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# Distributional implications and share ownership of record oil and gas profits

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**Abstract**

The 2022 oil and gas crisis resulted in record fossil-fuel profits globally that rehabilitated the oil and gas industry, obstruct the energy transition and contributed to inflation. We analyse the size and the distribution of financial beneficiaries of these unprecedented profits across countries and across wealth groups within the United States, using company income statements and comprehensive ownership data, to construct a global network of shareholdings with 397,619 nodes. We estimate that globally, net income in publicly listed oil and gas companies reached US$916 billion in 2022. The United States was the biggest beneficiary receiving US$301 billion in fossil fuel profits both from domestic extraction and through global shareholding, more than U.S. investments of US$267 billion in the low carbon economy that year. Analyzing the U.S. distribution including privately held US companies, 51% of profits went to the wealthiest 1%, predominantly through direct shareholdings and private company ownership. In contrast the bottom 50% only received 1%. The incremental fossil-fuel profits in 2022 over those in 2021 were enough to increase the disposable income of the wealthiest Americans several percent and compensate a substantial part of their purchasing power loss from inflation that year, thereby exacerbating inflation inequality. Record fossil-fuel profits also reinforce existing racial and ethnic inequalities and inequalities between groups with different educational attainments. Our results also show that only a small share of overall profits benefits institutions that serve the wider public such as pension funds. We discuss how windfall profits taxes could be used to both lower inequality and accelerate the energy transition as increasing geopolitical tensions and climate impacts portend continued volatility in oil and gas markets.

## Introduction

The spike in oil and gas prices in 2021 and especially 2022 brought record profits for the industry. An increase in profitability in an industry is a signal for additional capital allocation and

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expansion. This is counterproductive for climate change mitigation in the case of the fossil fuel industry, which needs to sunset but was instead rehabilitated by recent record profits.[1–3] Stock market valuations soared, and capital expenditure in the sector went up, including in new oil and gas fields.[4] Simultaneously, high fossil fuel profits hurt the renewable energy industry. The biggest oil companies cut back their transition plans, and the more attractive short-term profit opportunities in oil and gas made renewables, with comparatively poorer margins, a less desirable investment for short-sighted financial investors.[5] More investment in oil and gas supply also leads to more assets at risk of stranding in a subsequent transition[6] and potentially increased political lobbying to protect the investments' profitability by ensuring future demand for fossil fuel-intensive products.[7] Such efforts obstruct the transition.

Avoiding such high fossil-fuel profits is thus an important consideration for a successful low-carbon energy transition, when increasing geopolitical tensions and climate impacts portend continued volatility in oil and gas markets.[8,9] Here we suggest that important arguments for curbing spikes in oil and gas profits also arise from the inequality which they fuel.

A substantial proportion of global inflation in 2021 and 2022 was driven by oil and gas prices, both directly through higher prices ‘at the pump’ and for home heating and electricity, and indirectly as higher input costs pushed up prices – from fertilizers, to plastics and industrial products.[10–12] The deterioration of purchasing power caused a cost of living crisis and output curtailments, leading to widespread and fiscally costly price caps across Europe, while affluent governments bought gas at expensive spot prices. These European purchases priced out gas import-reliant developing countries, causing energy shortages, poverty increase and economic slowdown.[13] The impacts on the income distribution due to ‘inflation inequality’, i.e. that lower income households spend a larger share of their income on energy and were therefore disproportionately hit, have been documented.[14–16] Yet, relatively little attention has been paid to the fact that the substantial profits caused by these price spikes do not simply disappear but instead are someone’s income.

A better understanding of the volume and distribution of these oil and gas profits helps shed light on the net impact of energy price inflation, including the question whether it reduced or exacerbated inflation inequality. It can also inform policies to mitigate socioeconomic repercussions when prices spike, such as windfall taxes. The fossil fuel industry defended itself against such policies (successfully in the United States) by claiming their profits ultimately benefit the population in the form of dividends.[17] This raises two questions: How big were fossil fuel profits during the recent price shocks? And who received those profits and to what extent did this profit income compensate the increased costs of living?

We collect recent oil and gas profit data at the company level, estimate global aggregate profits for all stock-market listed companies in the sector and compare them across countries and with those in renewable energy. To trace the beneficiaries of the 2022 record oil and gas profits we construct a global network of shareholdings with 397,619 nodes for all publicly listed as well privately held companies in which U.S. investors own stakes. We focus on U.S. ownership because as we show the U.S. was the biggest beneficiary of the 2022 profit spike and has the

largest global ownership share; moreover, data availability allows for a fine-grained analysis of the ownership distribution. We merge the profit data with ownership information for oil and gas companies, which allows us to propagate claims on profits through the shareholding network via intermediaries, such as financial institutions and asset managers, all the way to individual beneficiaries. We finally assign profits to social groups according to wealth, race and ethnicity, and education, and confront income increases from these profits with income decreases from inflation.

**Record Profits in the United States**

Globally, annual profits after taxes or net income (henceforth profits) in stock market-listed oil and gas companies in 2022 were at a record high (Fig. 1a) reaching $916 billion (US dollars). In the second quarter of 2022, profits reached an all-time high. In the second, third and fourth quarters, profits were more than three times recent quarterly averages over 2016-19. This is the case despite the write-downs of Russian assets following the Russian invasion of Ukraine, which lowered fossil fuel profits in the first quarter.

The country experiencing the largest fossil-fuel profit increase was the United States: in 2022, the profits of companies headquartered in the United States exceeded their 2016-2019 annual average by $241 billion to reach $281 billion (Fig. 1b). US-headquartered stock market-listed oil and gas companies thus earned the largest amount of profits compared to any country in the world, a distinction that had during recent years belonged to Saudi Arabia with its listed national oil company, Saudi Aramco. In relative terms, the 7-fold increase above 2016-19 average profits in the United States was matched only by Brazil (10-fold) and Norway (9-fold), but with much smaller absolute increases in both cases of $34 billion and $29 billion, respectively. As we show below, the financial ownership of foreign oil and gas companies resulted in an additional net transfer of $20 billion to U.S. owners ($44 billion in claims were transferred abroad but $64 billion were transferred into the United States). This transfer increased overall fossil-fuel profit claims in the United States by a further 5% to $301 billion.

The uptick in oil and gas profits coincided with a divergence of stock market valuations between fossil and renewable energy companies, reflecting investors' expectations about the profits and shareholder distributions these two industries will generate (Fig. 1c). The renewables industry faced several challenges during this period, one being the higher interest rates which came in response to inflation. This surge in borrowing costs increased the financial burden of upfront investments, which constitute the largest expenses for wind and solar projects.[18] These changes in expectations moreover occurred in the context of vastly different scales of profit volumes across fossil fuels and renewables. 2022 global profits in renewables stock-market listed companies – while at all-time highs – were less than 2% those in oil and gas. For US-listed companies the ratio was a quarter of one percent (Fig. 1c).

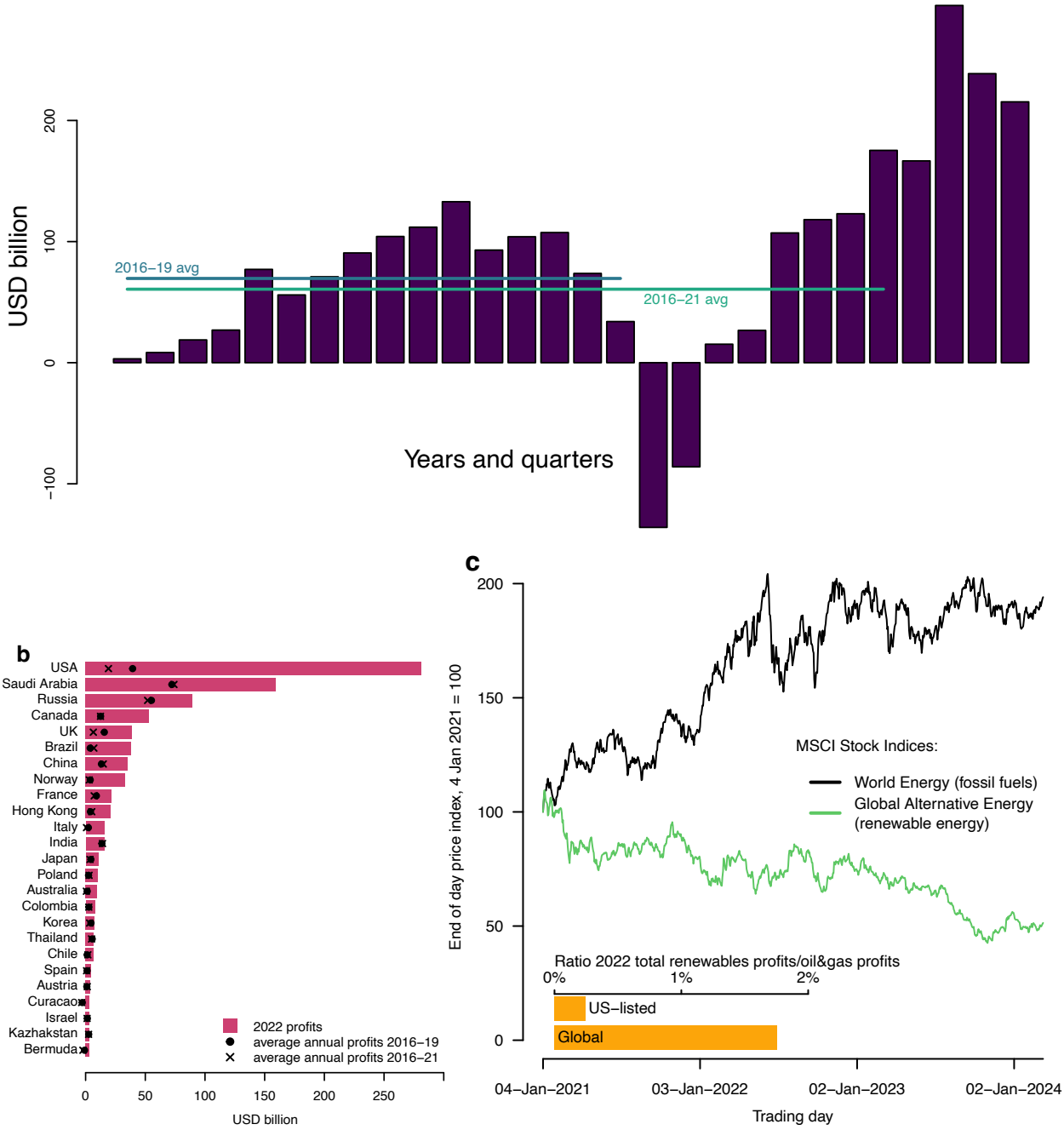



**Fig. 1 | Record after-tax profits in 2022 concentrated in the United States. a,** Quarterly profits in stock market-listed oil and gas companies were at a record globally in 2022, with a peak in quarter 2. **b,** Companies headquartered in the United States saw the largest increase in 2022 relative to recent averages, making the United States the country where the largest amount of profits were earned, overtaking Saudi Arabia and Russia. **c,** The stock market valuation of fossil-fuel companies tracked by the MSCI World Energy Index diverged sharply from that of renewable energy companies since 2021, while in the inset the total global volume of profits earned by renewable energy companies was less than 2 (0.3) percent of those earned by oil and gas companies globally (in US-listed companies only).

**Extremely unequal benefits**

We use a novel network model of company shareholdings to trace the 2022 record volume of oil and gas profits through financial intermediaries to their ultimate beneficiaries in the United States. We bring together asset ownership information from the Orbis, SEC, Federal Reserve, Pitchbook and Preqin databases, as well as from manual searches. We connect these data to our firm-level quarterly after-tax net income (profit) data of all stock market listed oil and gas firms with any share of U.S. ownership. We also include privately held companies (not included in Fig. 1) and companies listed abroad. For every firm, profits are propagated through the network to the immediate shareholders, and on to the shareholders' shareholders, and so on, until no further shareholders can be identified. The ultimate beneficiaries are individual shareholders and holders of mutual fund shares. Finally, we map ultimate beneficiaries into distributions by wealth, race and ethnicity, and education. Details of this procedure are provided in the Supplementary Information.

Our analysis reveals that the 2022 U.S. fossil fuel profits almost exclusively benefit the top wealth owners: 51% of all profit claims by U.S. beneficiaries are held by the top 1% of wealth owners, and 84% by the top 10% (Fig. 2). In contrast the bottom half of the population (66 million households) receive hardly any profits at all: only 1%. The top 0.1%—a mere 131 thousand households—receive 26 times as much as half of all Americans. The middle 40% (the 51$^{st}$ to 90$^{th}$ wealth percentile) only receive 15% of all profits.

Record fossil fuel profits reinforce existing racial and ethnic inequalities. Whites (64% of households) benefit disproportionately with a claim on 87% of all profits. Blacks (14% of households) have a claim on only 3% of all profits, and Hispanics (10% of households) a mere 1%. Blacks and Hispanics hold their entitlements to fossil fuel profits predominantly in the form of pensions. Other ethnic groups (12% of households), which includes Asian Americans, claim the remaining 9%.

Households with high educational attainment are prime beneficiaries of fossil fuel profits. 91% of all profits go to households with at least some college education even though this group only includes 66% of households. College degree holders alone (38% of households) claim 78% of profits.

Extended data Fig. 1 (last page of the file) displays the final leg of the Sankey diagram for distributions by race and ethnicity, and education. Since each component of these distributions includes people from all wealth quantiles, both distributions allow substantial within-group inequality, e.g. the majority of the 3% of profits claimed by Black households likely belongs to a small portion of those households.

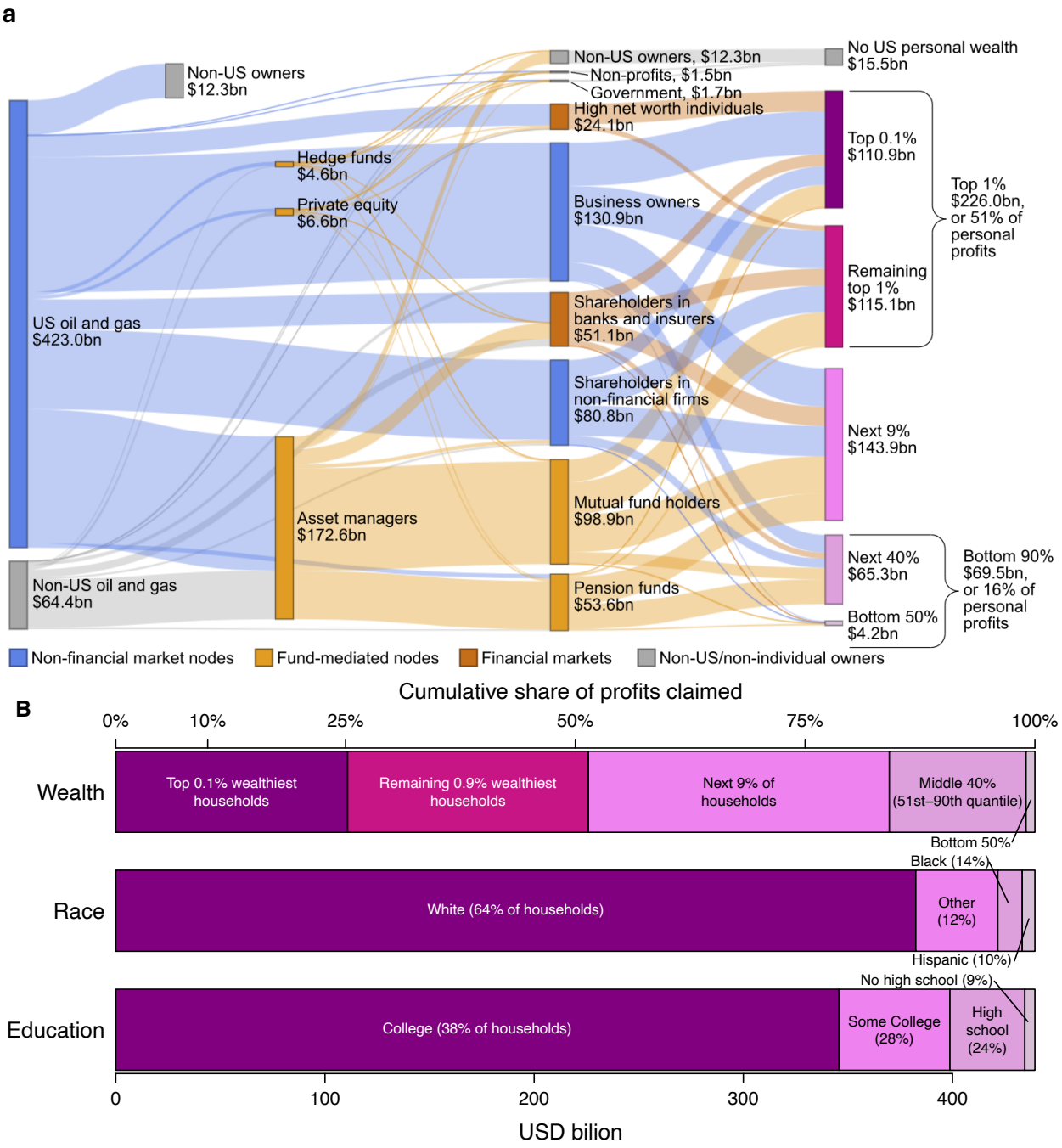



**Fig. 2 | Profits flow disproportionately to the most affluent, white, and highly educated Americans.** The Sankey diagram in **a,** shows how profits made by oil and gas companies in 2022 both in the United States and elsewhere are intermediated by fund managers and reach U.S. ultimate beneficiaries that belong to quantiles of the wealth distribution. **b,** results for ultimate beneficiaries also according to race and ethnicity, and education.

The channels through which profits reach beneficiaries differ by wealth group. Those groups who claim a disproportionate share of the profits relative to their share in the population receive profits predominantly via private company ownership and direct shareholdings. That includes the family offices of ultra-high-net-worth individuals as well as the stocks held by companies' executives as part of their compensation packages. For instance, the top 1% wealth owners

receive less than a quarter of their profits through mutual funds and pension funds, and college-educated Americans less than half. On the other hand, pension funds alone make up almost half of the profit channel to the 50$^{th}$-90$^{th}$ percentile of wealth owners (labelled the 'next 40%'), and more than half for Blacks and Hispanics.

Shareholder distributions are often justified with their contribution to pension funds, on which many people depend for their retirement savings. However, our results show that only a small share of overall profits benefits institutions that serve the wider public. In the case of fossil fuel profits, pension funds only account for a share of 18%. Asset managers intermediate more than half of all profit claims of listed companies but do so predominantly for individual holders of mutual funds, not pension funds.[19] Unlike the more equally distributed retirement assets, 90% of individually held mutual fund shares belong to the top 10% wealth owners. The importance of fossil fuel stocks and dividends for asset managers' business also helps explain why major asset managers recently walked back some of their Environmental, Social, and Governance (ESG) and climate pledges.

Despite the large share of profits flowing to top wealth owners we document, our analysis is likely to understate the importance of financial intermediation on their behalf: Due to limitations of our ownership data, we are probably understating the involvement of private equity funds, which, like hedge funds, cater disproportionately to the very affluent (see Methods).

**Impacts on income distribution**

To understand how these profit flows claimed by households from the fossil-fuel industry impact the income distribution, we compare them with income from other sources, and with the inflation burden. As a first approximation, we calculate income changes by assuming the entirety of the profits flows to the ultimate claimants as income. The US Consumer Price Index (CPI) rose 6.5% in 2022. That is, a basket of goods demanded by the average person cost 6.5% more at the end of 2022 than at the end of 2021. Counting all additional net fossil-fuel profits in 2022 over those in 2021 as disposable income of beneficiaries would increase the disposable income of the average U.S. American by 1.5%, thereby compensating them for part of the inflation and leaving them with a 5.0% residual inflation burden (Fig 3). This additional capital income would constitute a substantial reduction in the inflation burden that is left out when tracking how income from wages alone compares with inflation. But this compensating capital income effect is highly unequal across the wealth distribution. For the top 0.1%, the additional profits claimed from their fossil-fuel holdings would increase their disposable income by more than inflation reduced it, thus compensating for their entire inflation burden. For the top 1% as a whole, the capital income effect would increase disposable income by 5.1%, compensating for all but 1.4 percentage points of inflation. In contrast, the disposable income of the 50$^{th}$ to 90$^{th}$ percentile of the population would increase by only 0.6%. For the bottom 50%, the compensation from fossil fuel capital income would be hardly noticeable, amounting to 0.06% of disposable income and leaving them at a quantile-specific residual inflation of 6.8% (full calculations in supplementary information).

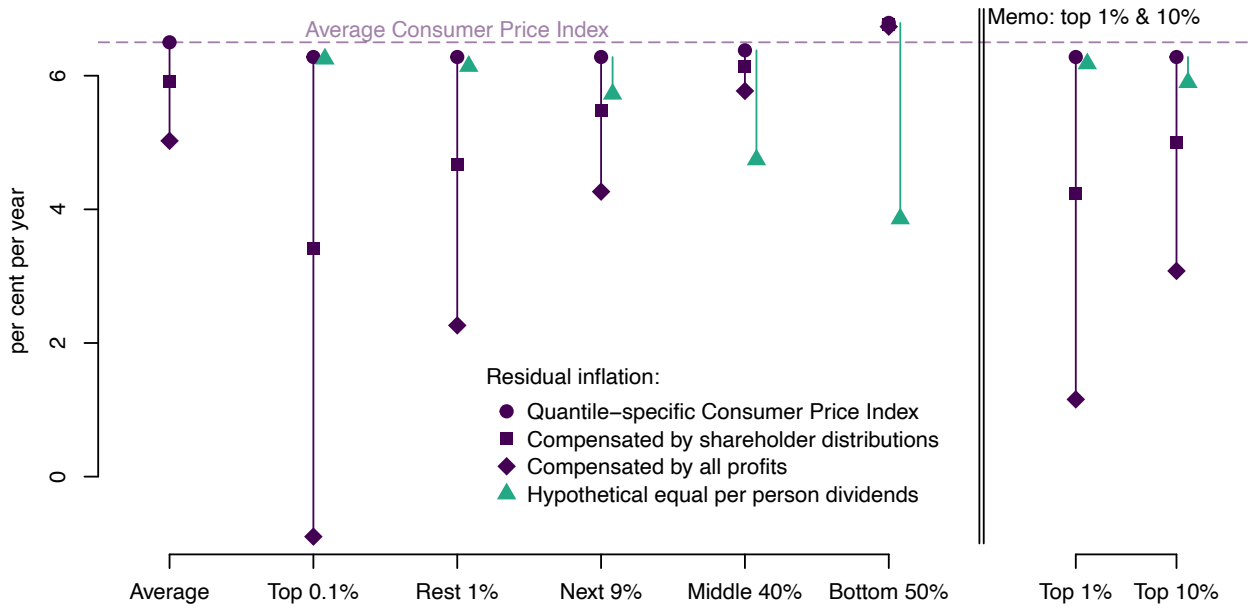



**Fig. 3 | Residual inflation after accounting for incremental 2022 fossil fuel profits as additions to disposable income by wealth quantile.** If oil and gas profits flow to the ultimate beneficiaries in the form of disposable income, they compensate for inflation in 2022 measured by the consumer price index (disks) to different extents. Diamonds show the reduction in the inflation burden assuming the entirety of the profits accrue to ultimate beneficiaries, while squares show the reduction assuming only 50% of these profits are distributed to shareholders and taxed a further 20%. CPI differs for different quantiles. Green triangles show the residual inflation if incremental 2022 profits had been paid out as equal per capita dividends.

As recent studies emphasize, inflation differs across groups as their consumption baskets' prices rise at different rates.[20,21] For instance, lower income groups tend to spend a larger share of their income on energy and therefore experience a higher rate of inflation when fuel prices increase. In the United States in 2022, this inflation inequality has been estimated to create differences in quantile-specific CPI rates of up to 0.5 annual percentage points (Fig. 3).[22] Our results show that this inflation inequality derived from heterogenous consumption baskets is dwarfed by the potential effect on residual inflation from the unequally distributed oil and gas profits that contributed to the onset of inflation.

In practice, not all profits flow directly to shareholders. For instance, ExxonMobil distributed $30 billion of its $56 billion profits to shareholders in 2022, a pay-out ratio of 54%. But shareholders ultimately own all profits. Higher profits tend to be reflected in higher stock prices, which allow shareholders to realize capital gains or borrow against assets. And indeed, the share prices of listed companies nearly doubled since the beginning of 2021 (Figure 1c). Moreover, our analysis only concerns profits over and above the levels in 2021, and for these incremental profits the pay-out ratio was higher than the average ratio, given that capital expenditures by oil and gas companies did not grow in the same proportion as profits.[4] Nevertheless, to account for the fact that not all incremental profits immediately flow as cash to ultimate beneficiaries, Fig. 3 (squares) also calculates how disposable income increases with a pay-out ratio of 50%, reduced by a further 20% by taxes on dividends. Even with this reduction, disposable income still increases by 2.9% for the top 0.1% wealth owners due to the increase in fossil fuel profits,

and by 2.0% for the wealthiest 1% of households, substantially reducing the impact of inflation. Under these assumptions, the least affluent 90% of households saw their inflation burden essentially unchanged from any fossil-fuel profits accruing to them. Regardless of the measure of the fraction of profits adding to disposable income, residual inflation was highly heterogenous across wealth quantiles. In conclusion, record fossil-fuel profits undoubtedly exacerbated U.S. inequality with most U.S. citizens receiving no significant benefit and a small number reaping sizable gains.

An important potential caveat to this inflation compensation analysis is that fossil fuel profits rose but profits in other industries may have fallen, so as to offset the fossil-fuel profit rise. That is, the inflation inequality specifically from fossil fuels remains, but it is offset by declining inflation inequality in other sectors (because affluent households would take the bulk of income losses there, too). Then, shareholders would not be better off in the aggregate than others. To have a one-for-one comparison would require analysing net income for all corporations in which U.S. Americans have stakes using the same methodology. As an approximation, corporate profits after tax in the United States increased by about half as much as our estimate of fossil fuel profits in 2022 according to the Bureau of Economic Analysis.[a] Therefore inflation inequality considering economy-wide profits is likely about half as high as that depicted in Fig. 3 which considers only fossil fuel profits. The upshot is that the signal to invest in the fossil fuel sector, as it performs better than the rest of the economy, was even larger and the larger the share of fossil fuel assets in a portfolio the bigger the gain.

**Distributional and climate arguments for fossil fuel profit curbs**

The oil and gas industry claims that it keeps energy affordable for all while the shift to renewables threatens higher energy costs.[23] Our analysis has instead shown that the spike in oil and gas prices, which resulted in record profits, primarily benefitted the wealthiest. Inequality increased in consequence, because the higher profits deriving from higher energy prices inflicted on the entire population are channelled as additional income mainly to an already affluent minority of owners of oil and gas shares. Whereas the richest 1% of households received a nominal income several percent higher than the prior year because of windfall oil and gas profits, we found no discernible increase in income from such profits for the least wealthy half of households. Since the correlation between wealth and income is high, most of these findings also translate to the top 1% and bottom 50% income earners.[24]

Moreover, these profits also exacerbated income inequality between white and Black, Hispanic, Asian, Native and other U.S. Americans, and college-educated and non-college-educated U.S. Americans. This inequality arising from high profits was much more marked than the inflation inequality that arises from lower income households spending a larger share of income on essentials like energy and food and therefore experiencing a higher rate of inflation for their consumption baskets.

2022 was a record year for fossil fuel profits, but profits have remained elevated since. As the energy transition deepens, oil and gas prices could remain volatile in a declining market where

[a] Bureau of Economic Analysis. National Product and Income Accounts. Tables 1.12.

demand and supply can be hard to balance.[25,26] Geopolitical turmoil, worsening climate impacts and future pandemics could further increase the risks of a disorderly transition and help recreate the kinds of fossil energy supply shocks that triggered the 2022 price rise.[8,9] Future rounds of cost-of-living increases for all would again be accompanied by compensation for wealthy households benefiting from high profits and shareholder distributions without proportional compensation for poorer households. This pattern might eventually be continued with profits from negative emissions technologies.[27]

Our results suggest that curbing high oil and gas profits could reduce income inequality in times of high energy-induced inflation. For instance, if excess profits in 2022 over those in 2021 had instead been distributed as equal 'dividends' to all households each would have received $2,094. In this scenario, reminiscent of dividends paid with the revenue from carbon pricing[28–31], the excess profits would have led to lower relative income inequality by boosting the incomes of the bottom 50% by 2.9% and those of the next 40% by 1.6% while leaving the incomes of the top 10% wealth owners nearly unchanged (Fig. 3 triangles). A dividend system of this kind has been in operation for royalties from Alaskan oil production since the 1970s.[32] An example of a more progressive redistribution was the $1,200 per person COVID-19 cheques under the CARES Act which were only sent to households jointly earning less than $150,000. More sophisticated redistribution measures could be implemented, and part of the revenue could also be directed towards ends other than compensation, such as towards the low-carbon energy transition. Clean energy investments (including renewables, transmission and end-uses such as efficiency and electric vehicles) totalled $266 billion in the United States in 2022. If the 2022 incremental profits had been taxed and invested in the U.S. low-carbon energy sector, total sector investments that year would have doubled from $266 to $540 billion. They would also have doubled investments in all emerging markets and developing economies without China – from $244 to $514 billion, if alternatively invested there.[4]

Policies such as windfall taxes that could generate the funds for dividends or other investments have been enacted elsewhere, e.g. in the United Kingdom and the European Union. In the United States the policy was discussed but not enacted. The opportunity that these policies present to reduce income and wealth inequality should be considered before the next price and profit shock occurs. An important added benefit of a fossil fuel windfall profits tax is that it corrects the misallocation of capital away from renewables and into oil and gas. This is critical for decarbonization.

**References**


1. Saul, D. Energy Stocks Outshone Peers In 2022. *Forbes* **Dec 29**, (2022).
2. Milman, O. 'Monster profits' for energy giants reveal a self-destructive fossil fuel resurgence. *Guardian* **9 Feb**, (2023).
3. SEI, Climate Analytics, E3G, IISD & UNEP. *The Production Gap: Phasing down or Phasing Up?* (Stockholm Environment Institute, Climate Analytics, E3G, International Institute for Sustainable Development and United Nations Environment Programme, 2023). doi:https://doi.org/10.51414/sei2023.050.
4. IEA. *World Energy Investment 2023*. (International Energy Agency, Paris, 2023).

5. Christophers, B. Fossilised Capital: Price and Profit in the Energy Transition. *New Political Economy* **27**, 146–159 (2022).
6. Semieniuk, G. *et al.* Stranded fossil-fuel assets translate to major losses for investors in advanced economies. *Nat Clim Chang* **12**, 532–538 (2022).
7. Cooper, M. J., Gulen, H. & Ovtchinnikov, A. V. Corporate Political Contributions and Stock Returns. *J Finance* **65**, 687–724 (2010).
8. Espagne, E. *et al.* Cross-Border Risks of a Global Economy in Mid-Transition. *IMF Working Papers* **2023**, A001 (2023).
9. Liu, Y., Han, L. & Xu, Y. The impact of geopolitical uncertainty on energy volatility. *International Review of Financial Analysis* **75**, 101743 (2021).
10. Ha, J., Kose, M. A., Ohnsorge, F. & Yilmazkuday, H. Understanding the global drivers of inflation: How important are oil prices? *Energy Econ* **127**, 107096 (2023).
11. Gagliardone, L. & Gertler, M. Oil Prices, Monetary Policy and Inflation Surges. *National Bureau of Economic Research Working Paper Series* **No. 31263**, (2023).
12. Weber, I. M., Lara Jauregui, J., Teixeira, L. & Nassif Pires, L. Inflation in times of overlapping emergencies: Systemically significant prices from an input–output perspective. *Industrial and Corporate Change* dtad080 (2024) doi:10.1093/icc/dtad080.
13. IEA. *World Energy Outlook 2022*. (IEA, Paris, 2022).
14. Jaravel, X. Inflation Inequality: Measurement, Causes, and Policy Implications. *Annu Rev Econom* **13**, 599–629 (2021).
15. Chakrabarti, R., Garcia, D. & Pinkovski, M. Inflation Disparities by Race and Income Narrow. *Federal Reserve Bank of New York Liberty Street Economics* **January 18**, (2023).
16. Kröger, M., Longmuir, M., Neuhoff, K. & Schütze, F. The price of natural gas dependency: Price shocks, inequality, and public policy. *Energy Policy* **175**, 113472 (2023).
17. McCormick, M. & Politi, J. Biden claims oil companies are 'war profiteering' as he floats windfall tax. *Financial Times2* **Oct 31**, (2022).
18. Schmidt, T. S. *et al.* Adverse effects of rising interest rates on sustainable energy transitions. *Nat Sustain* **2**, 879–885 (2019).
19. Baines, J. & Hager, S. B. From passive owners to planet savers? Asset managers, carbon majors and the limits of sustainable finance. *Compet Change* **27**, 449–471 (2022).
20. Weber, M., Gorodnichenko, Y. & Coibion, O. The Expected, Perceived, and Realized Inflation of US Households Before and During the COVID19 Pandemic. *IMF Economic Review* **71**, 326–368 (2023).
21. Pallotti, F., Paz-Pardo, G., Slacalek, J., Tristani, O. & Violante, G. Who Bears the Costs of Inflation? Euro Area Households and the 2021–2022 Shock. *ECB Working Paper* **2023/2877**, (2023).
22. Klick, J. & Stockburger, A. Experimental CPI for lower and higher income households. *BLS Working Papers* **537**, (2021).
23. McCormick, M., Smyth, J. & Chu, A. Oil executives talk down rapid shift to green energy as profits boom. *Financial Times* **March 23**, (2024).

24. Chancel, L. & Rehm, Y. Manuscript in preparation. *Paris School of Economics* (2023).
25. Grubert, E. & Hastings-Simon, S. Designing the mid-transition: A review of medium-term challenges for coordinated decarbonization in the United States. *WIREs Climate Change* **13**, e768 (2022).
26. Jain, G. & Palacios, L. Investing in Oil and Gas Transition Assets En Route to Net Zero. *Center on Global Energy Policy Commentary* **March**, (2023).
27. Andreoni, P., Emmerling, J. & Tavoni, M. Inequality repercussions of financing negative emissions. *Nat Clim Chang* **14**, 48–54 (2024).
28. Boyce, J. & Riddle, M. Cap and Dividend: How to Cap Global Warming while Protecting the Incomes of American Families. *Political Economy Research Institute Working Papers* **150**, (2007).
29. Akerloff, G. *et al*. Economists' Statement on Carbon Dividends. *Wall Street Journal* **January 16**, (2019).
30. Budolfson, M. *et al*. Protecting the poor with a carbon tax and equal per capita dividend. *Nat Clim Chang* **11**, 1025–1026 (2021).
31. Boyce, J. K., Ash, M. & Ranalli, B. Environmental Justice and Carbon Pricing: Can They Be Reconciled? *Global Challenges* **7**, 2200204 (2023).
32. Goldsmith, O. S. The Alaska Permanent Fund Dividend: An Experiment in Wealth Distribution. Preprint at https://scholarworks.alaska.edu/bitstream/11122/14552/1/2002-The Alaska Permanent Fund Dividend An Experiment in Wealth Distribution.pdf (2002).
33. Raimi, D. *et al*. The Fiscal Implications of the US Transition away from Fossil Fuels. *Resources for the Future Working Paper* **22–3**, (2022).
34. Battiston, S., Mandel, A., Monasterolo, I., Schütze, F. & Visentin, G. A climate stress-test of the financial system. *Nat Clim Chang* **7**, 283–288 (2017).
35. OECD. *The Size and Sectoral Distribution of State-Owned Enterprises*. (OECD Publishing, Paris, 2017).
36. IMF. State-owned enterprises: the other government. in *Fiscal Monitor April 2020* (IMF, Washington, DC, 2020).
37. Braun, B. Asset manager capitalism as a corporate governance regime. in *The American Political Economy: Politics, Markets, and Power* (eds. Hacker, J., Hertel-Fernandez, A., Pierson, P. & Thelen, K.) (Cambridge University Press, 2021).
38. BlackRock. *2021 Annual Report*. (BlackRock, 2022).
39. Haarmeyer, D. Global Energy: The Private Equity Opportunity of the Century. *The Journal of Private Equity* **17**, 6–13 (2014).
40. Sheffield, B., Montgomery, B., Hackett, J. & Manning, C. University of Texas Roundtable on The Role of Private Equity in the Financing and Restructuring of Oil and Gas Companies. *Journal of Applied Corporate Finance* **29**, 42–53 (2017).
41. Tabuchi, H. Private Equity Funds, Sensing Profit in Tumult, Are Propping Up Oil. *New York Times* **Nov 13**, (2021).
42. Joenväärä, J., Mäkiaho, J. & Torstila, S. Prolonged Private Equity Holding Periods: Six Years Is the New Normal. *The Journal of Alternative Investments* (2022) doi:10.3905/jai.2022.1.165.

43. Giachino, A. & Mehta-Neugebauer, R. *Private Equity Propels the Climate Crisis*. (Private Equity Stakeholder Project, 2021).
44. Federal Reserve. L.224 Mutual Fund Shares. *Financial Accounts of the United States - Z.1* **Fourth Qua**, (2023).
45. SEC. *Private Funds Statistics: Third Calendar Quarter 2022*. (Securities and Exchange Commission, 2023).
46. Batty, M. *et al*. Introducing the Distributional Financial Accounts of the United States. *Finance and Economics Discussion Series* **2019–017**, (2019).
47. Bhutta, N. *et al*. Changes in U.S. Family Finances from 2016 to 2019: Evidence from the Survey of Consumer Finances. *Federal Reserve Bulletin* **106**, 1–42 (2020).
48. LaSalle, J. P. *The Stability and Control of Discrete Processes*. (Springer, New York, 1986).
49. LaSalle, J. P. *The Stability and Control of Discrete Processes*. (Springer, New York, 1986).

## Supplementary information

Propagation network

The allocation of profits can be represented by a network, where nodes are oil and gas companies and their direct and indirect shareholders, and links are the ownership relations between them. Profits are then propagated from oil and gas company nodes to shareholders—and further on to the shareholders of shareholders—according to the strength of each link, until a node is reached that has no further shareholders. Nodes without shareholders—which can be individual persons, households, or other groups such as pension funds or governments—are called ultimate beneficiaries. For instance, if an oil company makes $1 million in profits, and is owned 60% by a holding company investing its own equity, then we propagate 60% of $1 million, or $600,000, to this company. If this holding company is itself owned by a group of 4 persons in equal proportions, then each person gets 25% of the $600,000 or $150,000. The 4 persons are ultimate beneficiaries. We take one more step to propagate the profits from the ultimate beneficiaries into socio-economic distributions by grouping ultimate beneficiaries into categories and propagating profits from categories to socio-economic distributions based on aggregate asset statistics of categories of ultimate beneficiaries. For instance, the 4 persons from the previous example belong to the category “shareholders in non-financial firms”. In the aggregate, 53% of individual shareholders of non-financial corporations belong to the top 1% of the wealth size distribution, so 53% of the $600,000 is finally propagated to the top 1% wealth quantile. The remaining 47% of the $600,000 is similarly propagated to the rest of the wealth size distribution based on the aggregate percentages of shareholders of non-financial corporations belonging to wealth size quantiles.

We take special provisions for nodes in the ownership network that are fund managers. Since fund managers maintain share ownership on behalf of their clients—rather than on behalf of their shareholders—profits are not propagated from fund managers to their shareholders. Instead, we group fund managers into special categories of fund managers (such as private equity funds), and further propagate profits from these categories of fund managers to

categories of ultimate beneficiaries based on aggregate statistics of the clients of fund manager categories. For example, suppose 10% of the oil company from the previous example is owned by a fund manager, who manages assets for its clients. We propagate $100,000 of the oil company's profits to the fund manager. We then identify which category of fund manager this firm belongs to. Suppose in this example the fund manager belongs to the category of private equity funds. On average, 26% of private equity fund clients are pension funds, which is a category of ultimate beneficiary, so 26% of the $100,000, or $26,000, is propagated to the ultimate beneficiary category of pension funds. We finally use the distribution of pensions across quantiles of the wealth size distribution to propagate the $26,000 to different wealth size groups. In our other two types of socio-economic distributions we proceed similarly. We use the distribution of pensions across race and ethnicity, and across educational attainments, to propagate the $26,000 to different socio-economic groups. In general, this procedure allocates all profits reported by oil and gas companies to their ultimate beneficiaries and on into socio-economic distributions. The procedure is summarized in Fig. S1.

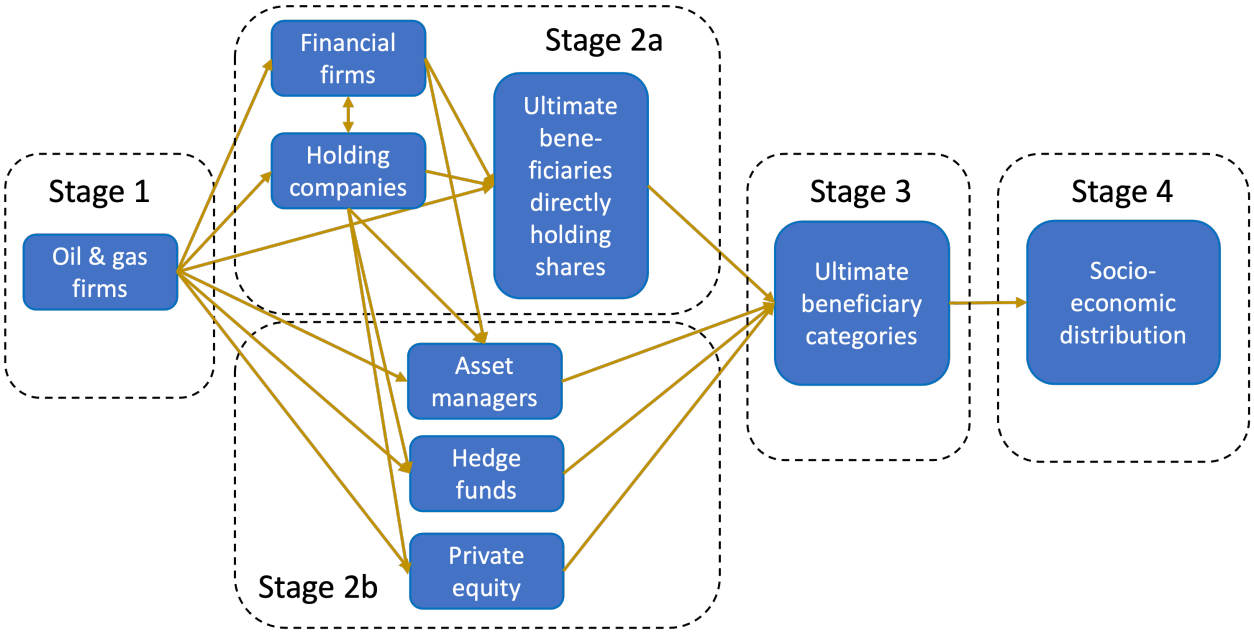



**Fig. S1. Propagation network schema.** Nodes (boxes) are connected by links (arrows), see Table S3 for a list of all ultimate owner categories at stage 3. Arrows from 'financial firms' to 'hedge funds' and 'private equity' are not shown for clarity.

It is useful to think of the propagation in Fig. S1 as a flow through 4 broad stages. Stage 1 identifies profits from oil and gas companies to be propagated through the network. Stage 2a allocates profits to direct ultimate beneficiaries (who own shares in their own names) and stage 2b to fund managers (who own shares on behalf of their clients), for which we make special provisions as detailed below. Stage 3 allocates profits from direct ultimate beneficiaries and funds to broad categories of ultimate beneficiaries, such as pension funds, business owners and mutual funds holders. Finally, Stage 4 allocates profits from ultimate beneficiary categories to socio-economic distributions, such as the wealth size distribution that we show in the main text

Fig. 2a. In what follows, we detail the construction of this network and then describe the propagation algorithm. At the end, we summarize additional data used for drawing Fig. 1 and calculate the extent to which higher fossil fuel profits might compensate inflation for different wealth quantiles.

Network construction part I: input profit data

Our input profit data at stage 1 comes from Refinitiv and Orbis. We selected the US generally accepted accounting principles (GAAP) measure of net income as the preferred measure of profits, which is also the main indicator of profits reported in the financial press. This measure of profits is sales minus costs of goods sold, expenses (including royalties), interest payments, depreciation, taxes on corporate income, and other taxes on production, where the latter include various state and local taxes on both upstream and downstream parts of oil and gas production.[33] In Refinitiv, we collected quarterly net income from all companies (1,382 companies) categorized under the industry groups “Oil and Gas” and “Oil and Gas Related Equipment and Services” according to The Refinitiv Business Classification (TRBC), which includes all stages of oil and gas mining, transport, refining and retail as well as oil field service companies. Since each firm defines its own fiscal calendar, we mapped fiscal quarters to calendar quarters based on the end of period date of each firm’s fiscal quarter.

Refinitiv focuses on stock market-listed companies. To capture profits from non-listed companies (e.g. Koch Industries) as well, we additionally included all non-stock market-listed (often family-owned companies or partnerships), US-based companies in Orbis that are classified under NACE sectors 06, 09.10, 19.2, 35.2, 46.71, 47.3, 49.5, and which fall under the climate policy relevant sector classification.[34b] In order to exclude subsidiaries, we only include non-listed companies in which no single shareholder has a shareholding of more than 50%. Thus, for instance, we exclude XTO Energy, which is a subsidiary of ExxonMobil.[c] Since XTO’s profits already show up on the ExxonMobil income statement, we need not include them again. We track US-based beneficiaries of profits, but for non-listed companies shareholder information is frequently not explicitly provided. However, non-listed companies registered in the US are most likely owned by US persons, whereas non-listed companies registered elsewhere that are not subsidiaries are most likely owned by non-US persons. Therefore we approximate profits accruing to US-based beneficiaries of private companies by limiting our view to private companies registered in the US. Since Orbis only reports annual data, we collected annual 2021 and 2022 profits and revenues.

We primarily rely on quarterly profit data from Refinitiv where available. Quarterly profit data for all four quarters of 2022 was available in Refinitiv for the majority of firms (903 out of 1,382), accounting for 86.4 percent of our final 2022 profits figure. However, not all companies report

[b] The selected sectors comprise all fossil fuel-related sectors minus coal. They are: extraction of crude petroleum and natural gas (06), support activities for petroleum and natural gas extraction (09.10), manufacture of refined petroleum products (19.2), manufacture of gas and distribution of gaseous fuels through mains (35.2), wholesale of solid, liquid, and gaseous fuels and related products (46.71), retail sale of automotive fuel in specialized stores (47.3), and transport via pipeline (49.5). We use NACE codes rather than TRBC for non-listed companies in Orbis because TRBC classifications are not available in Orbis.

[c] https://corporate.exxonmobil.com/who-we-are/our-global-organization/brands#Mobil

quarterly data to Refinitiv; some only report semi-annual data, while others report only annual data. Furthermore, some firms are missing random quarters of data in Refinitiv, while others did not yet report 2022 results by the time we collected data from Refinitiv. We therefore imputed quarterly 2022 profits for firms missing this data in Refinitiv from semi-annual and annual data as follows.

We first took the subset of firms that reported all eight quarters of profits and revenues from the first quarter of 2021 to the fourth quarter of 2022 in order to deduce aggregate trends in profits over time. For what follows, the term 'aggregate' refers to the sum of profits or revenues across this set of firms. Quarterly profits for 2022 were then assigned for those firms missing them in Refinitiv by the following logic: (1) For firms which reported one quarter of profits as well as corresponding semi-annual profits (2022-H1 or 2022-H2), profits for the missing quarter were calculated as its profits for the semi-annual period minus its profits for quarter that was available (e.g. if a firm reported 2022-Q1 and 2022-H1 profits but were missing 2022-Q2 data, profits for 2022-Q2 would be imputed by subtracting 2022-Q1 profits from 2022-H1 profits). (2) If a firm was missing just one quarter of profits, did not report semi-annual profits, but did report annual profits, the missing quarter of profits was deduced by subtracting the annual profits by the other three quarters of profits. (3) For firms missing all quarterly data but which reported semi-annual data, the profits for each quarter were calculated as one half of its profits for the semi-annual period plus the nominal difference between the quarter's aggregate profits and one half of aggregate semi-annual profits weighted by the fraction of the firm's revenue out of aggregate revenue for the semi-annual period (e.g. a firm's 2022-Q2 profits would be calculated as one half of its 2022-H1 profits plus the nominal difference between aggregate 2022-Q2 profits and one half of aggregate 2022-H1 profits ($38.7 billion) weighted by the fraction of the firm's revenue out of aggregate revenue for 2022-H1). (4) For the remainder of firms which reported annual profits for the full year 2022, quarterly profits were calculated as one fourth of its profits for the full year 2022 plus the nominal difference between the quarter's aggregate profits and one fourth of aggregate 2022 profits ($35.8 billion) weighted by the fraction of the firm's revenue out of aggregate revenue for 2022. (5) For the remainder of firms which reported annual profits for the full year 2021, profits for the full year 2022 were extrapolated by multiplying its profits for the full year 2021 by the percentage by which aggregate profits changed between 2021 and 2022 (an increase of 81.1%). This annual 2022 profits figure was then split into quarterly profits as in (4).

In other words, if there was a missing quarter of data, we first attempted to directly deduce the firm's quarterly profits when it was possible to do so from the available data (i.e. subtract its semi-annual profits by its first quarter profits), and when not possible, used trends in aggregate profits to predict what portion of a firm's semi-annual or annual profits would likely have been generated in each quarter. In instances of the latter, the steps described above ensure that the imputed quarterly profits for each firm sum to the semi-annual or annual data taken from Refinitiv. If 2022 data was not available and the firm was still listed as active by Refinitiv at the time of data collection, we used trends in aggregate profits to predict how a firm's 2021 annual profits would have changed in 2022 and which portion of those profits would have accrued each quarter, with profits from this category accounting for 7.5% of our total 2022 profits figure. Table

S1 summarizes the total 2022 profits derived for three categories: quarterly profit data taken directly from Refinitiv, quarterly profits imputed from semi-annual and/or annual data (i.e. profits imputed from any of the steps (1) to (4) above), and profits extrapolated from 2021 data (step (5) above).

**Table S1. 2022 profits by calculation method for publicly listed firms**

| Profit data source | Total profits in $ billion |
|---|---|
| Quarterly Refinitiv data | 804.7 |
| Quarterly profits imputed from semi-annual and annual data | 41.9 |
| Profits extrapolated from 2021 using aggregate trends | 68.9 |
| Total | 915.5 |

For the set of private companies, 2022 profit data were only available in Orbis for a small fraction of firms. When profit data was missing, we instead rely on revenue data, which were available for a much larger portion of firms. At the time of data collection 2022 data were still unavailable in Orbis for a large portion of firms, thus we also collected 2021 profits and revenue data. For each firm, we first attempt to take 2022 profits directly; if missing, we use 2022 revenue data; if 2022 revenue data is missing, we use 2021 profit data; and finally if 2021 profit data is missing we use 2021 revenue data. Our 2022 profit figures for the set of private companies are thus divided into four groups: those (1) taken directly from Orbis, (2) imputed from 2022 revenues, (3) extrapolated from 2021 profits, and (4) extrapolated from 2022 revenues. The extrapolations and imputations were done with the use of aggregate trends among publicly listed firms who reported all 8 quarters of data between 2021-Q1 and 2022-Q4, thus we rely on the assumption that changes in profits among private firms mirrored the changes in profits that occurred among publicly listed firms. For group (2), 2022 profits were imputed from 2022 revenues for each firm by multiplying the firm's 2022 revenue by the aggregate profit rate in 2022 (i.e. aggregate 2022 profits divided by aggregate 2022 revenues, where "aggregate" refers to the set of publicly listed firms who reported all 8 quarters of profit data in 2021 and 2022). For group (3), each firm's 2022 profits were extrapolated from its 2021 profits by multiply its 2021 profits by the percentage by which aggregate profits changed between 2021 and 2022. For group (4), 2022 profits were extrapolated by multiplying each firm's 2021 revenues by the percentage by which aggregate revenues changed between 2021 and 2022 and then multiplying again by the aggregate profit rate in 2022. Table S2 summarizes the profits derived for the four groups described above.

**Table S2. 2022 profits by calculation method for private firms**

| Profit data source | Total profits in $ billion |
|---|---|
| Group 1 (2022 profits taken directly from Orbis) | 5.3 |
| Group 2 (scaled imputation from 2022 revenue) | 0.7 |

| Profit data source | Total profits in $ billion |
|---|---|
| Group 3 (extrapolation from 2021 profits) | 5.2 |
| Group 4 (extrapolation from 2021 revenue) | 135.6 |
| Total | 146.8 |

Network construction part II: shareholders

The main data source for identifying stages 2a and 2b nodes and the transmission to them is Orbis' shareholder database. First we matched companies in Refinitiv's database with those in Orbis, achieving a match for 1,382 companies. Then for these listed companies as well as all non-listed oil and gas companies collected from Orbis (now totaling 80,017), we collected information on each company's shareholders in Orbis and the size of the share (the link) it holds in the company. For every collected shareholder, we in turn collected their own shareholders from ORBIS. We did this until no new shareholders were collected. This process resulted in a network of 397,618 companies and shareholders as nodes with shareholdings linking them. Of these, 182,432 are companies, and 215,186 are persons, i.e. ultimate beneficiaries. Our shareholding data is current as of October 2022.

The network of shareholding relations from oil and gas companies through intermediate shareholders (e.g. financial institutions or holding companies) to ultimate beneficiaries allows propagating a unit of profit from an oil company to its ultimate beneficiaries. An ultimate beneficiary is a shareholder that doesn't in turn have shareholders. Persons, groups of persons (e.g. families or the directors or employees of a company), and governments are ultimate beneficiaries. Companies cannot be ultimate beneficiaries: by definition a company is owned by persons or a government. For many companies only part of the shareholdings are disclosed, due to data limitations, as Orbis only records large shareholders (owning more than 0.05% of the company). In such cases where the shareholders sum to less than 100% ownership, we assumed that the rest is owned by small, private shareholders: i.e. no funds or governments. Again, we assumed that for US-incorporated companies, these ultimate beneficiaries are US persons, and for non-US incorporated companies these are non-US persons. In principle, there could also be US government or fund ownership among these unknown shareholders. But since government typically holds a substantial share of any company in which it has any position at all (see e.g. Table 3 in ref[35]) and the United States government has stakes in comparatively few companies, we assumed that all government holdings would be above 0.05% of the company's ownership and recorded by Orbis.[36] For funds, we similarly assume that any fund ownership is above 0.05% as it pools investments by several persons. The next section details our treatment of fund ownership in general.

On some occasions, the total listed shareholdings of a company according to Orbis exceed 100%. This issue could arise from asynchrony in Orbis' own sources. In the absence of any additional information to determine which shareholding values are in error, we rescale each

reported shareholding percentage by a common factor to ensure the total shareholding is exactly 100%. Shareholdings sum to more than 100% in 1,005 companies in the network. The mean excess is +5.7%, the maximum excess is +96%. These 1,005 companies have assets totaling 10.5% of the reported assets for the entire network, and the 289 above the mean excess have 6.7% of the reported assets.

Network construction part III: fund managers

To map profits from oil and gas companies to ultimate beneficiaries, we must account for the cases where shareholding is controlled by fund managers, rather than directly by the ultimate beneficiaries. A substantial part of equity on capital markets is held via funds rather than directly. In the US, only 40% of corporate equity is held directly by households, and the figure is even lower elsewhere.[37] The rest is held by institutions. This can either be direct holdings by institutional asset owners, such as pension funds; or – and that is the predominant configuration – holdings of fund managers. Here, the fund manager invests in a company's shares on behalf of clients, e.g. pension funds or individuals, who are the ultimate beneficiaries and invest in the shares of the fund. Funds are set up and maintained by fund managers, such as BlackRock and Vanguard. In Orbis, shareholding links via funds are flagged, and the fund manager is shown as the shareholder. But fund managers do not have a claim on the profits of the shares they manage because they are not the ultimate beneficiaries of the shares. Instead, the clients are the ultimate beneficiaries of the shares, while the fund managers merely receive fees for managing the funds.[d] As such, whenever a shareholding link is mediated through funds, we break the link from the fund manager to its shareholders and instead pass it to the fund manager's clients.

Inspection of the data shows that Orbis underreports shareholding via funds, i.e. not all links that are clearly mediated through funds are flagged as such. In particular, some asset managers – the most common type of fund managers – are shown to have large direct shareholdings (i.e. not via funds). That is implausible for an entity that has little of its own equity to invest. For instance, BlackRock had more than $10 billion in assets under management at the end of 2021, but its own assets were valued at $152 million, of which only $32 million were equity.[38] Thus, BlackRock could in principle financially invest only on the order of 1% of its assets under management on account of its own shareholders, but Orbis lists many of BlackRock's assets as direct shareholding links.[e] To improve our estimate of shareholding via funds we assume that *all* shareholdings of fund managers are mediated through funds.

We identify fund managers by type of organization. We leverage a variable within Orbis called 'shareholder type' that assigns one of fifteen categories to each shareholding node. The relevant classifications of shareholders from this typology are "Mutual and pension fund/Nominee/Trust/Trustee", "Hedge fund" and "Private equity firm", all of which tend to

[d] Since these fees are paid by clients, we do not add them here. To the extent that fees are paid out of oil and gas shareholder distributions, their addition would constitute a double counting of profits.

[e] Moreover, the assets on BlackRock's balance sheet are of course not all in the form of investible cash and instead reflect the book value of the physical capital (plant and equipment), such as office buildings and computers, that allows the company to carry out its asset management operations.

manage funds for their clients as their primary business function. We supplement this 'type' classification from Orbis with a list of 6,916 major financial institutions with our own classification. For these institutions, our list overrides the classification provided by Orbis, which is wrong or misleading in many cases. For instance, Orbis classifies BlackRock, the world's largest asset manager, as a bank. Vanguard, the second largest asset manager, is classified as a non-financial corporation. We use the following categories:

- Asset managers
- Banks
- Endowments
- Family offices
- Foundations
- Hedge funds
- Insurers
- Other government
- Private equity
- Private pension funds
- Public pension funds
- Sovereign wealth funds
- Wealth managers

We assigned financial institutions to these categories based on a mix of manual searches and publicly available lists, notably the P&I/Thinking Ahead Institute's list of the 500 largest asset managers, and the Sovereign Wealth Fund institute's public lists of various types of institutional asset owners. We then assume that any shareholdings by companies categorized as asset managers, hedge funds, private equity, private pension funds, public pension funds and wealth managers in our list are 'mediated through funds'. For companies classified by Orbis as one of the three relevant shareholder types mentioned above but which are not on our constructed list of 6,916 financial institutions, we rely on Orbis's classification to assign these firms as fund managers. For other firms classified by the remaining shareholder types by Orbis, such as banks, we follow Orbis' flag as to whether a firm has a direct or via funds shareholding linkage.

Measuring the importance of the fund manager category of private equity as owners of non-listed oil and gas companies poses a particular challenge. This is because the quality of ownership data in Orbis is significantly worse for non-listed firms than for listed firms. However, in light of recent studies documenting private equity's targeted push into the oil and gas sector, measuring the size of its equity holdings is crucial.[39–41] In order to meet this challenge, we use two additional data sources. First we use Preqin, the leading provider of data on private equity transactions. We sequentially apply the following filters:

- Primary industry : 'Oil & Gas' or 'Power & Utilities'
- Sub-industry: Contains the strings 'Oil|Gas|Petroleum|Petrochemicals'
- Investment type: 'Buyout' or 'Public to private'
- Investment status: 'Active'

- Investment stake: any except ‘Minority’

This leaves us with 671 oil and gas firms. Based on the finding that the average holding period for private equity buyouts has increased to six years, we exclude all firms with a purchase date prior to 2016, which leaves 262 oil and gas firms that in 2022 are likely owned by private equity funds.[42] Second, we use Pitchbook, another provider of data on private equity to collect all oil and gas firms held by ten of the largest private equity companies. These companies and the oil and gas firms they hold are identified in a 2021 report by the Private Equity Stakeholder Project (PESP), using Pitchbook, too.[43] We updated the list of current holdings to spring 2023, after dropping one of the ten private equity companies, because it isn’t based in the US. We apply the following filters:

- Private equity firm: one of the nine largest companies from PESP
- Ownership status: ‘Privately held (backing)’
- Backing status: ‘PE-backed’
- Industries: ‘Oil and Gas Equipment’ or ‘Energy Exploration’ or ‘Energy Refining’ or Verticals: ‘Oil & Gas’

This yielded 101 oil and gas backed by private equity as of early 2023.

Searching for the union of the 262 and 101 companies in Orbis produced 275 matches, including a small number of firms that were not found with the search filter described in network construction part I section above. These firms were added to the other ‘input profit’ firms and are part of the totals in Table S2. These 275 firms received a flag signifying ‘fully owned by private equity firm’. For these firms, all other ownership information from Orbis is disregarded. For all remaining firms in the network, whether listed or unlisted, ownerships stakes are assigned to private equity whenever a shareholder is classified as a private equity firm in our shareholder list, or else by Orbis’ own classification variable.

To create links from fund managers to their clients (which are not reported in Orbis), we use data on the clients of asset managers, hedge funds and private equity as groups. To link asset managers to clients, we use information from the Financial Accounts of the Federal Reserve (table L.224), which provides aggregate data on the clients of asset managers. The Financial Accounts allow us to create links between asset managers and the following groups beneficiaries: public and private pension funds, insurance companies, households, non-financial companies, the US government and the rest of the world.[44] For hedge funds and private equity funds, we use the Securities and Exchange Commission’s private fund statistics to create links to these same recipients and, in addition, to non-profits (endowments and foundations) and to high-net-worth individuals.[45,f] By not accounting for the common 20% performance fee charged by these alternative asset management firms—money that goes to the owners/general partners

[f] We assume that all clients of hedge funds and private equity funds designated as “U.S. persons” (roughly 14% and 6% of beneficiaries, respectively, in the SEC’s private fund statistics) are high net worth individuals , who own enough wealth to put them entirely into the top 1% of the wealth distribution. We split them evenly across top 0.1% and the rest of the 1% quantiles, which are detailed in the section on socio-economic distributions.

of these firms—we offer a conservative estimate of the share of hedge-fund and private-equity-held profits flowing directly to the top 1% of the wealth distribution. Generally, our allocation of fund holdings to ultimate beneficiary groups rests on the assumption that the structure of beneficial ownership for fund holdings in the oil and gas sectors mirrors that for fund holdings in the economy as a whole.

Network construction part IV: Socio-economic distribution

In the last step, we group ultimate beneficiaries into broad categories (Table S3) and then link these categories to the wealth size distribution and distributions by race and ethnicity, and by education. For this we use the Distributional Financial Accounts (DFA) from the Federal Reserve.[46] We match components of household financial assets in the DFA with our ultimate beneficiary categories. For instance, we match individual shareholders of a non-financial corporation with the DFA financial asset category "corporate equities and mutual funds". We match a pension fund with the DFA category "pension entitlements". Table S3 has a complete list of matches of our ultimate beneficiary categories with DFA categories. The DFA breaks down (partitions) the ownership of these asset categories according to the wealth size distribution. As a first approximation we assume that the ownership of fossil fuel financial assets reflects that of the overall economy (we are not aware of any studies that examine biases of particular wealth groups in the ownership of assets across industrial sectors). Thus, we can allocate shares summing to 100% of each ultimate beneficiary group to the quantiles in the wealth distribution. Similarly, the DFA reports the ownership of each financial asset category broken down by race and ethnicity and by educational attainment. Once again, we assume that the distribution of fossil-fuel ownership by racial and ethnic or educational groups resembles that of the whole economy. For more detail on the race and ethnicity, and education definitions, see ref[47].[g]

**Table S3. Match of ultimate owner categories with DFA financial asset categories**

| Ultimate beneficiary category (Stage 3) | Financial asset category |
|---|---|
| Business owners | Private businesses |
| Pension funds | Weighted average of defined contribution and defined benefit pension entitlements |
| Mutual fund holders | Corporate equities and mutual fund shares |
| Shareholders in non-financial firms | Corporate equities and mutual fund shares |
| Shareholders in banks and insurers | Corporate equities and mutual fund shares |
| High net worth individuals | Bespoke: 50% top 0.1% and 50% rest of top 1% |
| Government, nonprofits, rest of the world | No match as not US-based household wealth |

[g] Note in particular that the racial and ethnic categories come from self-identification in the Survey of Consumer Finance, and are listed as White non-Hispanic, Black non-Hispanic, Hispanic or Latino, and other or multiple race, and abbreviated as White, Black, Hispanic and Other in the DFA and our figures. The question of whether respondents consider themselves as "Hispanic or Latino in culture or origin", included in the survey since 2004, is ignored in the DFA for consistency with pre-2004 surveys.

This completes the network of shareholding where claims on profits flow from oil and gas companies all the way to quantiles in a socio-economic distribution. We identify 4 stages in this process. Where profits enter the network via oil and gas companies is stage 1. Stage 2a propagates profits from oil companies which are owned directly (i.e. not via funds) to ultimate beneficiaries, stage 2b propagates profits to fund managers. Stage 3 propagates both directly and fund-held profits to broad ultimate beneficiary categories. Stage 4 propagates these into socio-economic distributions. All that remains to develop is an algorithm to propagate these profit claims.

Profit propagation algorithm

We construct an algorithm to propagate profits from where they originate with oil and gas companies all the way to the socio-economic distributions. It builds on and is completely reworked, improved and expanded from the algorithm in ref[6]. The propagation is simplified within the financial network by considering accounting profit. Accounting profit is not a conserved quantity, but it accumulates at every level of the ownership chain. We recover conserved profit by isolating the fraction of the accounting profit that is not held by shareholders. We map the accounting profits reported by 80,017 fossil-fuel companies to their shareholders, company by company and shareholder by shareholder, and then isolate the (unowned) share of the economic profits in each shareholder. This ultimately leads to an allocation of economic profits to two types: to direct ultimate beneficiaries (who hold shares in their own names) and to fund managers (who hold shares on behalf of their clients).

Direct shareholding links in the network propagate a fraction of profits from a company to its shareholders. Therefore, for direct shareholder *i* – which can be a firm, individual, or group – the profits propagated to *i*, $p_i$, consist of the sum:

$$p_i = g_i + \sum_{j=1}^{N} p_j \times s_{i,j} \qquad \text{for } i \text{ in } 1, \ldots, N. \quad (1)$$

where $g_i$ is any profit deriving from shareholder *i*'s own oil and gas operations, and $s_{i,j}$ is the fraction that shareholder *i directly* holds of company *j*'s shares, with $s_{i,i} = 0$ by definition.[h] In our network of *N* = 397,618 firms and shareholders, $g$ is nonzero for the 80,017 firms that we identified as earning oil and gas profits, and zero for all others.

In the case of managed ownership, profits $m_i$ are propagated to fund manager *i* as follows:

$$m_i = \sum_{j=1}^{N} p_j \times f_{i,j} \qquad \text{for i in } 1, \ldots, N. \quad (2)$$

[h] When firm *i* reports self-shareholding in Orbis (e.g. because of how Orbis records a share buyback), this just increases the effective shareholding by all other shareholders proportionally. Thus, for reported self-shareholding $z_{i,i}$ and other reported shareholdings $z_{i,j}$, we calculate $s_{i,j} = z_{i,j}/(1 - z_{i,i})\ \forall\, j \neq i$ and set $s_{i,i} = 0$.

where $f_{i,j}$ is the shareholding of *i* in *j* mediated through funds. Notably, these managed profits do not appear in eq. (1) because they accrue to the fund manager's managed assets, not to its own balance sheet, and therefore do not propagate through other share ownership.

The total propagated profits in the network are equal to the total profits originating from the oil and gas firms:

$$\sum_i g_i = \sum_i \left((1 - S_i)p_i + m_i\right) \qquad (3)$$

where $S_i = \sum_j s_{j,i}$, the sum of ownership shares of all direct shareholders of company *i*, thus conserving profits.

Equations (1) and (2) are constrained by

$$\sum_{i=1}^{N} s_{i,j} + f_{i,j} \leq 1 \qquad \text{for } j \text{ in } 1, \ldots, N. \qquad (4)$$

that is, direct shareholders and shareholdings mediated through funds cannot together own more than 100% of a company's equity. Where shareholdings sum to less than 1, we assume that the rest is owned by direct shareholders, as explained in the network construction section above.

The solution to these equations is straightforward. Equation (1) defines profits implicitly, as the right-hand side involves $p_i$, so the solution must be obtained by inverting the matrix of shareholdings $s_{ij}$. Fortunately, Eqn. (1) can be solved simply by iteration; the profits of each oil and gas company are propagated to the direct shareholders during each iteration, until there is no further change in the distribution of profits across the network. Fig. S2 illustrates the propagation from a particular company to a sequence of shareholders.

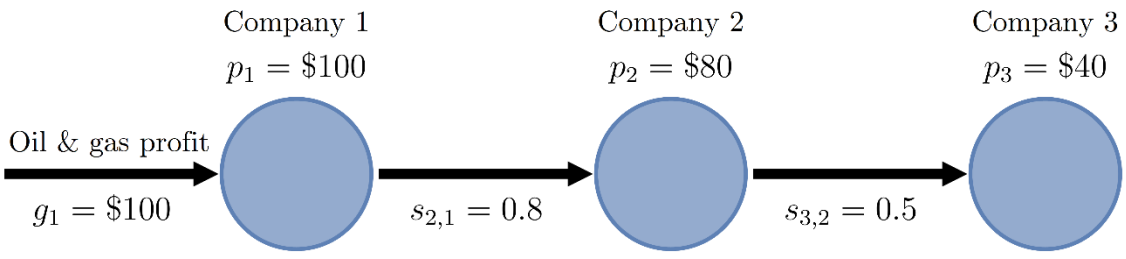



**Figure S2. Illustration of direct shareholding propagation.** Profits are propagated to shareholders by the fractional shares of the profiting company they hold.

A single propagation step can be expressed in matrix form as

$$\boldsymbol{p}_{k+1} = \mathbf{S}\boldsymbol{p}_k \qquad (5)$$

where $\boldsymbol{p_0} = \boldsymbol{g}_0 \; and \; \boldsymbol{p}$ and $\boldsymbol{g}$ are vectors of length N, **S** is a square matrix of direct shareholding links, and $k$ is the step of propagation. At $k = 0$ all profits reside in oil and gas companies only.

In order to propagate profits through to ultimate owners, we treat equation (5) as a system of first order linear difference equations, equivalent to solving via the Jacobi method. Intuitively, this system, with all entries in ***S*** in the interval [0,1), propagates smaller and smaller portions of the initial profits in vector $\boldsymbol{g}_0$, until vector **p** becomes an unchanging vector of profits after enough iterations. Formally, the system is asymptotically stable because its largest eigenvalue modulus is less than 1 (for a proof see e.g. ref[4849]). We therefore repeat iterations of propagation until $\boldsymbol{p}_{k+1} = \boldsymbol{p}_k$ within machine precision.

For the previous paragraph to hold, any closed shareholding loops must be removed. Conceptually, such loops cannot occur: corporations are (ultimately) owned by persons or groups of persons. But in practice, in some cases, asynchrony in ownership information within Orbis can introduce closed loops to the network, causing the iterative propagation of profits to cycle indefinitely without convergence. This phenomenon is resolved by identifying subsets of companies in which convergence fails, identifying closed ownership loops within each subset, and subjectively identifying and removing the least credible link in the cycle. We identify this link as one for which a smaller company (in terms of equity) owns 100% of a larger company, rather than vice versa. Twelve links are removed in this way to resolve the issue of convergence in the entire network.

Now that the directly held shares have been resolved, shares held mediated through funds are accounted for in a single matrix **F** and illustrated by Fig. S3.

$$\boldsymbol{m} = \mathbf{F}\boldsymbol{p}\,. \qquad (6)$$

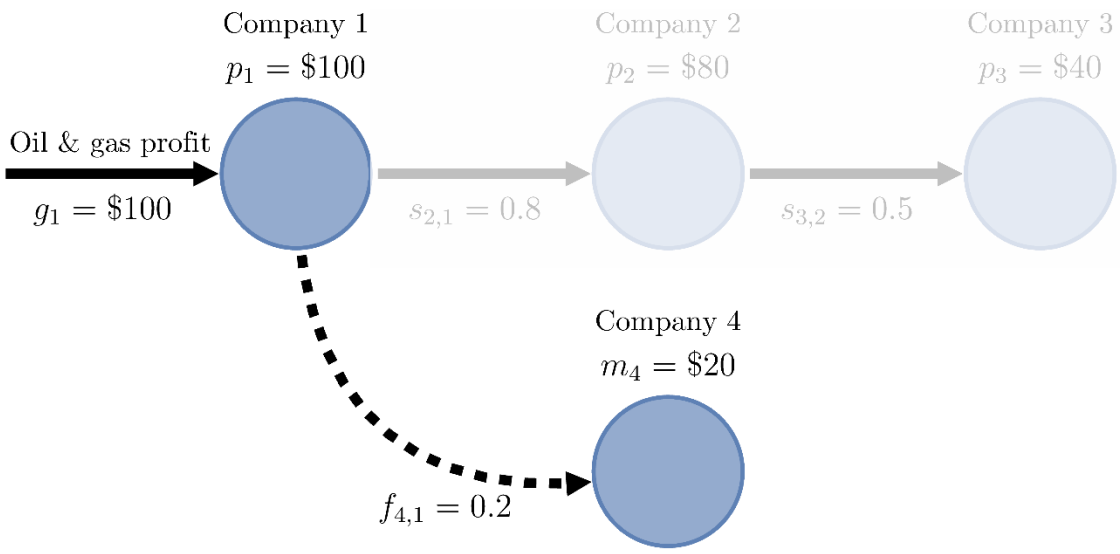



**Figure S3. Illustration of fund holding propagation.** Once the shareholder network has been iterated, thus finding the solution to Eqn. (1), ownership mediated through funds is resolved in a single step. These managed funds do not propagate further.

After allocating profits to ultimate owners via direct shareholdings and fund managers, three steps remain. First, we aggregate direct shareholdings into categories of ultimate owners shown in Table S3. Second, we use information on the average holdings of these different categories of ultimate owners in funds as described in the network construction above to propagate the profits mediated through funds to ultimate owner categories, and add them to the profits claimed via direct shareholdings. Finally, we use our match of ultimate owner categories with the DFA asset categories (also Table S3), as well as the DFA's data on the ownership of asset categories by components of our three socio-economic distributions, for our final propagation of profits to socio-economic groups.

Additional data for Fig. 1

Parts A and B of Fig. 1 in the main manuscript use profit data for all listed firms available in Refinitiv from the first quarter of 2016 to the fourth quarter of 2022, with the set of firms as described above. Part B partitions the data by the country of each firm's headquarters. Part C uses additional data all from Refinitiv. Renewable energy profits are calculated exactly as oil and gas profits, but on the set of companies that are in 'renewable energy' according to TRBC. The MSCI index end of day time series was downloaded for MSCI World Energy Sector Price Index USD, and for the MSCI Global Alternative Energy Net Index USD, approximations of fossil fuel and renewable energy sector equities. At the time of writing, the top 10 constituents of the former are Exxon Mobil, Chevron, Shell, ConocoPillips, TotalEnergies, BP, Canadian Natural

Resources, Schlumberger, Enbridge, and Marathon Petroleum.[i] Of the latter the top 10 constituents are Vestas, First Solar, Enphase Energy, Orsted, Adani Green Energy, Nextracker, Verbund, EDP Renovaveis, Northland Power, Solaredge Technologies.[j]

Inflation compensation with fossil fuel profits

Inflation leads to a loss in real income, i.e. the ability to purchase goods and services, with a given nominal, i.e. US-dollar or other currency, income. The Bureau of Labor Statistics' Consumer Price Index (CPI) was up 6.5% year-on-year in December 2022 and the Bureau of Economic Analysis' Personal Consumption Expenditure Price Index (PCE) was up 5.0% over the same time period. But since profits are part of nominal income for those who receive them, higher profits effectively compensate part of the real income loss from inflation by increasing nominal incomes. Table S4 presents a simple calculation of the extent to which the increase in oil and gas profits, year-on-year, from 2021-Q2 to 2022-Q2 compensated the various quantiles of the wealth distribution, on average, for inflation over the same period.

Column (1) estimates the disposable income of each wealth group in 2021, relying on the income earned by wealth shares from ref[24] and adjusting to Fed-reported wealth shares. Columns (2) and (3) report oil and gas profits in 2021 and 2022, assuming the oil and gas profits were split among quantiles in the same proportions in 2021 as in 2022. Column (4) calculates the proportional increase in nominal income as a result of the increase in oil and gas profits from 2021 to 2022 accruing to each quantile. Counting all the additional profits in column (3) we find that profits have increased disposable personal incomes by 6.4% for the top 0.1% and 0.5% for the middle 40%. On average, the rise in fossil fuel profits increased disposable income by 1.3% in the United States in 2022. Not all profits are typically distributed to shareholders, and there may be a 20% tax both on dividends and realized capital gains. Multiplying the profits in column (4) by 0.5 and 0.8, or a total of 0.4, we find that top 0.1% incomes may have increased between 2.6% and for all of the top 1% by 1.8%.

**Table S4. Profit increase impact on effective inflation by wealth quantile in USD billion**

| Wealth quantile | Disposable personal income, 2021 | Oil and gas profits | | Nominal income increase; all profits, no tax (%) | Nominal income increase; half of profits with tax (%) |
|---|---|---|---|---|---|
| | | 2021 | 2022 | | |
| | (1) | (2) | (3) | (4) = [(3)-(2)] ÷ (1) | (5) = (4)*0.4 |
| Top 0.1% | 966.4 | 48.6 | 110.9 | 7.2% | 2.9% |
| Rest top 1% | 1,792.2 | 50.5 | 115.1 | 4.0% | 1.6% |
| Next 9% | 4,467.2 | 63.1 | 143.9 | 2.0% | 0.8% |
| Middle 40% | 6,717.1 | 28.6 | 65.3 | 0.6% | 0.2% |
| Bottom 50% | 4,690.3 | 1.9 | 4.2 | 0.1% | 0.0% |
| All households | 18,633.1 | 164.6 | 439.4 | 1.5% | 0.6% |

[i] https://www.msci.com/documents/10199/4436b773-ee19-4bac-8fbf-307d28408ca8
[j] https://www.msci.com/documents/10199/40bd4fec-eaf0-4a1b-bfc3-8ed5c154fe3c

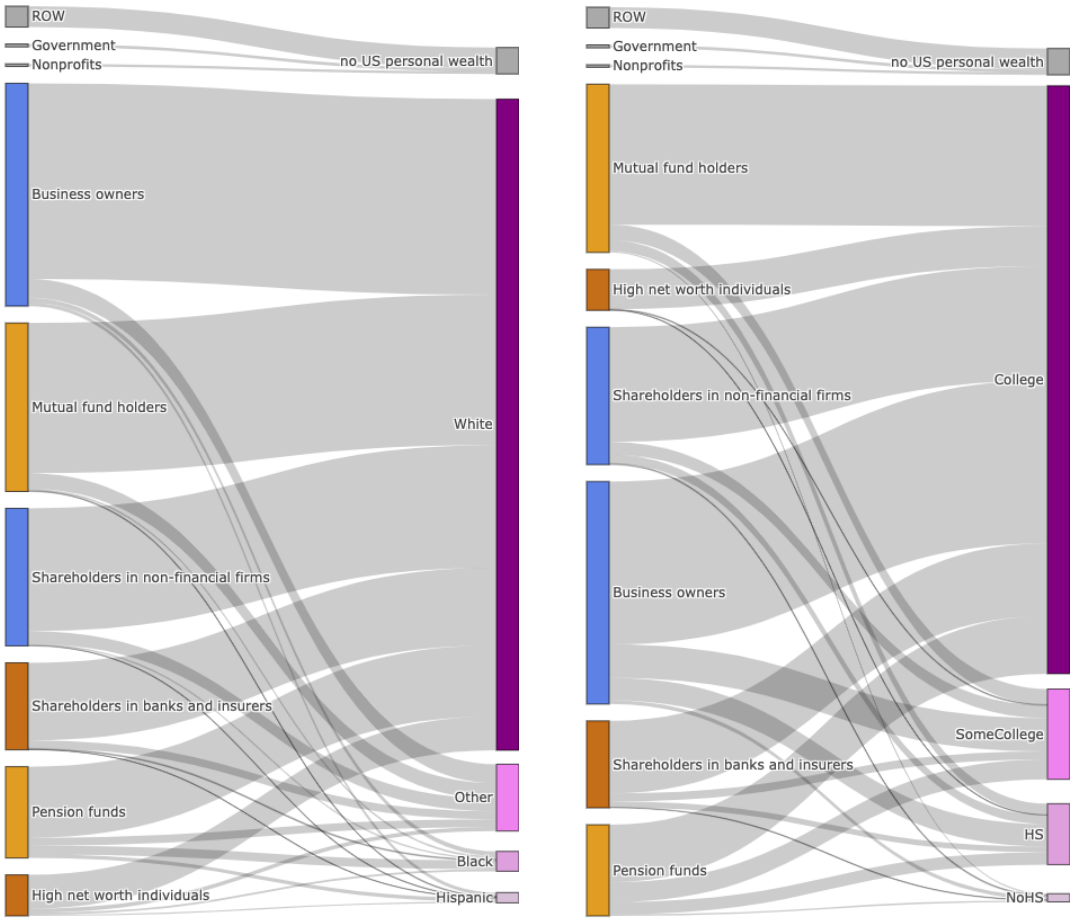
| | | | | | |
|---|---|---|---|---|---|
| Memo: top 1% | 2,763.2 | 84.6 | 226.0 | 5.1% | 2.0% |
| Memo: top 10% | 7,237.9 | 138.5 | 369.9 | 3.2% | 1.3% |

Note: Disposable income is from the Bureau of Economic Analysis, National Income and Product Accounts, Table 2.1, release 21 Dec, 2023.

Comparing columns (4) or (5) to inflation figures shows what part of inflation was compensated as discussed in the main text. The CPI inflation for the top 20% of income earners was 0.4 percentage points lower than the average in 2022, and possibly even lower for the top 10% and 1% by one estimate.[15] To account for this inflation disparity, Fig. 3 modifies the inflation for each wealth quantile using the Bureau of Labor Statistics estimates of inflation disparity by income quintile.[15,22] This lowers top 20% inflation by 0.2 percentage points and raises bottom 20% inflation by 0.3 percentage points. Deviations in between are lower and change monotonically. For lack of information on how wealth quantiles were affected differently by inflation, we use these broad categories on income quantile inflation for our wealth quantiles, leading to a conservative modification: the top 0.1% wealth owners are experiencing the same reduction of inflation as the top 20% income earners, and no more. The result is that for the top 0.1% column (5) should be compared to a CPI of 6.3%, not 6.5%.

**Extended Data**

**a)** **b)**




**Extended Data Fig. 1 | Sankey flow of profits to households grouped by race and ethnicity or education.**

The Sankey diagrams shows how claims on profits reaching ultimate beneficiary groups are allocated to households based on **a)** race and ethnicity and **b)** education.