Commentary

Potential pension fund losses should not deter high-income countries from bold climate action

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Universities, Neil became deeply involved with the early development of comprehensive Earth system models in the 1990s, playing a key role in developing the grid-enabled integrated Earth system (GENIE) framework and related models. Through GENIE, he contributed to the multi-millennial climate projections of the fourth and fifth IPCC assessment reports and has published extensively on climate dynamics, integrated assessment and climate impact modeling, and uncertainty quantification. He has published over 100 refereed papers.

Shutting down fossil-fuel production sites before available reserves are depleted or the useful life of the capital equipment exhausted is a necessary consequence of ambitious climate policy.[1,2] Yet, if unanticipated by the investors in these assets, it also leads to a loss on their investment, so-called stranded assets.[3] Governments in rich, Western countries may water down their climate policies for fear of the social repercussions of such asset stranding as these policies hurt oil and gas companies. In particular, pension plans invested in capital markets that are already underfunded could be at risk of falling even shorter of meeting their present and future pay-out obligations.[4] The current push to expand fossil-fuel investments in both Europe and the United States as a result of the reduced gas supplies from Russia, following Russia's invasion of Ukraine, only serves to underscore the worry of diluted climate ambition. As the valuations of oil and gas companies soar, their importance for the health of pension savings only grows.

However, it is unclear how socially relevant such asset stranding would really be. Are most people invested through their pension or is interest in excessive fossil-fuel production concentrated among a small group of affluent investors? Although there is good evidence that the richest few percent of individuals and households account for the bulk of carbon emissions through their consumption and investments,[5,6] the distribution of ownership of fossil-fuel assets and infrastructure at risk of stranding is much less analyzed.

We argue that governments should not be deterred by the risk of stranded fossil-fuel assets because any resulting wealth loss that causes economic hardship can be compensated at low cost. For an exploration of the distribution of stranded assets, we combine for the first time detailed macroeconomic and financial network modeling data on the value and location of financial ownership of oil and gas stranded assets[7] with estimates of the financial asset and overall wealth distributions[8] for the United States and European countries. Stranded assets are modeled as the present value of potentially lost profits from over 40,000 oil and gas fields as investor expectations realign to a lower-carbon future. Losses are traced to ultimate owners, i.e., the persons and governments that own stocks in oil and gas companies through shares and funds. Losses for persons living in the United States and Europe exceed $500 billion (US dollar) in a "medium" expectations realignment to a world of about 2°C warming (Figure 1). The financial asset size distribution is assembled from income tax records, wealth surveys, and national accounts data, and made comparable across countries by following Distributional National Accounts guidelines.[9,10] As a first approximation, we assume that each wealth fractile is allocated stranded assets to non-government ultimate owners in proportion to its share in the national distribution of financial assets, a wealth elasticity of stranded assets equal to one. That is, $1 invested by the bottom 50% of persons by wealth has the same probability of stranding as $1 invested by the top 1%. This certainly does not mean that the bottom 50% owns the same absolute amount of stranded assets as the top 1% (Figure 1), because of very large inequalities in financial asset ownership and savings between groups. For instance, the top 1% in the United States owns 39% of all US financial assets, whereas the bottom 50% owns less than 4% of them (Table S1). For robustness, we consider three alternative expectation realignments that lead to different totals and distributions of stranded assets as well as different elasticities of stranded assets reflecting potential biases in investment portfolios across the wealth distribution (Figure 2, see also Notes S1 and S2 and Table S2).

Unequal losses

In the United States, of an estimated $350 billion in stranded assets, only 3.5% of the total hits the poorest half of the population and one-third the bottom 90%. The remaining two-thirds split roughly equally between the top 1% of wealth holders and the next 9% (Figures 1A and S1). Overall losses in Europe are estimated at around $200 billion and are similarly skewed. Given the extremely high level of concentration of financial assets at the top of the distribution (apart from Germany, the top 10% hold 70–90% of the total depending on countries, i.e., much more concentrated than incomes, or than real estate), one would need to make extreme assumptions on the relative weight of stranded assets in lower income groups' portfolios to counterbalance this first-order effect. Even when introducing a strong fossil fuel and, by extension, stranded asset portfolio bias to lower wealth groups, the top 10% typically still hold most losses (Figures S2 and S3).

Although affluent persons own most losses in absolute terms, these are small compared to their wealth. Stranded assets in Figure 1 amount to less than one

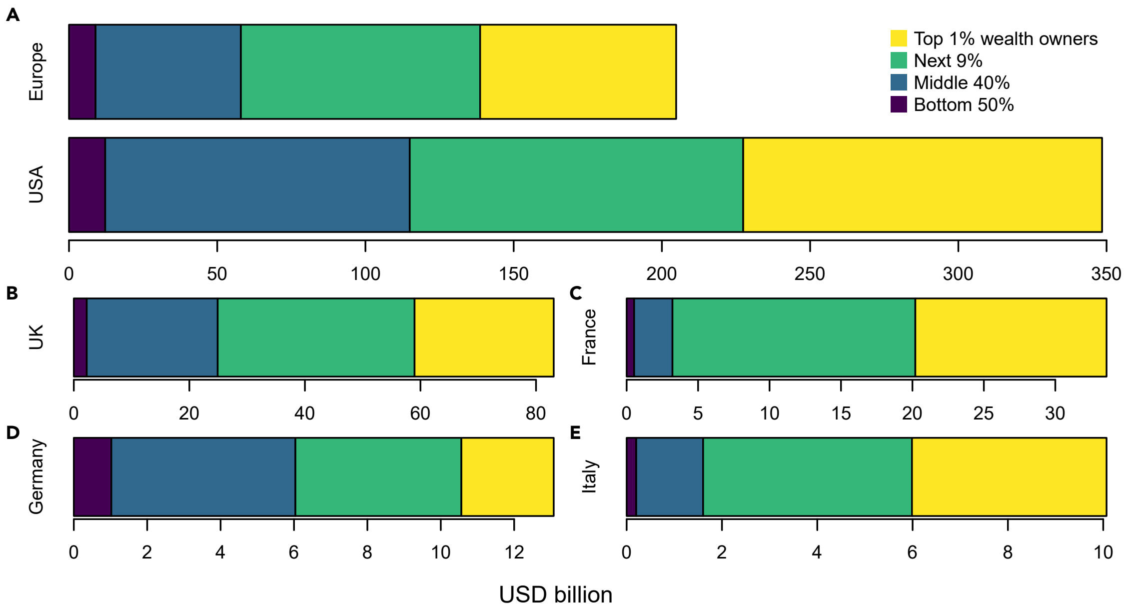

Figure 1. Distribution of stranded assets across the wealth distribution

Partition of country or regional stranded assets by wealth fractile for (A) Europe as a whole and the United States, and (B)–(E) four major European countries. Middle 40% corresponds to the group of the population between the bottom 50% and the top 10% of the population. Next 9% corresponds to the group between percentiles 90 and 99.

percent of the net wealth of the top 1% (Figure 2, right panel, green disks). This group corresponds to adults each owning, on average, several million US dollars (Figure 2, bottom). Even under the most severe asset-stranding scenario, consistent with oil and gas demand in a world limiting global warming to 1.5°C and a portfolio bias of affluent persons toward fossil fuels, their losses would be less than 2% of their wealth (Figure 2, right panel, dark blue squares). Stranded assets as a share of net wealth tend to be even lower for the next 9% and the middle 40% of wealth owners because financial assets make up a smaller share of their wealth, which is largely composed of housing assets.

Turning to the bottom 50% of the distribution, we find losses ranging from 0.05% to 1%, in continental European countries, to 4%–5% of total net wealth in the US, and even higher under some portfolio bias scenarios. A key observation is that the bottom 50% own little net wealth to start with, independently of any potential stranded assets losses. Therefore, even small absolute losses can be substantial as a share of net wealth. Relatively high losses as a share of net wealth in the United States and the United Kingdom can be explained by low levels of bank deposits of the poorest 50% as compared to other countries (deposits are not exposed to stranded asset losses in our framework). Conversely, in these two countries the bottom 50% have substantial assets as pension contributions in capital markets relative to deposits, and such pension investments are exposed to asset stranding (Table S1). This contrasts with French, German, and Italian pension systems, which are mostly independent of capital market valuations.

Social repercussions and compensation

Our results reveal two distinct social outcomes of asset stranding. First, top wealth groups own most of the losses yet appear to be protected by their considerable overall wealth. Stranded assets might extend beyond upstream fossil fuels, but fossil fuels are the most directly affected industrial sectors. Neglected losses in sectors that use fossil fuels as inputs, rather than outputs, could be of comparable magnitude according to one study[11] (for comparison with other stranded fossil-fuel estimates see Note S3). Moreover, other sectors that use fossil fuels as an input, rather than as their output, have more substitution opportunities (from petrol to electric vehicle manufacturing, for instance). As such, aggregate stranded asset losses in those sectors could be counterbalanced by an increase in the value of other portfolio positions.

Second, less affluent groups, particularly in the United States and United Kingdom, could be tipped (deeper) into net negative wealth, increasing risks of personal bankruptcy, and suffer pay-out reductions from defined contribution pension schemes. Because adults are unequally exposed, e.g., 9% of British pension funds have completely divested from fossil fuels,[12]

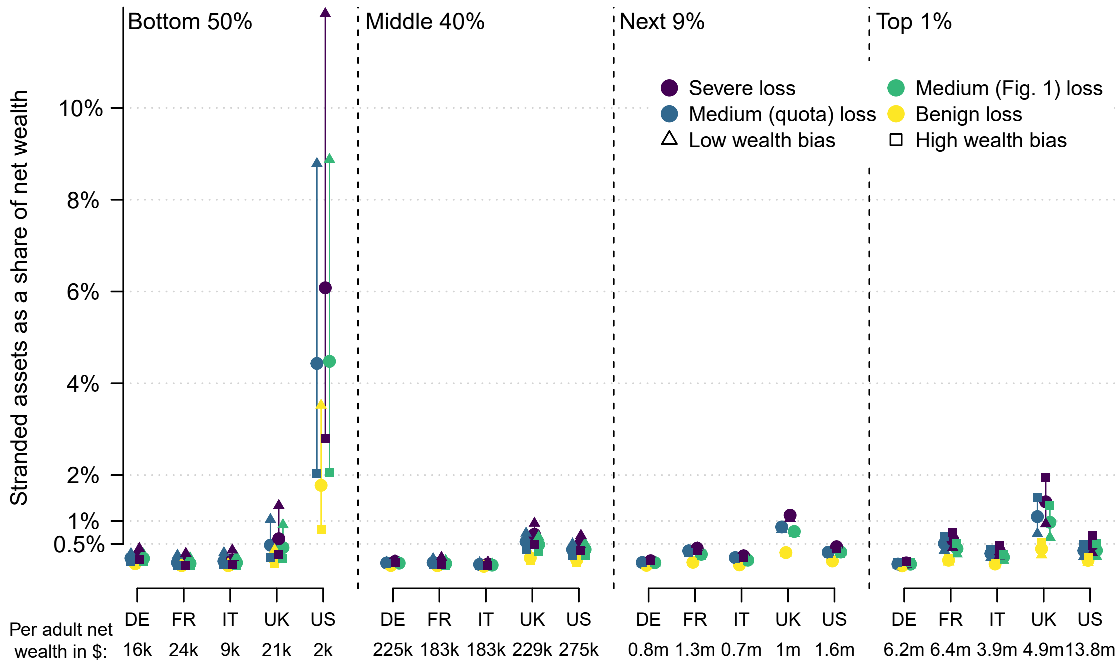

Figure 2. Stranded assets as a share of net wealth for different scenarios

Stranded assets as share of total net wealth by fractile for five large countries and for different scenarios. Each country-fractile shows four colors that reflect different totals and international distributions of asset stranding. Each color shows three shapes, with the disk showing losses proportional to financial assets, triangles a higher fossil-fuel portfolio exposure of the bottom 90%, and squares a higher exposure by the top 10%. The bottom row of numbers reports average net wealth by an adult person in the country-fractile observation (Chancel et al.[8] discuss international comparisons of wealth distributions). Figure S4 on a log scale distinguishes detail for low losses, Table S4 reports the data points and Figure S5 provides additional robustness checks for the United States.

the losses for those who do sustain them exceed the averages in Figure 2. In continental European countries, current high inflation rates arguably pose a bigger threat to the value of financial assets. Still, those groups who are most exposed to stranded assets and have little capital could experience economic hardship.

These two outcomes generate a key insight for ambitious climate change mitigation: governments could compensate socially relevant asset devaluation at low cost. For instance, compensating all stranded assets of the bottom 50% under medium losses (Figure 1), would cost $9 billion in Europe and $12 billion in the United States. These amounts are lower than the recent German government bailout of the utility Uniper for $15 billion,[13] or anticipated compensation to investors insured under the Energy Charter Treaty against losses caused by climate policy of up to $20 billion.[14] Even doubling compensation figures to extend equal protection to all groups would keep compensation figures modest. Figures S6 and S7 present what fully compensating each group would cost, expressed as a share of gross domestic product (GDP) and national wealth. Compensating all losses incurred by the least affluent 90% of individuals would cost between 0.1-1.2% of GDP and 0.02-0.3% of national wealth, depending on country.

Funding options

Funding for compensation could be procured in several ways. A modest price of $13/MTCO_2e$ on US carbon emissions would raise about $74 billion per year over the next decade[15]; compensating the bottom 50% would only use one-sixth of one year's revenue and thus leave enough funds to also avoid regressive redistribution from the pricing via, e.g., a carbon dividend.[16] In some countries, financing could also result from pushback against investor treaties, such as the Energy Charter. If some of these treaties were abolished, a portion of the savings could be redistributed. Finally, financing could also be done directly by redistributing wealth. A modest progressive wealth tax on the top 0.005% of the population (2% on the net wealth of persons owning over $100m and 3% on persons owning over $1bn) could compensate the totality of stranded asset losses in about 2 years in the United States and less than 3 years in Europe[8] (Table S3).

High-income country governments are expected take bold climate action. The prospect of stranded assets, and their potential impacts on low- and middle-class capital owners, is no credible deterrent to doing so. Stranded assets appear to be disproportionately concentrated among the very well-off and losses can be compensated at relatively low cost among the poor. Our results remain limited by little data transparency and availability on these important matters. We stress that increasing governments' statistical capacity to better track stranded asset ownership will be important for implementing fair decarbonization policies. If such compensation can be carried out, the main political economic challenge to be overcome is lobbying by affluent fossil-fuel interests to protect their wealth at risk. In principle, these investors should be able to hedge their portfolios against excessive exposure to stranded fossil-fuel assets. We stress that this analysis focuses solely on financial capital ownership and its distribution in affluent countries—that is, we leave aside the question of loss of labor incomes as well as that of other macroeconomic impacts, which could be analyzed in future work. Analyses of macroeconomic impacts in less affluent, oil-exporting countries find that those countries can face greater macroeconomic challenges associated with stranded assets, even if these are smaller in absolute numbers.[17] We also note that it would be important to investigate more precise portfolio holdings across the wealth distribution with more granular data. Given the limited variation in shares of wealth lost even under strong portfolio bias, we suggest that our results here provide a robust first-order approximation over possible outcomes.

DATA AND CODE AVAILABILITY

Figure and data code will be availbale with Zenodo upon publication at https://doi.org/10.5281/zenodo.7008065.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.joule.2023.05.023.

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AUTHOR CONTRIBUTIONS

All authors conceptualized the research. G.S., L.C., and E.S. curated and analyzed the data and drew the figures. G.S., L.C., P.B.H., and N.R.E. wrote the paper. G.S. and L.C. contributed equally.

DECLARATION OF INTERESTS

G.S. is affiliated with the University of Sussex, University College London and SOAS University of London. L.C. is affiliated with Harvard University and the London School of Economics. J.-F.M. is affiliated with the University of Exeter and University of Cambridge. N.R.E. is affiliated with the University of Cambridge.

REFERENCES

1. Welsby, D., Price, J., Pye, S., and Ekins, P. (2021). Unextractable fossil fuels in a 1.5°C world. Nature *597*, 230–234.
2. Mercure, J.-F., Salas, P., Vercoulen, P., Semieniuk, G., Lam, A., Pollitt, H., Holden, P.B., Vakilifard, N., Chewpreecha, U., Edwards, N.R., and Vinuales, J.E. (2021). Reframing incentives for climate policy action. Nat. Energy *6*, 1133–1143.
3. van der Ploeg, F., and Rezai, A. (2020). Stranded Assets in the Transition to a Carbon-Free Economy. Annu. Rev. Resour. Econ. *12*, 281–298.
4. Christophers, B. (2019). Environmental Beta or How Institutional Investors Think about Climate Change and Fossil Fuel Risk. Ann. Am. Assoc. Geogr. *109*, 754–774.
5. Semieniuk, G., and Yakovenko, V.M. (2020). Historical evolution of global inequality in carbon emissions and footprints versus redistributive scenarios. J. Clean. Prod. *264*, 121420.
6. Chancel, L. (2022). Global Carbon Inequality over 1990-2019. Nat. Sustain. *5*, 931–938.
7. Semieniuk, G., Holden, P.B., Mercure, J.F., Salas, P., Pollitt, H., Jobson, K., Vercoulen, P., Chewpreecha, U., Edwards, N.R., and Viñuales, J.E. (2022). Stranded fossil-fuel assets translate to major losses for investors in advanced economies. Nat. Clim. Chang. *12*, 532–538.
8. Chancel, L., Piketty, T., Saez, E., and Zucman, G. (2022). World Inequality Report 2022 (Harvard University Press).
9. Blanchet, T., Chancel, L., Flores, I., Morgan, M., et al. (2020). Distributional National Accounts (DINA) Guidelines: Concepts and Methods Used in WID.World (World Inequality Lab).
10. Blanchet, T., and Martinez Toledano, C. (2023). Wealth inequality dynamics in Europe and the United States: Understanding the determinants. Journal of Monetary Economics *133*, 25–43.
11. Cahen-Fourot, L., Campiglio, E., Godin, A., Kemp-Benedict, E., and Trsek, S. (2021). Capital stranding cascades: The impact of decarbonisation on productive asset utilisation. Energy Econ. *103*, 105581.
12. Egli, F., Schärer, D., and Steffen, B. (2022). Determinants of fossil fuel divestment in European pension funds. Ecol. Econ. *191*, 107237.
13. Miller, J., Chazan, G., and Sheppard, D. (2022). Germany ploughs €15bn into struggling energy group Uniper. Financ. Times. July 22, 2022.
14. Tienhaara, K., Thrasher, R., Simmons, B.A., and Gallagher, K.P. (2022). Investor-state disputes threaten the global green energy transition. Science *376*, 701–703.
15. Rosenberg, J., Toder, E., Lu, C., and Kaufman, N. (2018). Distributional Implicatios of a carbon tax. Columbia SIPA Cent. Glob. Energy Policy.
16. Fremstad, A., and Paul, M. (2019). The Impact of a Carbon Tax on Inequality. Ecol. Econ. *163*, 88–97.
17. Ansari, D., and Holz, F. (2020). Between stranded assets and green transformation: Fossil-fuel-producing developing countries towards 2055. World Dev. *130*, 104947.