CLIMATE CHANGE AND WEALTH INEQUALITY: A LITERATURE REVIEW AND NUMERICAL INSIGHTS

LUCAS CHANCEL
CORNELIA MOHREN
PHILIPP BOTHE
GREGOR SEMIENIUK

WORKING PAPER N°2024/27

DECEMBER 2024

WORLD INEQUALITY LAB

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Lucas Chancel, Cornelia Mohren, Philipp Bothe, Gregor Semieniuk[1]

This draft: 4 December 2024

In this paper, we discuss the potential impacts of climate change and related policies on wealth inequality. To that end, we provide an extensive overview of the existing literature, which documents substantial impacts of climate risks on single asset types. We then present a case study to illustrate the potential magnitude of effects of climate policies on aggregate wealth and its distribution. We explore the impacts of climate-related investments, demonstrating that future climate investments could substantially shape the distribution of wealth between the private and the public. Similarly, we show that if the wealthiest global 1% were to uptake climate-related investments, their share of global wealth could significantly increase by 2050. These preliminary findings call for further research to better understand the intersection of climate change and wealth inequality.

1 Introduction

Rising wealth inequality and climate change are two of today's most pressing policy challenges, yet the interplay between them remains largely unexplored. In this paper, we review the related literature on this topic and present two illustrations of the potential magnitude of climate impacts on wealth inequality, highlighting the need for further research in this area.

The past two decades have seen major advances in measuring wealth inequality, with scholars utilizing administrative data, household surveys, and national accounts to produce detailed wealth statistics [1]–[5]. Insights from this literature have documented stark disparities in the global wealth distribution: the poorest half of the world's population holds just 2% of total wealth, while the richest 10% hold 76%. The distribution of wealth is also highly uneven within countries, with the bottom half owning less than 10% of the total wealth stock in many countries [6]. In addition, wealth is increasingly concentrated in the private sector. Since the 1970s, public wealth relative to national income has significantly declined, while private wealth has surged [2], [7]. In rich countries, private wealth has grown from 200-400% of national income in the early 1980s to 500-700% by the early 2020s. Meanwhile, public wealth has decreased from 60-100% of national income in the early 1980s to near or below zero today, leaving public sector debt in many countries surpassing public sector assets. Extreme concentration of private wealth has been linked to

[1]The authors acknowledge support from the Stone Program at Harvard Kennedy School, as well as from a European Union Horizon 2020 grant (WISE). Lucas Chancel: Harvard Kennedy School, Sciences Po and Paris School of Economics, lucas.chancel@sciencespo.fr; Cornelia Mohren: Paris School of Economics, cornelia.mohren@psemail.eu; Philipp Bothe: Paris School of Economics, philipp.bothe@psemail.eu; Gregor Semieniuk: UMass Amherst and World Bank, gsemieniuk@umass.edu. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

impacts on economic and political systems [4], [8], [9], as well as economic power dynamics [10]. In addition, long-term trends in public and private wealth concentration can have macroeconomic effects, including on debt and monetary policy [4], [11].

The climate literature, at the same time, has shown that climate change exacerbates income inequality both within and between countries, with poorer populations experiencing greater exposure and vulnerability to climate impacts [12]–[20]. Additionally, numerous studies highlight how climate policies can worsen both vertical and horizontal inequalities, underscoring the importance of thoughtful policy design and compensatory mechanisms to mitigate these effects [21], [22]. While income is an important driver of wealth accumulation, using insights from income-focused studies to project climate-driven wealth inequality would overlook key differences: Wealth is not only more concentrated than income, but climate risks might also shape it through distinct mechanisms.

The literature at the intersection of wealth inequality and climate change has explored the carbon intensity associated with wealth, revealing that affluent individuals disproportionately contribute to climate change: the carbon footprint of the average top 10% wealth holder in countries like France and Germany is estimated to be three to five times that of individuals in the lower half of the wealth distribution [23]. Wealth concentration also correlates with a concentration of financial resources for climate adaptation and mitigation efforts. A modest wealth tax of 1.5% on individuals holding assets over USD 100 million—representing merely 0.001% of the global population—could generate the funding needed to protect vulnerable populations globally from escalating climate impacts [24].

However, only few studies have investigated the impacts of climate change and related policies on wealth inequality. This paper takes an initial step to address this gap. We start by presenting an extensive review of the empirical literature on climate effects across single asset types. We then provide two illustrations of the potential magnitudes of these effects on aggregate wealth and its distribution. First, we use econometric methods to estimate past effects of climate shocks on wealth inequality within countries. We find that for relatively hotter countries, increasing temperatures are likely to impose an additional barrier to wealth access for the poorest parts of the population. We do not find such effects for wealthier population groups. Second, we investigate the potential effects of future climate investments on global wealth inequality. Our calculations indicate that the impacts could be substantial: When the private sector performs all necessary climate investments until 2050, the private/public wealth ratio could increase from 2.3 nowadays to 2.7 in 2050. Moreover, if the richest 1% of global wealth owners own all new climate-related investments in the next decades, their share in global wealth might rise from 38.5% today to 46% in 2050. These potentially profound implications of climate change and climate policy for future economic inequality call for further research by climate and wealth scholars.

The remainder of this paper is structured as follows. We present the literature review in Section 2. In Section 3, we provide numerical insights on the potential magnitude of climate risks on wealth inequality. Section 4 concludes.

2 The Limited Focus of the Climate Literature on Wealth Inequality

Earlier studies on the impact of climate risks on wealth have either investigated the impact of climate change on different asset types, or quantified global investment needs and stranding risks associated with ambitious climate policy. This research has largely been sectoral, with limited focus on aggregate wealth dynamics and minimal attention to wealth distribution dynamics. In the following section, we summarize this body of literature to provide an initial perspective on climate-induced wealth dynamics and to motivate further research in this area. We distinguish between non-financial assets (e.g., housing, land, and natural capital) and financial assets (e.g., equity and bonds), recognizing the different significance of these asset classes across the wealth distribution.

2.1 Impacts on Non-financial Wealth

Climate change has a significant impact on the value of non-financial assets. Starting with housing, several studies have found that climate risks - both acute (such as floods, hurricanes or forest fires) and chronic (such as sea level rise) - are priced into residential real estate. Most of the literature is centered on the US [25]–[30], but there also exists some evidence for other countries [31]–[34]. Furthermore, commercial owners and investors place higher risk premiums in areas exposed to climate events, sometimes even if their own properties are not directly affected [35]–[37]. In this context, some studies also highlight the importance of beliefs and information about climate risks for people's valuation of risks [26], [38]–[41].[2]

Another strand of the literature analyses the impacts of climate change on agricultural land values. Findings vary depending on the region under study; while changing temperatures and precipitation patterns could substantially increase the values of French farmland by the end of the century [43], case studies predict predominantly detrimental effects of global warming on farmland values, in low-income [44] as well as in high-income countries [45]–[49]. Parts of the literature also describe substantial impacts of climate change on agricultural productivity and livestock without making explicit the resulting movements in land values [50]–[57].

Climate change not only affects housing and land, but also natural capital, for example through the degradation of glaciers, forests and oceans, as well as its profound impact on biodiversity [58], [59]. Several studies estimate that the resulting economic losses will be material [60], given that more than half of the world's total GDP is moderately or highly dependent on nature [61]. For example, the present value of forest land in Europe is expected to decrease by 14% to 50% until the end of the century [62]. Several characteristics of (and benefits provided by) natural capital, which are not traded on markets (such as water purification, carbon absorption or cultural services) will be affected by climate change. According to one study, their value - which is much

[2] A more extensive summary and discussion of the literature is provided by Clayton et al 2001 [42].

more difficult to quantify - could diminish significantly [63], with projections indicating a potential devaluation of up to 9% by the year 2100 [64].[3]

Turning from climate change to climate policies, several studies quantify the investment needs for a net zero transition [54]–[56], [65], [66]. An average estimate of cumulative spending needs until 2050 stands at USD 266 trillion [56], implying that global annual climate finance must increase by a factor of five as quickly as possible. Investment needs are largest in the buildings & infrastructure, energy and transport sectors. The decarbonization of the housing sector will for example require the retrofit of almost all existing buildings, as well as the application of stringent energy efficiency standards to new construction [65], which has increased the value of properties in the past [67], [68]. Natural capital is affected as well, as the transformation of the energy sector will likely stimulate investments in renewable resource flows (e.g. wind and solar energy) as well as carbon sequestration (e.g. reforestation) [55].

Climate policies will not only require the creation of new - low carbon - capital, but will also lead to stranding of high-carbon assets. This means that assets that are harmful to environmental objectives, such as manufacturing equipment for internal combustion engines or oil and gas pipelines, will be potentially underutilized or retired before the end of their useful life [69]. The stranding of physical capital could be substantial. For example, one study calculated that future carbon emissions from all fossil-fuel-burning infrastructure (industrial infrastructure, electricity infrastructure, existing residential and commercial infrastructure, etc.) that was existing and planned as of 2018 already exceeded the entire carbon budget for 1.5°C [70]. Several studies also attempt to assign monetary values to these stranding risks, in particular for the fossil fuel sector, building up on the insight that a substantial share of existing fossil-fuel reserves that contribute to fossil-fuel companies' assets cannot be extracted with stringent mitigation [71]. Thus, depending on the study design, under a 1.5° temperature scenario, the assets of the upstream oil and gas industries are supposed to lose USD 7.3 to 12.1 trillion and USD 3.7 to 4.1 trillion in value, respectively [72]. Using a methodology that emulates the expectations and valuation procedures used by fossil fuel firms, on study estimates that fossil fuel reserves will suffer a devaluation up to 50% until 2040 under a 1.5°C temperature scenario [73]. Another study also finds that the global stock of commercial and residential property could lose about one tenth of its current value due to asset stranding [74].

2.2 Impacts on Financial Wealth

The revaluation of financial assets from climate impacts and policies is more complicated than analysing physical assets. In addition to the cost and physical productivity of the underlying physical asset, the values of financial assets value also depend on expectations about a wide range of market and macroeconomic factors [75]–[77]. For instance, credit risks arise when the destruction of physical assets or economic shocks not only leads to non-performing loans for the

[3] For an extensive discussion of the risks of climate change on natural capital and its economic consequences see Ranger et al 2023 [63].

destroyed assets but elevates expectations of default for other assets in this class, raising interest rates and lowering the value of bonds. Holders of financial assets are also exposed to market risks, for example, when prices adjust to the revaluation of companies that are expected to lose market share even as they are still fine in the present. Therefore, expectations about future technologies [78] matter as well as policy announcements [79], [80] or the appointment of climate skeptics in government institutions [81].

A broad body of literature finds that climate-related risks are already, at least partially, priced into financial assets. Starting again with the physical impacts of climate change, numerous studies document the repercussions of increasing dryness, hurricanes, and rising sea levels, in different types of financial assets such as bonds [82]–[84] and equity portfolios [85]–[89].The effects are particularly strong when these assets are associated with facilities situated near disaster-prone areas or belong to sectors notably vulnerable to climate-related disruptions, such as agriculture and the food industry [90]. Climate disasters can also curtail access to credit [91] and threaten the stability of banks across countries, for example if the ratio of nonperforming loans increases or if they provoke bank runs [92]–[95].

Not only climate change, but also climate policies, affect the value of financial assets. Several studies provide ex post impact evaluations of climate policies and find effects on stock returns, the cost of equity, or the interest rate spread, for example, in the context of the Paris agreement [96] or the Shenzhen Pilot ETS [97]. A key role could be played by central banks and financial regulators if they decide to intervene to try and make the financial system resilient against transition and physical risks [98], [99].

To estimate the future impacts of different transition scenarios on financial assets, various studies quantify the exposure of sovereign and corporate bonds, as well as equity holdings and investment, insurance or pension funds to climate policy-relevant sectors [100]–[103]. Climate policies primarily threaten high-carbon assets from high-emission firms which are at risk of stranding [104]. Low-carbon assets of companies with low carbon intensity or from renewable energy producers, at the same time, are considered beneficiaries of a low carbon transition [105]–[111]. In this context, some authors analyse if investors price climate risks correctly [38].

Importantly, different reports highlight that the financial risks associated with the transition might become systemic [102], [112]–[114]. Studies also show that a stronger and smoother climate action leads to less financial system losses than a business-as-usual pathway or a delayed and disruptive transition [94], [115], [116]. Notably, a large share of the research literature on the impact of climate risks on banking stability and financial stress is published outside of or in collaboration with academia [55], [104], [115]–[118].

2.3 Unequal Impacts

Some parts of the literature implicitly address wealth inequality by discussing the ownership of affected assets, mostly on country level. In general, the threat of climate change on non-financial and financial assets is considered to be greater for developing countries than for developed countries, as they are both more exposed and more vulnerable [118], [119]. There are also differences among developed countries; in Europe, for example, impacts of sea-level rise are concentrated in few regions [120]. In addition, there exists evidence for substantial differences in bank exposures to transition risks [94] as well as insurance gaps for physical risks between countries: In the European Union, currently only about 35% of economically relevant climate losses are insured, with substantial protection gaps for specific physical risks in some countries [94]. Climate investment needs and stranding risks particularly concern countries with lower GDP per capita and/or substantial fossil fuel resource production [55]. In this context, one study quantifies the heterogeneity in the exposure to transition risks of sovereign bonds from OECD countries [121].

A few studies also explicitly analyse the effects of climate risks on wealth inequality. One study projects that the global capital-to-net-income ratio first increases in this century to an unprecedented level due to a stronger effect of climate change on production than on capital and decreases in the next century when destruction of physical capital begins to dominate the production effect [122]. The implications of such fluctuations in the capital-to-income ratio are significant for inequality given the large concentration of wealth [4]. In a modeling analysis of flood risks in the Netherlands, another study finds that climate disasters exacerbate wealth inequality as low-income workers suffer relatively greater income losses, while the savings rate of wealthier households rises [123].

Two studies come closest to our primary question. One of them estimates a substantial impact of temperature and precipitation anomalies on the distribution of material wealth between households in low- and middle-income countries [124]. Material wealth encompasses durable goods such as cars, but excludes other important assets such as housing and financial assets, which play an important role in asset portfolios of wealthy households [6]. Another study directly analyses the distribution of fossil fuel ownership and infrastructure at risk of stranding [125]. The authors find that losses from pension plans of rich Western governments primarily affect the wealthiest (i.e. adults who own several million USD on average). Similar research on the effects of climate change on a more comprehensive measure of household wealth as well as ownership patterns of other assets and more countries will be necessary in order to assess the broader implications of climate change and climate policies.

To summarize, the current literature finds that climate and related policy shocks have significant effects on all forms of capital. While it is well established that these effects exhibit variations across asset types, regions, sectors, and financial institutions, existing research has rarely analyzed implications on aggregate and distributional wealth dynamics in a systematic manner.

3 Global Wealth Inequality Projections under Alternative Climate Investment Scenarios

As highlighted in the literature review, a key component of the net-zero transition will be substantial investments in low-carbon capital. In this section, we integrate existing estimates of these investment requirements with data on public and private wealth to assess their possible impacts on wealth distribution. Here, we broaden our scope to consider other dimensions of wealth inequality, specifically global inequality between households and the distribution of wealth between the public and private sectors, in contrast to the focus on within-country inequality effects in the previous section.

Specifically, we project global public and private wealth stocks, and the inequality of global wealth ownership, between now and 2050, under different climate investment scenarios. We begin by forecasting the potential trajectories of the public and private capital stock-to-GDP ratio by 2050, contingent on which sectors finance the necessary investments to achieve the 1.5°C climate target. We then examine the evolution of the share of private wealth held by the wealthiest 1% of the population, assuming they play a leading role in filling the climate investment gap.

We start by describing our data and methodology before presenting the projections of the impact of climate investments on public and private wealth inequality. We also discuss the shortcomings of our basic projections and highlight the need for further research.

3.1 Data and Methodology

For our analysis, we combine estimated climate investment needs from the Climate Policy Initiative (CPI) [56] with data on the historical evolution of capital by public and private entities from the IMF Investment and Capital Stock Dataset (ICSD) and data on personal wealth inequality from the World Inequality Database (WID).

Projections of the new climate capital stock by 2050

To begin, we estimate the annual climate investment requirements from 2025 to 2050, in order to ultimately determine the value of the additional capital stock in 2050. According to the CPI, aggregate investment needs are projected to reach USD 266 trillion over this period, based on a synthesis of various scenarios and models on climate finance requirements.[4] These investments are not distributed evenly across the 26-year span but vary significantly over time (see Figure A.1). We have requested more granular data, but have not yet received it. To approximate the fluctuation in annual investment needs, we decided to extract values for 2025 and 2031 using a web plot digitizer (automeris.io), and interpolate the remaining data points linearly. Following a similar approach, we estimate the lower and upper bounds of investment needs, which sum to approximately USD 217 trillion and USD 312 trillion, respectively, from 2025 to 2050.

[4]The methodology accompanying the CPI report provides detailed explanations of the data sources, including widely referenced estimates from the IEA, which tend to be on the lower end of the range.

We assume that these "gross" investment needs will be reduced by current climate finance levels and by fossil investments redirected to climate finance in the future. According to the CPI, existing climate finance represents approximately 0.7% of GDP for both private and public sectors, a share we assume remains constant, all else being equal. For consistency in calculating this ratio, we adopt the CPI's approach of aggregating current climate finance across countries using market exchange rates (without adjusting for purchasing power differences), and estimate global GDP similarly, using exchange rates from the WID. In 2022, fossil investments constituted roughly 0.9% of GDP, a ratio we also assume will hold steady over the period studied. Additionally, we assume that fossil investments are equally financed by public and private sectors.

In a next step, we express the value of additional climate investments as a share of 2050 GDP. To get there, we assume that real GDP is exogenous and grows at a rate of 2% per year in the first step. This allows us to compute annual climate investment needs as a share of GDP.[5] Finally, in order to compute the total value of the new climate capital stock by 2050, we depreciate the investments based on depreciation rates used by the IMF (see the Supplementary section 4 for a more detailed discussion). We also provide an lower and an upper bound, applying our methodology to the range of climate investment needs scrapped from the CPI report.

Projections of public and private capital stocks in 2050

We first want to investigate the potential evolution of public and private capital under different climate financing scenarios. In order to project the capital stocks of the two sectors in 2050 in the absence of climate investments, we rely on data from the IMF ICSD. This data base covers capital stocks and investments of the general government, the private sector, and public-private partnerships in 170 countries [126]. In our predictions, we make the simple assumption that the capital shares of total GDP of the sectors remain at the same level as in 2019. This is motivated by two reasons. First, the ratio of capital stock to GDP is indeed quite stable over time (see Figure 1). Second, we have made a similar assumption for climate investment, namely that it remains at its 2022 level as a share of GDP.[6]

[5]For example, for 2025 we predict an average gross climate investment need of 8.1% of GDP. If we now assumed that the public sector aimed to fill this gap (i.e. it redirects its fossil fuel subsidies, but the private sector does not), its average finance gap would be at 8.1%-0.7%-0.7%-0.45%=6.25% of GDP.

[6]An important motivation for this assumption is that past observations are limited due to a lack of data, definitional clarity and granularity [56].

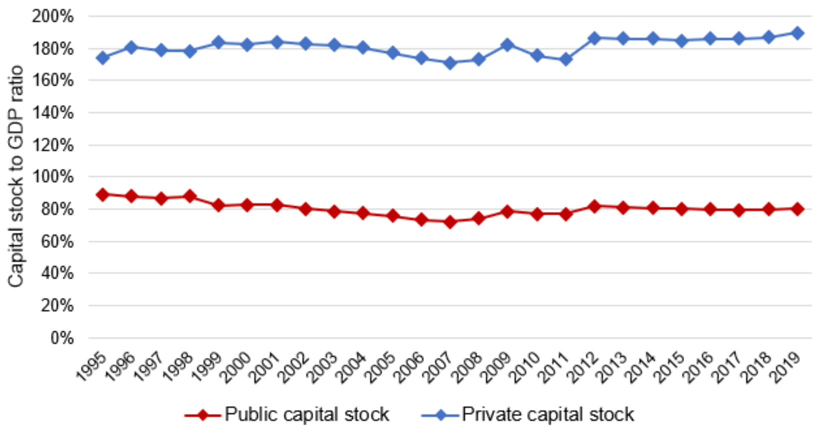

Figure 1. Ratios of the Capital Stock to GDP between 1995 and 2019 [126]

The only minor modification we make to the data is to adjust for differences in the definition of capital and the distinction between the public and private sectors between the IMF and the CPI. First, neither the public nor the private investments reported by the IMF take into account the investments of bilateral DFIs, sovereign FIs, multilateral DFIs and national DFIs, which however account for 66.4% of public climate investments and 33.6% of total climate investments in 2022, as well as 0.4% of GDP in 2022, according to the CPI report. We therefore decide to add these investments to the public capital stock (expressed over GDP), and we apply the same average depreciation rate to this additional capital stock as to our projections of climate capital stock. Second, SOE investments are classified as private investments by the IMF but as public investments by the CPI, according to which they account for 17.2% of public climate finance and 8.7% of total climate investment in 2022. When considered as private, they account for 0.6% of the private investments reported by the IMF. Therefore, we assume that the private capital stock in % of GDP is equal to the stock reported by the IMF minus 0.6pp, and the public capital stock in % of GDP is equal to the stock reported by the IMF plus 0.6pp. Lastly, we divide the (rather negligible) public-private capital stock and investments equally between the public and private sectors.

In our projections, we then model two scenarios: In the first scenario, the public sector owns 100% of the new climate capital by 2050. In the second scenario, ownership of the new climate capital lies entirely with the private sector. To predict the resulting capital-to-GDP ratios for each sector in 2050, we then simply need to add the projected additional climate investments as a percentage of GDP in 2050 to the existing estimates of private and public capital stocks.

Projections on the evolution of the top 1% wealth share

In a next step, we project the development of the share of wealth (rather than capital) of the richest 1%, assuming that they finance the complete climate investment needs identified above. We distinguish between two scenarios: One where they subsequently own the required climate investments (i.e. their wealth grows, Scenario 1), and another where they finance the needs through a wealth tax (i.e. their wealth decreases, Scenario 2). We obtain the total global private wealth in 2019 as well as the share held by the top 1% in 2022, $s_{top1,2022}$, from the WID database.

It is important to note a key difference between the IMF's definition of capital and WID's definition of wealth (see Figure A.2). The IMF defines capital as non-financial, produced assets, whereas WID's definition of wealth is broader, encompassing non-financial, non-produced assets like natural resources and land, as well as all types of financial assets, including deposits, pensions, and shares. Additionally, WID provides information on net wealth (after deducting debt), while the IMF reports only gross capital, without accounting for how capital investments are financed.

In our projections, we add or subtract additional climate capital directly to the wealth held by the top 1% wealth group. Hence, this approach may underestimate potential impacts, as it excludes the effects on other assets that may comprise the total wealth held by this wealth group. This method should be seen as simplistic, but also has the advantage of being explicit and transparent.

In a first step, we construct the 2019 ratio of private wealth to GDP, $(W/Y)_{2019,priv}$. In addition, from our computations in the previous section, we derive the private and public capital stock to GDP ratios for each year between 2020 and 2050 ($t \in [2020, 2050]$), $(C/Y)_{t,priv}$ and $(C/Y)_{t,publ}$, assuming that the respective sector fills the cumulative climate investment gap until that year.

As in our projections for the evolution of public and private capital, we assume that the ratios of capital and wealth to GDP as well as the top 1% wealth share would have remained constant if no climate investments were made, i.e., that wealth and capital increase at the same rate as GDP for all wealth groups. Denoting with a $\bar{t}$ index the scenario in year t without any additional climate investments, this implies that $(W/Y)_{\bar{t}} = (W/Y)_{2019}\ \forall t$, $(C/Y)_{\bar{t}} = (C/Y)_{2019}\ \forall t$ and $s_{top1,\bar{t}} = s_{top1,2022}\ \forall t$.

We can then project the evolution of the top 1% wealth shares for all years between 2020 and 2050 under the two scenarios of climate finance provided by the richest 1%.[7] In Scenario 1, we assume that the richest 1% fill the climate investment gap, and we abbreviate $\Delta(C/Y)_{t,priv} = (C/Y)_{t,priv} - (C/Y)_{\bar{t},priv}$. The share of wealth held by the top 1% can then be expressed as

$$s_{top1,t} = \frac{s_{top1,\bar{t}} * (W/Y)_{\bar{t},priv} + \Delta(C/Y)_{t,priv}}{(W/Y)_{\bar{t},priv} + \Delta(C/Y)_{t,priv}} \qquad \text{(Scenario 1)}$$

In Scenario 2, we assume that the richest 1% pay a tax to the public sector, which then fills the climate investment gap. This implies that total private wealth in year t is reduced by the amount that is transferred from the top 1% to the government.[8] Denoting $\Delta(C/Y)_{t,publ} = (C/Y)_{t,publ} - (C/Y)_{\bar{t},publ}$, the projected top 1% wealth share under this scenario writes as

$$s_{top1,t} = \frac{s_{top1,\bar{t}} * (W/Y)_{\bar{t},priv} - \Delta(C/Y)_{t,publ}}{(W/Y)_{\bar{t},priv} - \Delta(C/Y)_{t,publ}} \qquad \text{(Scenario 2)}$$

[7] Note that we assume that the top 1% finances these investments without needing to issue debt. We also assume that these investments have the same rate of return as average investments in the economy.

[8] Here we abstract from any potential effect of such a tax on the total value of public or private wealth, and of wealth inequalities in order to isolate the specific effect, ceteris paribus, of the tax.

3.2 Projections

Let us now turn to the results of our projections. In Panel A of Figure 2, we first present the observed and projected values for private and public capital as a share of GDP in 2000, 2019, and between 2025 and 2050. Under the first scenario (S1), where the public sector fills the climate investment gap between 2025 and 2050 and subsequently owns the additional capital stock, we project that the public capital stock to GDP ratio shifts from around 80% in 2016 to more than 110% in 2050 – an increase of more than 40%. Such an accumulation of public capital would substantially alter the distribution of wealth, and could decrease the ratio of capital that is held privately vs publicly from 2.3 in 2019 to 1.6 in 2050. Conversely, when the private sector performs all additional climate investments (S3), we estimate that its capital position could be at 216% as a share of 2050 GDP, implying that the private/public ratio could increase from 2.3 nowadays to 2.7 in 2050. We also present a scenario where both the public and private sectors contribute equally to financing half of the investment gap (S2). This, again, would particularly affect the public wealth position in relative terms, considering its lower baseline in 2019.

Panel B of Figure 2 shows possible trajectories for the global top 1% wealth share if the richest percent owns all required climate investments (green dashes) or if all these investments are financed by a tax on the top 1% and then invested and owned by the public sector (red dots). Under the first scenario - keeping everything else as in 2019 - the share of wealth held by the richest 1% of the global population could increase from 38.5% nowadays to 46% in 2050. If, on the other hand, we assume that the richest 1% pay a tax to the government, which then uses the revenue to close the climate investment gap, their share of wealth could fall by around 13 percentage points to 26%.

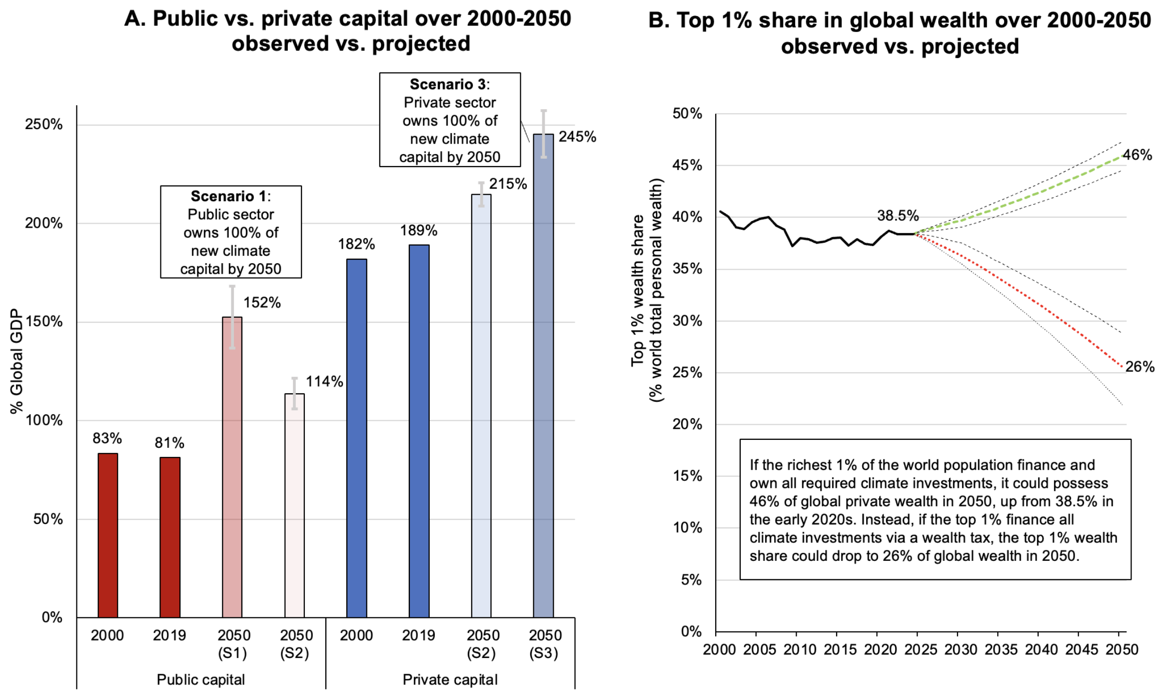

Figure 2. Projections of Global Wealth Inequality Under Alternative Climate Investment Scenarios, 2020-2050

Panel A presents observed and projected values for private and public capital as a share of GDP. Scenario 1 (S1): the public sector performs all additional required climate investments (compatible with the objectives set by the Paris Agreement) and subsequently owns the associated additional capital stock. S2: the public and the private sector perform half of required climate investments and own half of the additional capital generated. S3: the private sector performs all additional required climate investments and subsequently owns the associated additional capital stock. **Panel B** presents possible dynamics of the global top 1% wealth share if the top 1% owns all required climate investments (green dashes) and if all these investments are financed by a tax on the top 1% (red dots). Source: [127].

3.3 Limitations

The basic projections presented above suffer from many limitations. First, let us stress that they disregard any behavioral or dynamic responses to climate investments, which should be taken into account in further work. A better understanding of how savings rates and returns on different asset types might vary under different climate and policy scenarios should be at the heart of wealth inequality research in the coming years. Such analyses will help build models much more elaborate than the simple calculations presented above.

Focusing on investment needs, we also note that the actual estimated volume of climate investment is also subject to uncertainties and should be read with caution (see Appendix Figure A.1 in particular). However, alternative estimates found in the literature point out to needs of broadly similar orders of magnitude of cumulated investment needs. In addition, the dotted lines in Figure 2 show that the projected effects on public and private wealth ratios remain substantial when estimates of the lower and upper bounds of investment needs are used.

One key parameter in the estimation of past and future investment needs and of the total capital stock is the rate of depreciation of capital and in particular climate capital. Here, we use implied average depreciation rates (see Appendix) for the private and public sector for the world as a whole.

We acknowledge that country-level estimates on investment needs combined with country-level depreciation rates would help increase the precision of our estimates. We argue that we are likely to overestimate the depreciation of climate capital accumulated, rather than underestimate it.

Focusing on top 1% projections, let us start by stating that many alternative scenarios can be thought of. In particular, we have not looked at cases where the public sector subsidizes private capital investments (in line with the U.S. Inflation Reduction Act): in this case, the difference in the capital to GDP ratio of the private vs the public sector could be magnified. Conversely, more or less progressive tax scenarios could be thought of to finance varying levels public investments.

Overall, our findings call for a more in-depth scrutiny of possible mechanisms connecting climate change and wealth inequality.

4 Conclusion

In this paper, we have addressed the significant but underexplored intersection of climate risks and wealth inequality. A growing body of research has documented substantial effects of climate change and associated policies on various asset classes. For example, it is well established that climate events affect the value of housing, land and businesses, as well as financial assets through related credit and market risks. Likewise, the fight against climate change requires massive investment in low-carbon infrastructure and poses stranding risks for carbon-intensive assets. However, more research is needed to understand the aggregate and distributional wealth effects of these climate risks.

To advance in this direction, we have provided a numerical case study on the impact of climate change and climate policies on different dimensions of wealth inequality. We have shown that, under very simple assumptions, climate investments in the coming decades could significantly affect the private/public wealth ratio and the share of wealth held by the top 1%: Specifically, we showed that if the public sector were to undertake and own all new climate-related capital, the value of publicly held capital worldwide is likely to almost double. We also find that the sheer volume of climate investment could have significant upward or downward implications for global inequality, depending on which groups finance these investments. In our simple projections, the share of global wealth owned by the global top 1% could rise up to 46% or drop to 26% by 2050, depending on how climate investments are financed and their property rights defined. These scenarios are nothing more than "naive" projections into a future made of many unknowns, but they illustrate how different climate investment strategies can significantly impact who will own the capital built to shield societies from climate change and could reap benefits of this ownership.

Overall, these potentially profound implications of climate risks for future economic inequality call for further research by climate and wealth scholars.

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Appendix

Supplementary information

Constructing depreciation rates

One challenge in our projections presented in Section 3 is to find an appropriate rate to depreciate the stock of necessary climate investments over the next few decades. As we combine the forecasts for climate investments with the IMF's capital stock projections, one intuitive option would be to simply use the IMF's depreciation rates. These rates vary over time and by country income group. However, IMF depreciation rates are applied to investment data after converting them to constant 2017 international dollars. Applying these rates to past data converted to 2022 USD - which is our unit of interest - results in estimates that substantially differ from the capital stock reported by the IMF.

In addition, we need a depreciation rate that reflects the development of the aggregated capital stock (rather than different depreciation rates depending on the income level of countries). Therefore, we decide to rely on implied depreciation rates for our predictions. This means, we take historic IMF capital data and calculate the implicit depreciation rates of the capital stock aggregated to the global level and converted to 2022 USD.[9] We assume that climate investments depreciate at different rates depending on whether investments are done by the public or the private sector. Since these implied depreciation rates are very volatile, we take the mean of the last 20 years and apply it to our projections (instead of assuming a monotonically increasing depreciation rate as the IMF does in its 2017 calculations in constant USD). The implicit depreciation rates in current 2022 USD are slightly higher than in constant 2017 international USD (see Table 1), i.e. using them leads to a more conservative estimate of the resulting value of the climate capital stock in 2050.

	Private capital stock	Public capital stock
Constant 2017 international dollars	6.15%	3.58%
2022 USD dollars	6.35%	4.03%

Table 1. Average depreciation rates in the aggregate IMF private and public capital stocks between 2000 and 2019, for different currencies

Note that with this approach we implicitly assume that the future climate investment gap will be filled to similar shares by low-, middle- and high-income countries, as is the case with current investments. This, again, is a conservative approach: In 2019, total private (public) investments in 2022 USD were financed to 58.28% (40.41%) by high income and to 41.34% (59.01%) by middle income countries; the contributions of low income countries were below 1%. From the

[9]To construct the historic capital stock, we use investment data and a capital accumulation equation used by the IMF.

CPI report we know that 84% of climate finance in 2019/2020 came from developed economies, which roughly align with high-income countries. If we follow the IMF's logic, according to which the depreciation rate increases with the income level of countries, this means that we are likely to overestimate rather than underestimate the depreciation of the climate capital accumulated between 2025 and 2050.

Figures

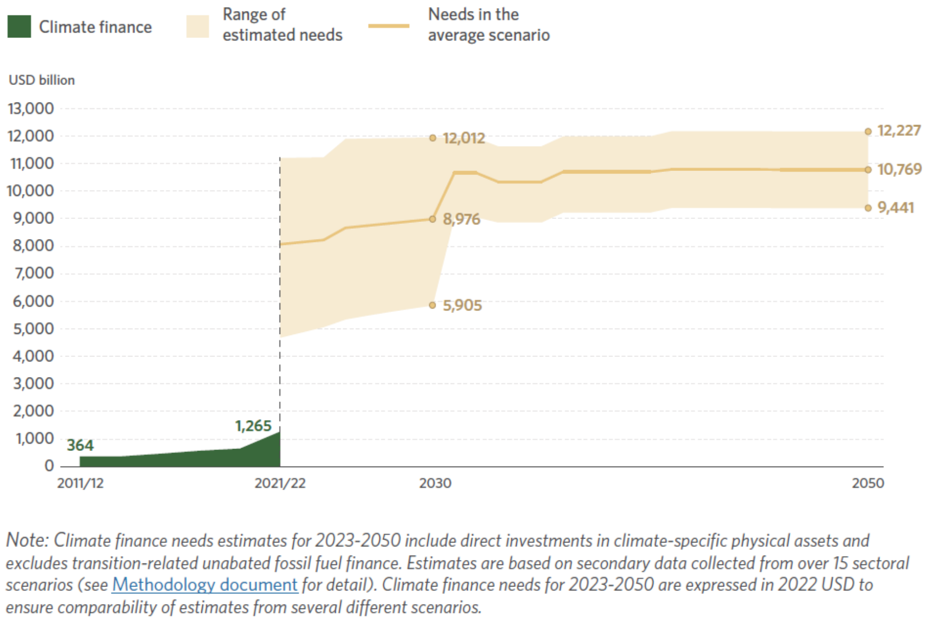

Figure A.1. Global Tracked Climate Finance and Average Estimated Annual Needs Through 2050 [56]

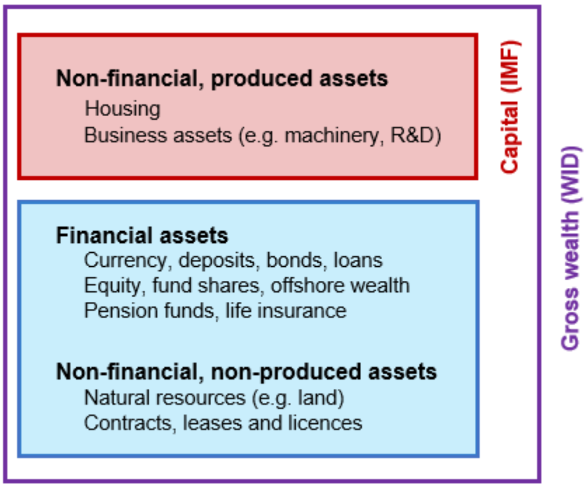

Figure A.2. Comparison of WID Wealth and IMF Capital definitions

How to cite this working paper: Chancel. L., Mohren. C., Bothe. P., Semieniuk. G., *Climate Change and Wealth Inequality: A Literature Review and Numerical Insights*, World Inequality Lab Working Paper 2024/27