A Welfare Analysis of Policies Impacting Climate Change

Executive Summary

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What are the most effective ways to address climate change? This paper addresses this question by examining a comprehensive sample of 96 US environmental policy changes whose causal effects have been rigorously estimated over the past 25 years. These policies span four main categories: subsidies (e.g. tax credits to wind energy producers), nudges (e.g., home energy reports), revenue-raisers (e.g. fuel taxes), and international policies (e.g., subsidies for efficient cookstoves). We evaluate each policy by constructing the policy's Marginal Value of Public Funds (MVPF). The MVPF is the ratio of a policy's benefits (as measured by the willingness to pay of beneficiaries) to a policy's net costs to the government. This provides a measure of the "bang for the buck" of each climate policy. It provides a single unified metric to compare across the broad set of policies we consider.

Here we highlight five key findings from our work:

Key Findings

1. Subsidies for renewable energy generation, such as wind and solar, have the highest MVPFs in our sample.

2. Energy conservation and vehicle subsidies have comparatively low MVPFs, with values around 1.

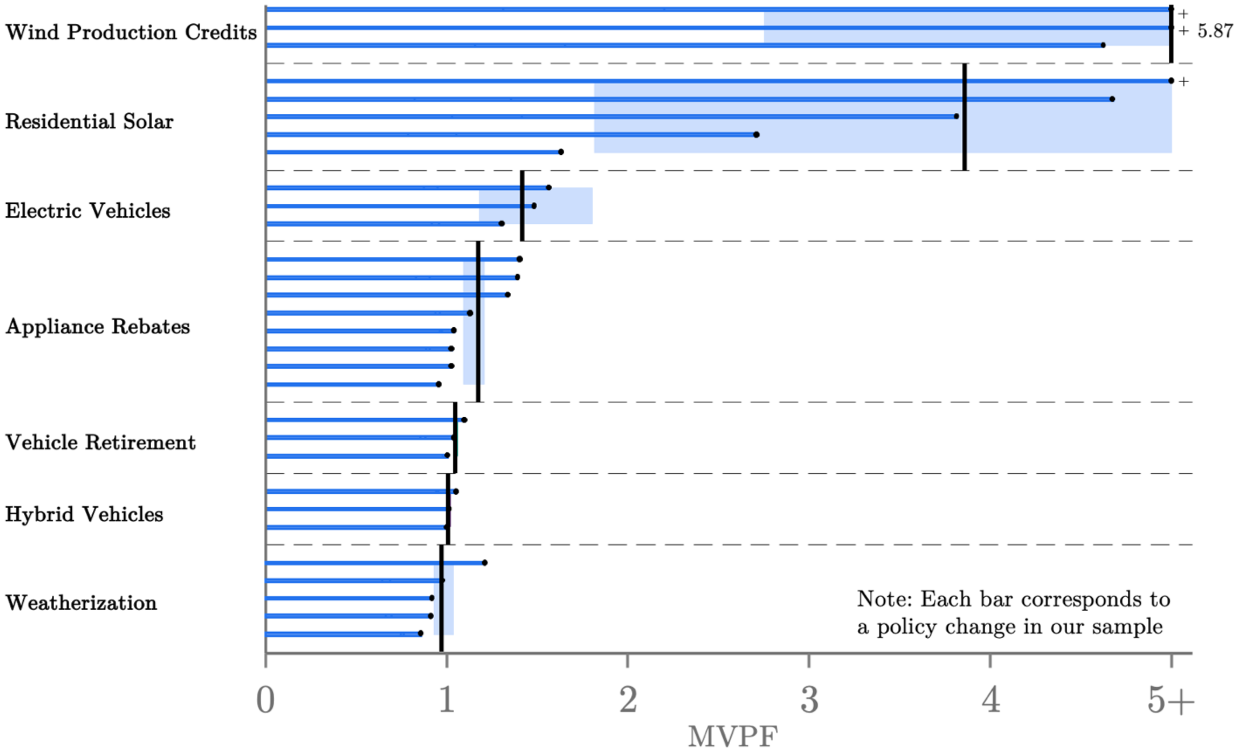
3. Climate-focused revenue raisers such as fuel taxes and cap-and-trade schemes are particularly efficient means of raising revenue, as indicated by their low MVPFs.

4. International climate subsidies have the potential to produce very high returns, even when only considering the impact on US residents and US taxpayers.

5. Typical measures of cost effectiveness such as "cost per ton of CO_2 abated" do not account for the full sets of benefits and costs of climate policy. Consequently, they fail to capture the lessons of the MVPF approach.

Finding #1: Subsidies for renewable energy generation, such as wind and solar, have the highest MVPFs in our sample.

The Figure below shows our MVPF estimates for each of the subsidy types studied in our sample. We find that subsidizing technologies that displace the production of dirty energy leads to the highest MVPFs. In particular, production tax credits that encourage the production of utility-scale wind energy yield MVPFs exceeding 5. We also find high, but slightly more modest, MVPFs for residential solar subsidies. These MVPFs typically exceed 2.



Finding #2: Energy conservation and vehicle subsidies have comparative low MVPFs, with values around 1.

We consider several major types of energy conservation and vehicle subsidies, including subsidies for home weatherization, appliance rebates, vehicle retirement and hybrid vehicles. We find that the MVPFs are relatively low across each of these categories, with MVPFs near 1. These low values contrast with the high MVPF values for renewable energy generation policies discussed above.

Interestingly, we find that subsidies for electric vehicles have MVPFs that are slightly above the MVPFs of other policies targeting vehicles (hybrids, retirement, etc.) or energy conservation. The MVPF of EV subsidies is buoyed by potential learning-by-doing gains in the production of batteries, but these subsidies still have considerably lower MVPFs than policies that subsidize the direct production of clean energy.

The differences in returns across policy categories also provide a lens through which to evaluate historical changes in US spending on environmental policy. For example, we can compare the allocation of funds under the American Recovery and Reinvestment Act (ARRA) of 2009 with the allocation of funds under the Inflation Reduction Act (IRA) of 2022. We calculate that the ARRA spent 3 times more on clean energy than on energy efficiency, while the IRA spent 9.4 times more on clean energy than energy efficiency. This represents a substantial relative reallocation toward spending categories with higher MVPFs. At the same time, there has also been an increase in spending on EV subsidies as compared to clean energy spending, allocating funds toward an area with comparatively low returns.

Finding #3: Climate-focused revenue raisers such as fuel taxes and cap and trade have low MVPFs, suggesting they can be highly efficient means of increasing revenue.

We analyze the MVPF of a wide range of revenue raisers such as gasoline taxes, jet fuel taxes, diesel taxes, and cap and trade. We find that nearly all of the climate-focused revenue raisers studied in our sample have MVPFs below 0.7. A lower MVPF means that a policy is a more efficient means of raising revenue. For example, an MVPF of 0.7 means that the policy costs individuals 70 cents for each dollar of government revenue raised. These MVPF values for environmental taxes are lower than MVPFs for typical revenue raisers such as income taxes. (Those often have MVPF values above 1.) This relative ordering is consistent with classic theories of taxation, suggesting that taxing goods with negative externalities enables raising revenue at a relatively low cost to society.

We also examine cap and trade policy and construct the MVPF of reductions in cap and trade permits. We find that these policies have often delivered large benefits to society while also raising government revenue.

Finding #4: International climate subsidies have the potential to produce very high returns, even when only considering the impact on US residents and US taxpayers.

While our primary focus is US environmental policy, the benefits of reduced greenhouse gas emissions flow across international borders. Some of the largest MVPFs in our sample are policies designed to reduce emissions in developing countries (such as subsidizing efficient cookstoves and payments to reduce deforestation). Even setting aside any benefits to local residents, we find that the US-specific gains from reduced CO_2 emissions can be many times larger than a policy's costs. Moreover, the prevention of damages from CO_2 emissions can generate returns to US taxpayers because increased productivity increases government revenue. We caution that not all international policies we study have high returns and that there is substantial uncertainty regarding the formal incidence of carbon damages. The math suggests, however, these types of policies have the potential to unlock large welfare gains to the direct policy beneficiaries, to US residents, and to US taxpayers.

Finding #5: Typical measures of cost effectiveness such as "cost per ton of CO_2 abated" do not account for the full set of costs and benefits of climate policy. Consequently, they fail to capture the lessons of the MVPF approach.

When measuring the cost effectiveness of climate policy, researchers typically report a measure of "cost per ton." Unfortunately, the notion of cost per ton is amorphous and varies substantially across technical analyses. Some research uses a measure of resources expended per ton, some research uses a measure of government costs, and some research uses a measure of net social costs per ton. We show that the same policy can have cost per ton measures that vary drastically based on the definition employed. For example, we estimate that appliance rebates have values of cost per ton that range from -$2 to $470 per ton across definitions.

Even if one were to remain consistent in applying the definition of cost per ton when evaluating environmental policy, we show that each measure fails to capture the insights provided by the MVPF approach. For example, we find that wind production tax credits have the highest MVPFs, followed by residential solar subsidies and then electric vehicle subsidies. The social cost approach yields the exact opposite ordering.

In short, the MVPF captures the full set of costs and benefits associated with each climate change policy. It provides a consistent method for ranking such policies, and we hope it can help to inform climate policy in the years ahead.

Read more in the full paper here.