Rothstein, 2005). Additional measures are the belief that most people are fair and do not try to take advantage of others, and the belief that most people are helpful and are not just looking out for themselves. Often all these three approaches are taken in concert, either aggregated to an index, summarized to a predicted factor score, or simply used as individual variables.

There are several theories of how social capital emerges. Three major contemporary approaches are based on the work of Putnam, Ostrom and Rothstein. Putnam finds empirical evidence that social capital is created by the experience of voluntary association in civil society, such as in churches, labor unions, sports leagues and other membership organizations, where citizens successfully experience collaboratively solving societal problem (Putnam, 2015; Putnam & Leonardi, 1993). Here, social capital is caused by democratic practice, and simultaneously makes democracy possible. Putnam's approach also applies to formulating policies addressing the challenges of climate change and other environmental issues. For example, a study using a Putnam-type social capital measure finds that interpersonal trust mediates the negative effect of corruption on stringency of environmental policy in US states (Dincer & Fredriksson, 2018).

Ostrom, however, emphasizes a flavour of "spontaneous" self-organization in order to address collective action problems (Ostrom, 1990; Ostrom & Ahn, 2009). She emphasizes the setting and the environment, which create conditions that enable the building of social capital through people's past experience and the ability to interact face-to-face, as well as due to favourable community characteristics and group traits, and the formal right of people to self-govern.

Rothstein shifts the perspective towards the question of how the state, represented by, for example, public administration or the criminal justice system, interacts with citizens (Rothstein, 2011; Rothstein & Teorell, 2008). In his conceptualization, the quality of government, and especially the impartial treatment of citizens, entices institutional trust, and by extension, social capital as well, especially because of the resulting lack of corrupting behaviour, which tends to corrode and undermine interpersonal trust. Rothstein's research thus closely relates political and social trust.

These three scholars' concepts of social capital creation lie on a spectrum, reaching from the ability to personally interact and self-organize (Ostrom), to active involvement in existing civil society organizations (Putnam), to a more passive experience of impartial treatment by state institutions (Rothstein). What they all have in common is the strong belief that humans are able to solve their own societal problems collectively by developing norms and building institutions which promote collaboration and cooperation to avoid dysfunctional social traps.

While there are different approaches on social capital, we here follow Rothstein's emphasis on Quality of Governance (QoG) for the creation of social capital (Rothstein, 2011). This approach is based on the observation that QoG, equality, and social capital cluster together, while inversely, high levels of corruption, inequality, and interpersonal distrust also cluster together. A low level of corruption is important to enable the belief that a government has both the willingness and capacity to execute impartial justice and redistributive policies. Impartial policies are those that treat everyone equally, i.e., they are not means-tested. Through impartiality redistributive policies can be better achieved, for example via lump-sum cash transfers and universal, stigma-preventing provision of social services that are equally accessible to everyone (Rothstein, 2010). Due to data limitations, we focus here on equality rather than equity, but the literature holds that both measures are correlated with each other and with impartiality. Means-tested programs where one has to prove poverty to obtain funds are more common in countries with high levels of economic inequality (Rothstein, 2011). These policies can give discriminatory power to clientelist leaders and/or increase corruption (Morris & Polese, 2016; Sandberg & Tally, 2015), and as such can be self-defeating because they may not achieve buy-in from all parts of society. They are harder to administer fairly, thus reproducing or even creating distrust and resentment (Rothstein & Uslaner, 2005; Overbye, 2012).

Applying these considerations to environmental policies, a worldwide study of 144 countries shows that low corruption and higher capacity of governance is associated with lower $CO_2$ emissions, but only in combination with high levels of democracy (Povitkina, 2018). Similarly, other studies on European countries present evidence that interpersonal trust levels have a positive impact on the support for either environmental or climate taxes, just as high quality of government does (Davidovic et al., 2020; Davidovic & Harring, 2020). In summary,

**Table 1**
Variable description and data sources.

| | Variables | Description | Value | Source |
|---|---|---|---|---|
| **Quality of Government** | Impartiality | Summated index of | | International Country Risk Guide – The PRS Group |
| | | Corruption | 0–6 | |
| | | Impartial courts (Law and order) | 0–6 | |
| | | Bureaucracy | 0–4 | |
| **Inequality** | Gini Coefficient | Income Inequality Coefficient | 0–100 | World Bank |
| | Gender Inequality Index | Measures gender inequalities in health, empowerment and labor market participation[1] | 0–1 | Human Development Reports Office (HDRO), UNDP |
| **Social Capital** | Interpersonal trust | Would you say that most people can be trusted, or that you can't be too careful in dealing with people?' with 0 = 'You need be too careful', 1='Most people can be trusted". | 0–1 | World Value Survey |
| **Standard of Living** | GNI per capita (PPP$) | Gross National Income per capita | Value as is | Human Development Reports Office (HDRO), UNDP |
| **Climate Policies** | Carbon Price | Price of carbon: Carbon Tax or Emission Trading Scheme | as is | Carbon Pricing Dashboard – World Bank |
| **CC Mitigation metrics** | $CO_2$ emission intensity (kg/kgOE) | $CO_2$ emissions from solid fuel consumption mainly from use of coal as an energy source. | as is | Carbon Dioxide Information Analysis Centre, Oak Ridge National Laboratory, USA and World Bank |
| | Percentage change in $CO_2$ emissions | Annual emissions stemming from the burning of fossil fuels and the manufacture of cement. They include $CO_2$ produced during consumption of solid, liquid, and gas fuels and gas flaring. | as is | |

[1]reproductive health, measured by maternal mortality ratio and adolescent birth rates;

**Table 2**
Summary statistics.

| Variable | Observation | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| Impartiality | 378 | 1.65 | 0.60 | 0.42 | 3.00 |
| Gender Inequality Index | 424 | 0.33 | 0.22 | 0.00 | 0.82 |
| Gini coefficient | 209 | 36.39 | 8.13 | 24.50 | 63.40 |
| Social Capital | 43 | 1.25 | 0.17 | 1.03 | 1.67 |
| Standard of Living (GNI) | 300 | 0.75 | 0.15 | 0.39 | 1.00 |
| Carbon Price | 520 | 2.43 | 15.01 | 0.00 | 166.64 |
| Annual (%) change in Carbon Emissions | 294 | 0.72 | 9.63 | −36.43 | 46.88 |
| Carbon Emission Intensity | 276 | 2.28 | 0.72 | 0.16 | 3.47 |

existing analysis demonstrates that both social capital and quality of government result in better and more successful environmental or climate policy. Based on these insights, we take Rothstein's framework as a starting point, and, relying on the best available data sets, explicitly model the interaction between social capital, measured as interpersonal trust, and quality of government, measured as impartiality.

## 3. Statistical analysis: Impartiality and social capital underpins effective climate policies

Our central research question seeks to understand how impartial governance, social capital, income and gender equality and climate policies are related. To answer this question we combine data from the World Values Survey, the World Bank, UNFCCC policy data sets, and UNDP inequality indicators, on which we apply qualitative comparative analysis and structural equation modelling.

## 4. Data and methods

For the analysis of the relationship between Quality of Governance, measured as impartiality, social capital, equality and climate policy, our research combines data from different sources of data and utilizes multiple methods. The World Bank Carbon Pricing Dashboard provided information concerning carbon prices as a proxy for climate policies. Carbon prices are a variable in the range [0, ∞) and thus by design all countries have a climate policy. The International Country Risk Guide (ICRG) gave us the annual values to form an impartiality index (Rothstein & Stolle, 2008). The variable 'Social Capital' was drawn from the cross-national World Value Survey, specifically the wave 2010–2014. Inequality data came from two separate sources, including the *World Income Inequality Database (WIID4)* for the Gini Coefficient for Income Inequality and from United Nationas Development Programme (*UNDP)* for the Gender Inequality Index (GII). We merged all the variables into one database and used the years 2011–2013, which leaves us with 520 observations for 173 countries. More detail about the variables is documented in Table 1.

Table 2 shows the summary statistics of the data and Table 3 provides cross-correlation. We find that social capital correlates negatively with income and gender inequality (more social capital means more equal societies) and positively with impartiality. Carbon pricing, as a key climate policy, correlates positively with political trust, standard of living, and impartiality, and negatively with income and gender inequality.

### 4.1. Qualitative comparative analysis

We start out with a qualitative comparative analysis (QCA), which can even for small numbers of observations identify necessary and sufficient conditions for certain outcomes using fuzzy sets. We conduct QCA for the variable pairs impartiality/carbon prices and social capital/carbon prices, as we hypothesize that impartiality indirectly through social capital and social capital directly are relevant requirements for a climate policy, such as carbon price. As seen in Fig. 1 we find that both impartiality and social capital are necessary conditions for carbon prices. This finding is supported by the results of the necessity matrix, where the values for both impartiality and social capital are very close to unity, 0.95 and 0.97 respectively. The combined set of impartiality and social capital is also a necessary condition for carbon prices, as the values in the necessity table between 0.87 and 0.99 indicate.

### 4.2. Structural equation model

Using data for 173 countries in the years 2011 to 2013, we have built a structural equation model (SEM) where we hypothesize that higher levels of impartiality and lower levels of inequality indirectly as well as social capital directly have an effect on climate policy. Inequality is measured as a latent variable, with two inputs, the Gini coefficient and the gender inequality index. The carbon price is seen only as an efficient climate policy as long it decreases the country's $CO_2$ emissions and lowers the $CO_2$ intensity of energy use. The whole system is mediated by the country's standard of living as a control variable. Fig. 2 documents the full SEM model (Regression results in Table A2 in the Appendix).

We have optimized the paths using the modification indices tool until the accepted benchmarks of typically used SEM performance measures were reached and the model could not be improved anymore. The

**Table 3**
Pairwise correlation between variables (Period 2: 2011–12-13): Heat map depicting the correlation between selected variables accompanied by their level of significance (indicated by an asterisk). Values range from −1 to 1. The darker the colour, the stronger the correlation – positive (Green) or negative (Red). (*) indicates correlation coefficients significant at the 5% level.

| | Impartiality | Gender Inequality Index | Gini coefficient | Social Capital | Standard of Living (GNI) | Carbon Price | Annual change in Carbon Emissions (%) | Carbon Emission Intensity |
|---|---|---|---|---|---|---|---|---|
| Impartiality | 1 | | | | | | | |
| Gender Inequality Index (GII) | -0.78* | 1 | | | | | | |
| GINI Index | -0.53* | 0.63* | 1 | | | | | |
| Social Capital | 0.58* | -0.57* | -0.58* | 1 | | | | |
| Standard of Living (GNI) | 0.68* | -0.78* | -0.35* | 0.53* | 1 | | | |
| Carbon Price | 0.37* | -0.26* | -0.25* | 0.43* | 0.27* | 1 | | |
| Annual change in Carbon Emissions (%) | -0.20* | 0.31* | 0.23* | -0.16 | -0.31* | -0.12* | 1 | |
| Carbon Emission Intensity | 0.02 | -0.14* | 0.14 | 0.12 | 0.31* | -0.26* | -0.06 | 1 |

| Legend | |
|---|---|
| Dark green | strong positive significant |
| Light green | weak positive significant |
| Yellow | not significant positive |
| Dark red | strong negative significant |
| Light red | weak negative significant |
| Orange | not significant negative |

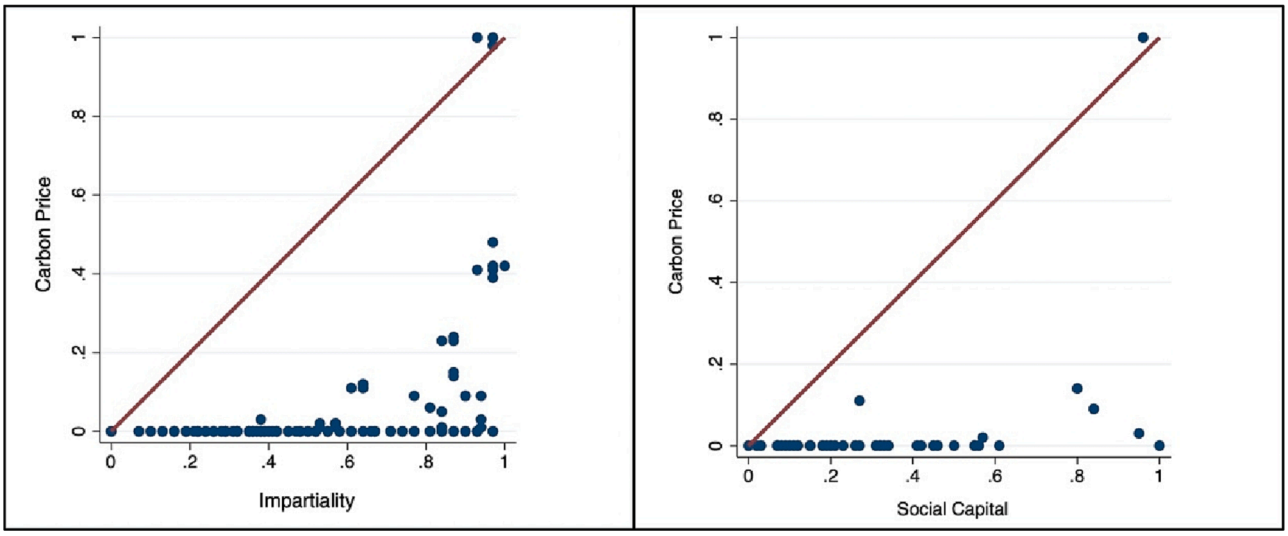


**Fig. 1.** Qualitative Comparative Analysis (QCA). A certain level of impartiality or social capital is necessary for a certain level of carbon prices, as revealed by data points below the main diagonal line.

performance measures are shown in Table 4. With the $R^2$ being at 0.805, the model explains about 80 percent of the variation in the dependent variables. The equation-level goodness-of-fit measures are included in the regression table in the Appendix. The root mean squared error of approximation (RMSEA) is with 0.041 relatively small, with a probability of 0.685 of being below the value of 0.05. Both the comparative fit index (CFI = 0.987) and the Tucker-Lewis index (TLI = 0.972) exceed the critical values of 0.95. Altogether, we have a well-fitted structural equation model. Following the values of the modification index, we also have accounted for correlation between the error terms of the Gini coefficient and the gender inequality index, as well as the errors between both inequality and social capital with the error of the standard of living.

Based on the direct effects shown in Table 5 our SEM model verifies the findings of the previously undertaken qualitative comparative analysis, which is that increased social capital and impartial governance support effective climate policy. The SEM also finds that impartiality support social capital via the route of the more equitable societies, and that social capital underpins higher carbon prices. In addition, we find that carbon prices are an effective climate policy as they significantly decrease the country's carbon emissions and the carbon intensity of

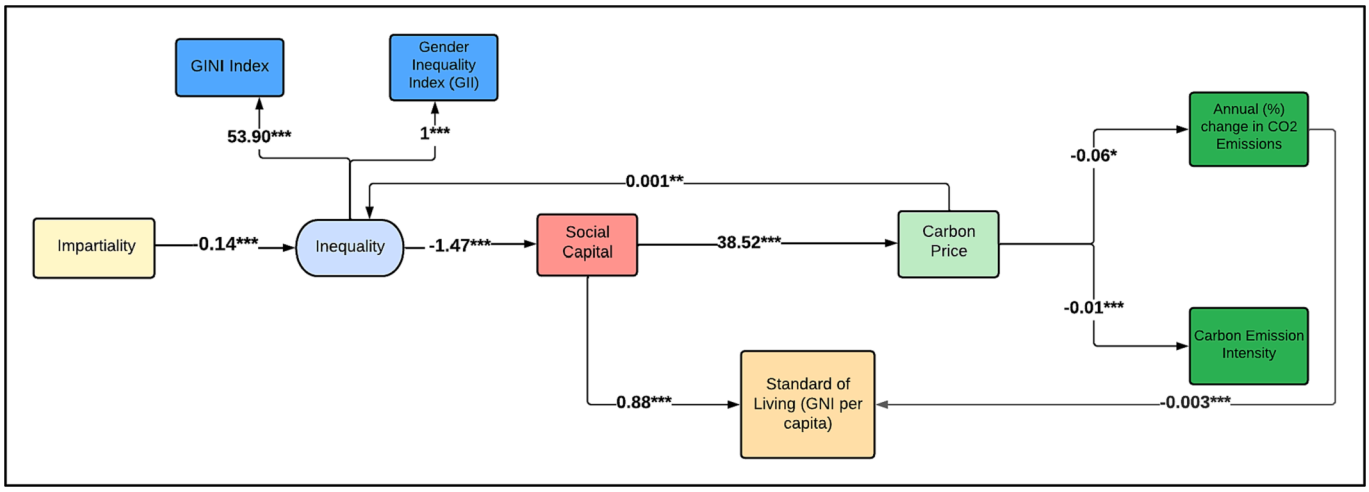


**Fig. 2.** SEM results for Period 2 for year 2011–13. **Equality and good governance, characterised by impartiality of institutions, relate significantly to trust in government, which in turn is a precondition for effective climate policies**. Structural equation modelling: Continuous lines indicate significant paths and dashed lines show insignificant paths. Significance level (***p < 0.01, **p < 0.05, *p < 0.10).

**Table 4**
Performance indicators.

| Performance Indicators | | Goodness of fit criteria |
|---|---|---|
| Root mean squared error of approximation (RMSEA) | 0.041 | RMSEA < 0.05 (p = 0.685) |
| Comparative Fit Index (CFI) | 0.987 | CFI > 0.95 |
| Tucker-Lewis Index (TLI) | 0.972 | TLI > 0.95 |
| Equation-level R-squared | | |
| Social Capital | 0.615 | |
| Carbon Price | 0.136 | |
| Gender Inequality Index (GII) | 0.773 | |
| GINI Index | 0.375 | |
| Inequality (latent variable) | 0.690 | |
| Standard of Living (GNI) | 0.138 | |
| Carbon Emission Intensity | 0.241 | |
| Annual change in Carbon Emissions (%) | 0.009 | |

**Table 5**
Direct and Indirect effects (only policy relevant variables).

| Pathways | Direct Effects | | Indirect Effects | |
|---|---|---|---|---|
| | **Coefficient** | **SE** | **Coefficient** | **SE** |
| Carbon Price -> Social Capital | No path | −0.001 | 0.000 | |
| Inequality -> Social Capital | −1.470 | 0.293 | 0.059 | 0.029 |
| Impartiality -> Social Capital | No path | 0.202 | 0.029 | |
| Social Capital -> Carbon Price | 38.518 | 6.505 | −1.544 | 0.846 |
| Inequality -> Carbon Price | No path | −54.369 | 10.193 | |
| Impartiality -> Carbon Price | No path | 7.780 | 1.063 | |
| Carbon Price -> Inequality | 0.001 | 0.000 | 0.000 | 0.000 |
| Impartiality -> Inequality | −0.143 | 0.020 | 0.006 | 0.003 |
| Overall Goodness-of-fit | 0.805 | | | |

energy use. There is, however, a negative feed-back loop from carbon prices to inequality, meaning that higher carbon prices increases inequality. This result points to the fact that a climate policy such as putting a price on $CO_2$ might be regressive. However, this effect is comparatively less relevant as can be seen in Table 5 where the direct effect from carbon prices to inequality is about three orders of magnitude smaller than the total effect from inequality to carbon price. That counter effect also explains the different signs for all the paths with direct and indirect effects, but again, the indirect effects are always much smaller than the direct effects. Social capital is also indirectly relevant: it support a higher standard of living, which in turn has a small effect on effective climate policy.

To illustrate our analysis, consider a few country examples. Sweden is the extreme case, with top values for both social capital (0.96 on a scale from 0 to 1) and impartiality (0.97 on a scale from 0 to 1). Sweden also has by far the highest carbon pricing (165USD/$tCO_2$). Similar, New Zealand boasts the trifecta of high social capital (0.95), high impartiality (0.95), and a relevant carbon price, though much smaller than Sweden (15USD/$tCO_2$). For comparison, consider Poland and Turkey, two countries of comparable economic size and income level (similar GDP per capita level and development trajectory between 2000 and 2016 (World Bank, 2023)). Poland has above median social capital and above median impartiality, whereas Turkey has below median social capital and below median impartiality. Poland has carbon pricing, but Turkey does not. This example also points to some variation due to regional allegiance. Singapore features higher in terms of social capital and impartiality, compared to Poland, but didn't have a carbon price in place. Here, the EU emission trading scheme made a difference. China is notable for its importance for global climate change mitigation. China features high social capital (0.99) but only medium levels of impartiality (0.47), featuring a low (but not zero) carbon price.

In summary, our analysis confirms previous research findings: social capital positively correlates with carbon pricing (Klenert et al., 2018), and so do indirectly impartial institutions. For example, a case study analysis of low-carbon transport policies shows that trust, and in particular trust in the competence of political decision makers, which is correlated with social capital, is central for support of more ambitious climate policies, such as $CO_2$ pricing (Kitt et al., 2021). This also holds from a macro perspective: An analysis of the most current data shows a clear relationship: Social capital is a necessary conditions for effective carbon pricing (Fig. 1).

### *4.3. Explaining relationships between QoG, equality, trust and climate policies*

Statistically significant relations found in the structural equation model are supported by literature investigating each path independently. A rich body of evidence emphasizes the importance of income

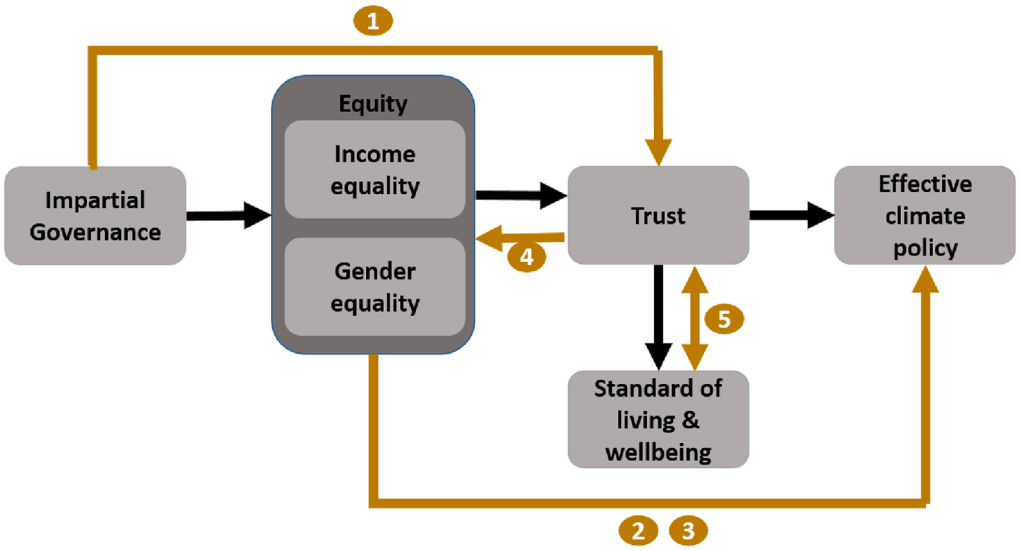


**Fig. 3.** Relationships between impartial governance, equality, interpersonal trust and effective climate policy as identified via structural modelling and literature review. See text for explanation and evidence on path arrows. Black arrows encode relationships identified in the Structural Equation Model of Fig. 2, whereas golden arrows encode relationships identified in the literature.

and gender equality for successful adoption and implementation of climate policies. The role of generalized trust and social capital for climate policies, however, is not established in this literature, making it difficult to verify the specific results of our empirical model. Nevertheless, as discussed in the following, this literature on two-way links broadly confirms the general direction of impact between specific links in our empirical model. Fig. 3 summarizes the relationships identified in the literature, as complementing the relationships identified in our SEM.

First, there is support for the claim that **impartial governance creates social capital and interpersonal trust** directly, not via social inequality ((1) in Fig. 3)**.** Impartial governance, understood as equal treatment of everyone through the rule of law, creates interpersonal trust procedurally and is thus a key enabler of inclusive and participatory demand-side climate policies (Kulin & Sevä, 2019; Rothstein, 2011). Impartiality via inclusive and broad-based participation itself similarly increases interpersonal trust. Higher social capital, interpersonal trust and inclusive participatory processes also reduce inequality, restrain opportunistic behaviour and enhance cooperation (Drews & van den Bergh, 2016; Gür, 2020) (thus affirming the relevance of equality).

Second, **income equality benefits climate policies** ((2) in Fig. 3)**.** More equitable societies have the institutional flexibility to allow for mitigation to advance faster; given their readiness to adopt locally appropriate mitigation policies, they also suffer less from policy lock-in (Seto et al., 2016; Vandeweerdt et al., 2016). Inversely, a number of studies demonstrate that alienation or distrust weakens collective governance and fragments political approaches towards climate action (Bulkeley and Newell, 2015; Fairbrother et al., 2019; Hayward & Roy, 2019; Kulin & Sevä, 2019; Smith & Mayer, 2018; Vossole, 2012). Worsening income inequality has been associated with higher global emissions in the period 1990–2019 (Diffenbaugh & Burke, 2019; Liu et al., 2020; Rao & Min, 2018). From 1985 to 2011, for a group of 35 developed countries, higher income inequality was linked to a tighter connection between economic growth and CO2 emissions, while decreasing income inequality reduced the association between economic growth and CO2 emissions (McGee & Greiner, 2018); in other words, growth in equitable societies is associated with lower emissions than in inequitable societies. A key reason is that conspicuous consumption by the wealthy causes a large proportion of emissions in all countries, leading to an increased consumption of positional goods across all social strata with net zero social benefits, as seen in highly inequal expenditures on such things as air travel, tourism, large private vehicles and large homes (Gössling & Humpe, 2020; Hubacek et al., 2017; Jorgenson et al., 2017; Kenner, 2019; Nielsen et al., 2021; Ramakrishnan & Creutzig, 2021; Sahakian et al., 2020).

Third, **gender equality supports effective climate governance** ((3) in Fig. 3)**.** Higher female political participation, controlled for other factors, leads to higher stringency in climate policies, and results in lower GHG emissions (Cook et al., 2019). Carbon emissions are lower per capita in countries where women have more political 'voice', controlling for GDP per capita and a range of other factors (Ergas & York, 2012; Mavisakalyan & Tarverdi, 2019; Opoku et al., 2021). In societies where women have more economic equality, their votes push political decision-making in the direction of environmental / sustainable development policies, less high-emission militarization, and more emphasis on equality and social policies (Bryan et al., 2018; Glemarec et al., 2016; Resurrección, 2013; UNEP, 2013). In contrast, climate change denialism is mostly male (Jylhä et al., 2016; McCright & Dunlap, 2011; Nagel, 2015). Women are more likely to be environmental activists, and to support stronger environmental and climate policies (McCright & Xiao, 2014; Whyte, 2014). The political contributions of women, racialized people, and Indigenous people who are socially positioned as those first and most affected by climate change are substantial (Dankelman and Jansen, 2010; Pearse, 2017; Vinyeta et al., 2016). Equitable power, participation, and agency in climate policy-making is hence an effective contribution for improving governance and decision making on climate change mitigation (Collins, 2019; Reckien et al., 2017).

Fourth, **social capital and interpersonal trust often renders societies more equitable** ((4) in Fig. 3). By facilitating cooperation, trust often leads to more equal outcomes, and trust facilitates policies that reduce net inequality (Bergh & Bjørnskov, 2014; Ivarsflaten & Strømsnes, 2013; Jordahl, 2011; Phan, 2008; Rothstein & Uslaner, 2005; You, 2012). Conversely, income inequality is also negatively correlated with political trust in American cities (Rahn & Rudolph, 2005).

Fifth, **social capital and interpersonal trust leads to improvements in well-being** ((5) in Fig. 3). Trust is associated with greater human development (Özcan & Bjørnskov, 2011) and with individual and country-level happiness (Tokuda et al., 2013) and life satisfaction (Mikucka et al., 2017). Social capital and trust in government institutions reduce wellbeing inequality and foster resilience, especially for those at lower levels of wellbeing (Helliwell et al., 2016; Nannestad et al., 2014). In so far as trust in other-regarding altruistic preferences and own other-regarding preferences are related (Fehr, 2008), evidence

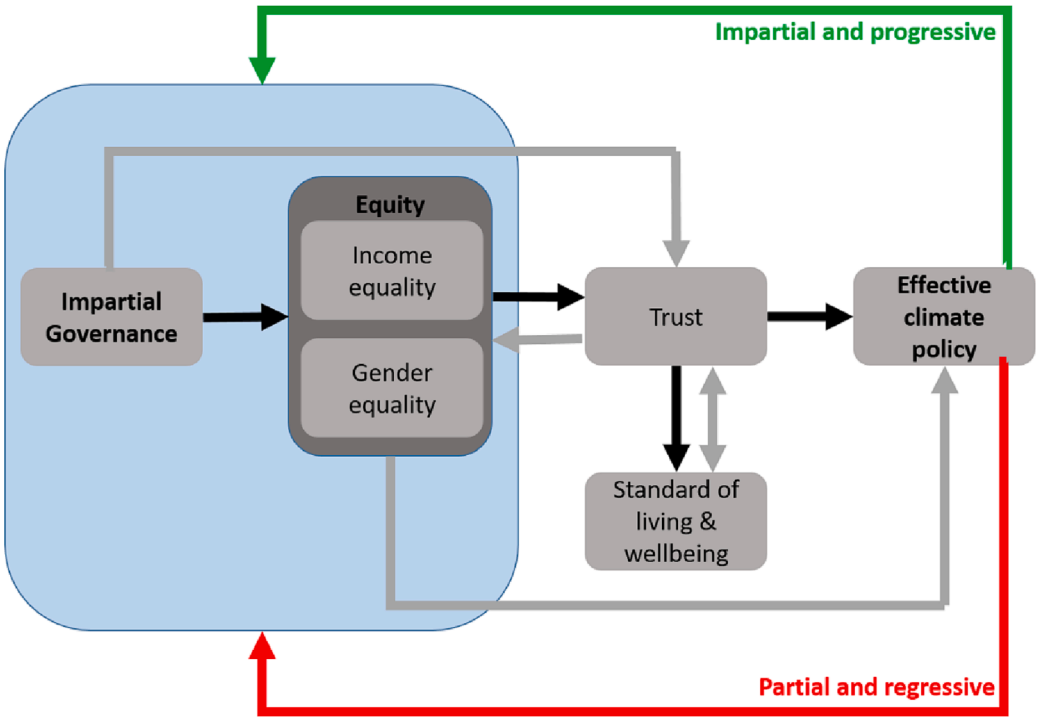


**Fig. 4.** Climate policies can reinforce or reduce the social precondition of their own implementation depending on their impartial and distributional design.

also points to a positive feedback loop between subjective and objective measures of well-being and social capital (Rhoads et al., 2021).

Thus, the literature documents strong interrelationships of two-way correlation among impartial governance, social capital, equality including gender equality, well-being, and strong climate policy; our model relates all of these to each other and tests the evidence.

### 4.4. *Bi-stability: feedback between trust and (impartial) climate policies*

The way climate policies are implemented has repercussions for equality and social (interpersonal) trust[28]. Well-implemented climate policies can be seen as furthering impartial governance. The impartiality of climate policies is of high relevance, as climate policies are often related to large scale redistribution of assets. In fact, some climate mitigation policies, such as badly designed carbon taxes, worsen global and local income inequalities (Diffenbaugh & Burke, 2019; Fremstad & Paul, 2019).

There are three closely related ways that design of carbon pricing circulates back into impartial governance, social equality, and indirectly into social capital. A central starting point is that $CO_2$ prices should be equal per ton of carbon, independent of source and sector, to incentivize optimal abatement of GHG emissions. Here there is little opportunity to change the design of the pricing scheme. However, revenue distribution is (mostly) independent of the pricing regime and thus offers opportunities for impartial and equitable design in policy packages. Revenue redistribution is also important because $CO_2$ pricing is often regressive since poorer households spend a larger portion of their income on energy. Three step-wise revenue distribution options can be considered. A first option is that revenues should be distributed impartially, i.e., according to a general rule and without means testing, for example as a climate dividend. As summarized above (Rothstein, 2011), this increases trust in government and quality of governance. A second option is to distribute the revenues such that the overall financial effects of the pricing scheme are progressive. These two options can be achieved, for example, by balancing the $CO_2$ prices with reduced taxation on electricity. A third consideration is to additionally increase the saliency of the revenue distribution, i.e., to increase the awareness of the impartiality and progressivity of revenue recycling. While this does not change objective metrics, it does change people's perception of the political process and, in particular, it helps to build trust in $CO_2$ pricing. A key measure to achieve this is lump-sum redistribution, ideally antedating the pricing incidence (or introducing both at the same time / day), to make personal benefits directly related and salient (Dominioni & Heine, 2019). Empirical evidence supports this argument. Lump sum redistribution that was very clearly and transparently communicated was a success factor in Iran's fossil fuel subsidy reform, whereas a lack of such strategies hindered the implementation of Nigeria's reform (Atansah et al., 2017). In British Columbia, Canada, revenues were clearly redistributed to citizens and businesses, and where carbon pricing was initially opposed, the measure gained increasing support (Murray & Rivers, 2015).

The evidence above combines insights from our structural equation model with robust results from the literature and supplements it with current understanding of carbon pricing revenue recycling. It points to a cyclical feedback system, where impartial governance and policies increase social capital and equality, which in turn helps to make effective climate policies more feasible. If climate policies are impartial themselves, they reinforce a virtuous cycle of increased equality and trust and effective climate action, whereas if climate policies are partial and/or regressive, they act as a negative feedback interrupting the cycle (Fig. 4). More generally, governance systems with a high level of corruption and low level of social capital will have weak preconditions for implementing effective climate policies, whereas systems based on high quality of governance and social capital will have comparatively easy points of entry for effective climate policies (cf. (Rothstein, 2011)). Importantly, climate policies should be impartial to maintain positive feedbacks reinforcing the desirable properties of this system.

Both cycles are stable equilibria and hard to change, resulting in a bistability in the joint governance-trust-climate policy system. Options to change from vicious to virtuous cycles are difficult to identify and beyond the scope of this paper. Indicatively, education has been suggested as the best entry point to change these dynamics (Rothstein, 2011). This is because universal public education creates a sense of equal opportunity and also generates the precondition for economic

equality. It gives parents a sense of optimism for their children's future, a hallmark of social trust. Individually, education also supports social capital. Bringing together children from different social, religious and ethnic backgrounds creates social capital. In addition, social capital emerges when inequitable economic incentive structures are removed and when both formal and informal actors are included in consideration (Ostrom, 2000; Stiglitz, 2000).

### 4.5. Social equality and trust drive climate change mitigation

Analysing the relationships between impartial governance, equality, social capital and climate policies, our analysis finds consistent evidence that impartial governance precedes social capital and equality, and that social capital and equality precede effective climate policies. Comparing our empirical model with the existing literature base, we find slightly diverging results on the precise intermediate relationships, notably on the relative role of social capital and equality. In our analysis, we consider not only income but also gender equality. Consistently, we find a strong positive role for both income distribution and gender equality in fostering social capital and climate action. We also identify a small but significant regressive role of carbon pricing and demonstrate the potential for a virtuous cycle, if carbon pricing revenues are redistributed progressively and impartially (e.g. with climate dividends).

These results matter because they show that equality and social capital are not independent from climate change mitigation but that their explicit consideration together is important exactly to strengthen climate policies. Economists sometimes isolate policy targets in order to address them separately (for example, the so-called Tinbergen rule advises that n different independent policy targets require at least n different policy instruments). This is understandable for theoretical analysis. But in practice, as our analysis shows, the apparently different policy targets – equality and climate change mitigation – are in fact related via intermediate variables, such as social capital and political acceptance. Policy makers are thus right to take a more comprehensive, 'big picture' view when designing carbon pricing.

Our insights draw attention to the question of whether social capital and Quality of Governance are preconditions for effective climate policies, and in turn, how climate policies can become supportive ingredients of the virtuous cycle. Specifically, our results support the proponents of a Green New Deal and the Build Back Better bill who aim to align strong climate change mitigation with environmental justice and progressive social policies. Our analysis, however, specifies the important role of impartiality – treating everyone according to the same rules. Though not always, this factor is often progressive, and an important characteristic of high quality governance per se.

Our analysis points out that lack of social capital and impartiality is a major barrier to climate change mitigation in many countries. As climate change mitigation is a global public good that can only be achieved together this is troublesome news. There are two directions for productively addressing this challenge. First, consider international efforts to increase Quality of Governance as crucial also in the context of global climate governance. Second, look for non-policy streams of climate action, such as increased deployment of renewable energy, making use of ever declining costs of such technologies.

Our analysis is also relevant for integrated assessment modelers. Dominant models that develop mitigation pathways and analyze policy options to reduce emissions currently do not incorporate socio-economic and political contexts. Our analysis could be used to better calibrate these models by informing them on enablers and barriers of climate policy.

Our results are relevant for the global assessment of climate change mitigation, as notably performed by the Intergovernmental Panel on Climate Change. Historically, social aspects of climate change mitigation have played a marginal role in IPCC assessments, although the most recent report included a chapter on demand, services and social aspects of mitigation (Creutzig et al., 2018). The importance of wider social systems, socio-economic equality, and the way societies cooperate globally has not yet been systematically considered. Our findings support the idea that future assessments should put social systems at the core of analysis (c.f. (Emmerling & Tavoni, 2021)), especially when considering the enabling factors for mitigation policies.

Finally, our analysis demonstrates the role of impartial governance and social capital, verifying that Bo Rothstein's insights on the Quality of Governance also apply to climate policies. We cannot, however, discount the importance of more decentralized approaches, as advanced by Putnam and Ostrom. In particular, Ostrom's theoretical approach to social capital (local, bottom-up, interpersonal) is underrepresented in this paper due to data limitations. In countries where extreme poverty and deep governance failures (in many cases legacies of colonialism and structural adjustment) seem to inhibit fair, effective top-down climate policies, collective social capital still exists at local levels and in informal-sector activities that have great potential for energy justice and decentralized low-carbon transformations (Garland, 2015). This indicates a strong role for collective social capital in informal settings, and in providing access to drudgery-reducing energy sources. We invite further analysis on such bottom-up processes of social capital and environmental governance, and their interactions with impartial top-down national state policies.

**Table A1**
Country list.

| Country List | Africa: | Africa: |
|---|---|---|
| | Burkina Faso, Ethiopia, Ghana, Mali, Morocco, Zambia<br>**Asia**:<br>China, Hong Kong, India, Indonesia, Iran, Iraq, Japan, Jordan, Malaysia, South Korea, Taiwan, Thailand, Turkey, Vietnam<br>**Oceania:**<br>Australia<br>**Europe**:<br>Bulgaria, Cyprus, Finland, France, Germany, Italy, Moldova, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom<br>**North America**:<br>Canada, Mexico, United States<br>**South America**:<br>Argentina, Brazil, Chile, Colombia, Peru, Trinidad and Tobago, Uruguay | Ghana, Morocco, Nigeria, South Africa, Tunisia, Zimbabwe<br>**Asia:**<br>Armenia, Azerbaijan, China, Egypt, India, Iraq, Kazakhstan, Lebanon, Malaysia, Pakistan, Philippines, Singapore, Taiwan, Thailand, Turkey<br>**Oceania:**<br>Australia, New Zealand<br>**Europe:**<br>Belarus, Cyprus, Estonia, Germany, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Ukraine<br>**North America:**<br>Mexico, United States<br>**South America:**<br>Argentina, Chile, Colombia, Ecuador, Peru, Spain, Uruguay |

### *CRediT authorship contribution statement*

**Felix Creutzig:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Frank Goetzke:** Conceptualizing, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Anjali Ramakrishnan:** Data curation, Visualization, Writing – original draft, Writing – review & editing. **Marina Andrijevic:** Writing – review & editing. **Patricia Perkins:** Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Table A2**
Regression.

| | Direct Effects | | Indirect Effects | |
|---|---|---|---|---|
| | **Coefficient** | **Std. err.** | **Coefficient** | **Std. err.** |
| Carbon Price -> Gender Inequality Index (GII) | No path | | 0.001 | 0.001 |
| Social Capital -> Gender Inequality Index (GII) | No path | | −0.629 | 0.126 |
| Standard of Living (GNI) -> Gender Inequality Index (GII) | −0.773 | 0.085 | No path | |
| Annual (%) change Carbon Emissions -> Gender Inequality Index (GII) | No path | | 0.003 | 0.001 |
| Inequality -> Gender Inequality Index (GII) | 1 | | 0.926 | 0.246 |
| Impartiality -> Gender Inequality Index (GII) | No path | | −0.276 | 0.012 |
| Carbon Price -> Social Capital | No path | | −0.001 | 0.005 |
| Social Capital -> Social Capital | No path | | −0.040 | 0.018 |
| Inequality -> Social Capital | −1.470 | 0.293 | 0.0589 | 0.029 |
| Impartiality -> Social Capital | No path | | 0.202 | 0.029 |
| Carbon Price -> Standard of Living (GNI) | No path | | −0.001 | 0.001 |
| Social Capital -> Standard of Living (GNI) | 0.878 | 0.137 | −0.028 | 0.0167 |
| Annual (%) change in Carbon Emissions -> Standard of Living (GNI) | −0.003 | 0.001 | No path | |
| Inequality -> Standard of Living (GNI) | No path | | −1.250 | 0.204 |
| Impartiality -> Standard of Living (GNI) | No path | | 0.179 | 0.011 |
| Carbon Price -> Carbon Emission Intensity | −0.013 | 0.002 | −0.001 | 0.001 |
| Social Capital -> Carbon Emission Intensity | No path | | 1.321 | 0.339 |
| Standard of Living (GNI) -> Carbon Emission Intensity | 2.136 | 0.282 | No path | |
| Annual (%) change in Carbon Emissions -> Carbon Emission Intensity | No path | | −0.007 | 0.002 |
| Inequality -> Carbon Emission Intensity | No path | | −1.943 | 0.497 |
| Impartiality -> Carbon Emission Intensity | No path | | 0.278 | 0.056 |
| Carbon Price -> Annual (%) change in Carbon Emissions | −0.060 | 0.028 | 0.002 | 0.002 |
| Social Capital -> Annual (%) change in Carbon Emissions | No path | | −2.192 | 1.102 |
| Inequality -> Annual (%) change in Carbon Emissions | No path | | 3.223 | 1.653 |
| Impartiality -> Annual (%) change in Carbon Emissions | No path | | −0.461 | 0.228 |
| Carbon Price -> Inequality | 0.001 | 0.000 | −0.000 | 0.000 |
| Social Capital -> Inequality | No path | | 0.027 | 0.013 |
| Inequality -> Inequality | No path | | −0.041 | 0.018 |
| Impartiality -> Inequality | −0.143 | 0.020 | 0.006 | 0.003 |
| Carbon Price -> Carbon Price | No path | | −0.040 | 0.018 |
| Social Capital -> Carbon Price | 38.518 | 6.505 | −1.544 | 0.846 |
| Inequality -> Carbon Price | No path | | −54.370 | 10.193 |
| Impartiality -> Carbon Price | No path | | 7.785 | 1.063 |
| Carbon Price -> GINI Index | No path | | 0.038 | 0.016 |
| Social Capital -> GINI Index | No path | | 1.469 | 0.713 |
| Inequality -> GINI Index | 53.900 | 7.313 | −2.160 | 1.023 |
| Impartiality -> GINI Index | No path | | −7.404 | 0.785 |

## Data availability

Data will be made available on request.

## Appendix

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