The Heritage Foundation
LEADERSHIP FOR AMERICA

BACKGROUNDER

No. 2802 | MAY 28, 2013

A Cure Worse Than the Disease: Global Economic Impact of Global Warming Policy

David W. Kreutzer, PhD

Abstract

Adopting carbon restrictions of the magnitude mandated by the Lieberman–Warner and Waxman–Markey cap-and-trade bills or the Boxer–Sanders carbon-tax bill would harm the U.S. and global economies. By 2100, the global economy would lose more than $100 trillion. Analysis suggests that countries with stronger economies can overcome the challenges posed by warming. Indeed, faster growth would insulate the economy from the negative impacts of global warming.

How would adopting a global-warming policy affect world income?

Adopting carbon restrictions of the magnitude found in the Lieberman–Warner cap-and-trade bill[1] would actually reduce worldwide income, even after accounting for the economic benefits of moderated warming. The costs would exceed the benefits by more than $100 trillion over the remainder of the 21st century. The perverse impact of climate policy would be even worse if the major developed countries join the U.S. in implementing an equivalent policy to restrict carbon emissions. Further, the net negative impact would grow exponentially, causing those working in the last two decades of this century to suffer annual income losses that would be hundreds of times greater than those suffered in the early years of the climate policy.

Warming and National Income

There is some debate about the magnitude of warming experienced worldwide over the past century. However, there is more

Key Points

- Carbon-restricting policies of the magnitude set out by the various cap-and-trade bills and recent carbon-tax proposals would impose costs on the world economy that exceed benefits by more than $100 trillion by the end of this century.
- Extending the carbon policy to all major developed countries would only increase the overall negative impact on the world economy, leading to net losses of nearly $400 trillion by 2100.
- Carbon-restricting policies would harm future generations more than the current generation. The annual net impact in the final two decades of this century would be 200 times larger than in the first two decades of the policy, even after adjusting for inflation.

This paper, in its entirety, can be found at **http://report.heritage.org/bg2802**

Produced by the Center for Data Analysis

The Heritage Foundation
214 Massachusetts Avenue, NE
Washington, DC 20002
(202) 546-4400 | heritage.org

debate about how much manmade carbon dioxide (CO_2) emissions have contributed to this increase in temperature, and there is even greater uncertainty about how rapidly the Earth will warm over the next century and beyond.[2]

If there will be little warming, then there is little need to address carbon emissions. However, regardless of the amount of projected warming, policies should be evaluated by comparing their impact relative to their costs. We find that carbon policies flunk the cost-benefit test by wide margins.

We find that carbon policies flunk the cost-benefit test by wide margins.

When considering both costs and benefits, a carbon policy with restrictions similar in size and scope to those in the Waxman–Markey legislation (an 80 percent cut in CO_2 emissions by 2050),[3] which the House of Representatives passed in 2009, would lead to:

- An aggregate income loss to the U.S. of $207.8 trillion by 2100;
- An aggregate income loss worldwide of $109.6 trillion by 2100;
- A one-year worldwide loss of $3.5 trillion in 2100, equivalent to 4.75 percent of U.S. gross domestic product (GDP); and
- Adverse impacts, on net, in every year of implementation.

These same results would hold for a carbon tax, and the results are even worse if more countries adopt the carbon-restricting policies.

Economics of Warming

For the purpose of this analysis, we assumed warming of 4.5 degrees Celsius by 2100, a high-end estimate by the Intergovernmental Panel on Climate Change (IPCC).[4] This estimate also assigns the greatest change in warming for a given change in carbon emissions. In short, it is a best-case scenario for supporting a carbon policy, because it has the highest estimated temperature and the greatest reduction in warming for given policy interventions.

Estimating the economic impact from warming has traditionally followed one of two paths. The first compares the per capita income of different countries to their average temperatures. Those who are uncomfortable with blaming the weather for weak democratic institutions believe this method exaggerates warming's negative effect because of the preponderance of dysfunctional governments found at low latitudes.

The second path creates models of economic activity built with equations that estimate the impacts of warming on various sub-sectors of the economy. The complexity of an economy and the complexity of responses by various sectors to warming make this method extremely difficult. Further, biases, which may be subconscious, will be introduced by the researchers' choices of which impacts to include.

A recent paper by Melissa Dell and her coauthors offers an alternative calculation that avoids the complexity of the second method and the problems of the geographic distribution of civic quality.[5] They analyzed 125 countries over 55 years to estimate

1. Lieberman–Warner Climate Security Act of 2007, S. 2191, 110th Cong., 1st Sess.
2. Websites and blogs cover all sides of this issue and often provide links to academic papers and discussions. For a few of the websites offering a variety of viewpoints of this animated debate, see Watts Up With That, http://wattsupwiththat.com/ (accessed May 14, 2013); Real Climate, http://www.realclimate.org/ (accessed May 14, 2013); World Climate Report, http://www.worldclimatereport.com/ (accessed May 14, 2013); Roger Pielke Jr.'s Blog, http://rogerpielkejr.blogspot.com/ (accessed May 14, 2013); Dot Earth, http://dotearth.blogs.nytimes.com/ (accessed May 14, 2013); Global Warming, http://www.drroyspencer.com/ (accessed May 14, 2013); and Climate Debate Daily, http://climatedebatedaily.com/ (accessed May 14, 2013).
3. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong., 1st Sess.
4. Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis* (Cambridge, U.K.: Cambridge University Press, 2007), p. 12, http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm (accessed May 20, 2013).

the impact of warming on each country's GDP. By focusing on the impact on overall economic activity, they include all the negative and positive impacts of warming on income. Their statistical technique uses annual changes in temperature and avoids the problems of a simple cross-country comparison.

They found that countries with above-average income for the sample period suffered no impact from warming. On the other hand, countries with below-average income suffered a significant 1.3 percentage point decrease in their growth rate for each degree (Celsius) increase in temperature.

Poverty and Climate Impacts

Although most poverty policies address relative poverty, absolute poverty is a greater concern when assessing the impact of climate on income. As countries become richer, they can afford to air-condition larger fractions of their homes, businesses, and factories. In addition, the climate-sensitive agricultural sector typically becomes a smaller fraction of GDP. At the same time, richer countries can afford to plant the more expensive, climate-tolerant hybrid seeds and spend more on irrigation and other yield-enhancing agricultural capital.

As with virtually all adversity, a stronger economy helps to overcome the challenges posed by warming—although not all effects of warming on income are negative.[6] By the same logic, as weak economies grow stronger, the impact of global warming becomes less problematic.

Expected economic growth of the developing countries will move more and more countries above the income threshold at which Dell et al. found a negative impact on economic growth. However, rising temperatures will retard the progress toward this climate insulation. Policies to moderate warming could, therefore, help poorer countries reach this income threshold sooner and reduce the economic losses caused by warming until they do so.

The authors divided their database into high-income and low-income groups by comparing each country's per capita GDP to the world average for the year in which the country entered the database. Those above the cutoff are high income. One of the authors suggested that the average income for the middle year (1976) of their database would be a proxy for the threshold of income. This threshold is $6,574 in 2011 dollars. A single threshold makes an admittedly crude variable, but we use it in our analysis because Dell and her coauthors used it.

As with virtually all adversity, a stronger economy helps to overcome the challenges posed by warming—although not all effects of warming on income are negative.

Costs of Carbon Cuts

On the other side of the equation is the cost to economic growth from cutting carbon emissions through policies that increase costs. Carbon caps and carbon taxes will have roughly the same economic impact if they reduce carbon emissions to the same degree. Estimates of the economic impacts vary depending on the assumptions about the availability of alternatives to cutting carbon. Notable alternatives include building additional nuclear capacity; capturing and sequestering carbon, especially from coal-fired power plants; and offsetting emissions with verifiable and permanent carbon reductions elsewhere.[7]

Although more generous toward nuclear capacity, carbon capture, and offsets than our analysis at The Heritage Foundation, the Environmental Protection Agency (EPA) analysis of the Lieberman–Warner

5. Melissa Dell, Benjamin F. Jones, and Benjamin A. Olken, "Temperature Shocks and Economic Growth: Evidence from the Last Half Century," *American Economic Journal: Macroeconomics*, Vol. 4, No. 3 (July 2012), pp. 66–95.
6. For instance, warming is likely to reduce cold-related mortality more than it increases heat-related mortality. W. R. Keatinge et al., "Heat Related Mortality in Warm and Cold Regions of Europe: Observational Study," *British Medical Journal*, September 16, 2000, pp. 670–673, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC27480/ (accessed April 17, 2013).
7. For a discussion of the alternative assumptions, see David W. Kreutzer, "Heritage Analysis of Waxman–Markey Hits Where Others Miss," Heritage Foundation *WebMemo* No. 2580, August 6, 2009, http://www.heritage.org/research/reports/2009/08/heritage-analysis-of-waxman-markey-hits-where-others-miss.

bill did not use the much higher—therefore the less believable—target for offsets found in later bills, such as Waxman–Markey. In its analysis of Lieberman–Warner, the EPA estimated that the carbon cuts would reduce the annual U.S. economic growth rate by 0.11 percentage point.[8]

The third factor needed for the calculation is the impact that the climate policy would have on average world temperature. Chip Knappenberger estimated that the carbon cuts from Waxman–Markey (slightly larger than the cuts from Lieberman–Warner) would moderate world temperatures 0.19 degree Celsius by the year 2100.[9] He assumed the same IPCC high-end sensitivity of temperature to carbon levels: 4.5 degrees Celsius for a doubling of carbon dioxide. Therefore, this gives a high-end estimate of the temperature impact of any carbon reductions.

Knappenberger estimated that the temperature could be moderated by up to 0.4 degree by 2100 if all Kyoto Annex I countries participated in a similar carbon policy.

The Calculations

We projected per capita and aggregate income for each of 179 countries using 2011 income data from the International Monetary Fund (IMF), population and population growth projections from the IMF and the World Bank, and income growth projections from PricewaterhouseCoopers. (For more information on this calculation, see the Appendix.)

To generate the baseline case, the economic growth rate for countries with per capita GDP below $6,574 in real 2011 dollars was reduced by 1.3 percentage points times the increase in temperature since 2011. Over time, more and more countries pass the Dell threshold and are no longer subject to the GDP reductions of increased warming. On the other hand, those that have yet to pass the threshold find the increasing temperature continuously reduces their economic growth.

For the policy case, those countries implementing carbon policies—just the U.S. in the first scenario and all of the Kyoto Annex I countries in the second scenario—find that their annual economic growth rate is reduced by 0.11 percentage point per the EPA estimate for the entire period. At the same time, the economic growth rates for countries still below the $6,574 threshold increased as temperatures rise more slowly. This better growth results from a lower temperature penalty. However, this moderation of the temperature penalty is small, especially in the early years.

The Results

For the scenario in which only the U.S. enacts the carbon policy, the impact is a significant net loss to world GDP. The calculations show gains in the poorer countries, but the losses in the U.S. more than offset these gains. The projected, inflation-adjusted economic impacts include:

- An aggregate loss to the U.S. of $21 trillion through 2050 and $207.8 trillion by 2100,
- An aggregate net loss worldwide of $15 trillion through 2050 and $109.6 trillion by 2100, and
- A one-year net loss worldwide in 2100 of $3.5 trillion, equivalent to 4.75 percent of U.S. GDP.

In no year is the policy impact positive.

For the scenario in which all Kyoto Annex I countries enact carbon restrictions equivalent to Lieberman–Warner or Waxman–Markey, the projected, inflation-adjusted economic impacts include:

- An aggregate net loss worldwide of $395 trillion by 2100 and
- A single-year net loss worldwide of $13.8 trillion in 2100 (more than 2 percent of world GDP).

In no year is the policy impact positive.

Although including the other Annex I countries in the carbon-cutting program adds $79 trillion of

8. This lost growth factor is the average from the ADAGE and IGEM models from U.S. Environmental Protection Agency, Office of Atmospheric Programs, "EPA Analysis of the Lieberman–Warner Climate Security Act of 2008," March 14, 2008, p. 61, http://www.epa.gov/climatechange/Downloads/EPAactivities/s2191_EPA_Analysis.pdf (accessed May 14, 2013).
9. Chip Knappenberger, "Climate Impacts of Waxman-Markey (Part II)—Global Sign-Up," MasterResource, May 7, 2009, http://www.masterresource.org/2009/05/part-ii-a-climate-analysis-of-the-waxman-markey-climate-bill%e2%80%94what-if-the-world-played-along/ (accessed February 5, 2013).

additional income to the poor countries, it reduces GDP by $365 trillion in the Annex I countries. In short, the lost GDP in countries restricting CO_2 vastly outweighs the gains in GDP to countries that benefit from moderated warming.

Future Generations

Proponents of carbon restrictions frequently invoke concern for future generations to justify the costly policies. The irony is that the annual net losses grow over time so that future generations lose more than the generations in the early years of a carbon policy. For instance, if all Annex I countries participate in the carbon policy, the average annual net loss in worldwide GDP is $500 billion per year until 2030. For the years 2031–2100, the average net loss is $5.5 trillion per year. For the final 20 years of the projections (2081–2100), the average net loss worldwide GDP exceeds $100 trillion per year. (These costs have been adjusted for inflation to reflect prices in 2011.)[10]

For perspective on this increasing cost, the net GDP loss in 2050 is projected to be $2.76 trillion, which is 2.2 times the GDP of Sweden in 2050. However, in 2100 the projected net GDP loss is $13.7 trillion, which is 4.4 times the GDP of Sweden in 2100.

In either absolute dollars or fraction of income lost, a carbon policy like the one analyzed in this paper would impose greater hardship on future generations.

Thus, the impact on those several generations from now would be 200 times as great as the impact on the current generation. With or without the carbon policy, future generations will be considerably wealthier than the current generation, but future generations will suffer disproportionately larger losses. In either absolute dollars or fraction of income lost, a carbon policy like the one analyzed in this paper would impose greater hardship on future generations.

Discussion

In their paper, Dell and her coauthors estimated the impact of warming on GDP. They found no significant impact on the richer half of their data set. The case for this economic insulation from the effects of warming argues for an absolute income threshold for this insulation rather than a relative threshold. This means that worldwide economic growth will push more and more countries above the threshold, reducing the impact of warming. According to them, a constantly warming climate would slow the pace at which a country approaches this threshold and would cause GDP losses until it passes that threshold. Some countries would not pass the threshold by 2100.

The EPA estimated that the Lieberman–Warner cap-and-trade bill would slow economic growth. The EPA's methodology would generate the same impacts for a carbon tax targeting the same reduction in CO_2 emissions. Coupling this impact with the estimated temperature moderation of the policy (from Knappenberger) enabled us to calculate the net worldwide effect of such a carbon policy.

The net effect is overwhelmingly negative and grows worse over time. A simple sum of the inflation-adjusted net losses exceeds $100 trillion by 2100. In no year would the carbon policy have a net positive impact.

The Dell analysis does not account for direct costs and benefits of CO_2 emissions, rather it counts only the net impacts caused by any induced warming. In addition, the impacts measured by Dell are caused primarily by year-to-year fluctuations and do not fully incorporate long-run adaptive behavior. For instance, in agriculture, global warming could lead to movement of crops toward the poles and development and adoption of seed varieties that grow better in warmer weather. This longer-run adaptation would reduce the negative impact of warming on growth rates.

Mounting evidence indicates that the world will likely not become 4.5 degrees warmer by the

10. In percentage terms, the net loss of worldwide GDP in 2100 is 2.25 percent. Of course, the higher the threshold, the more benefit there will be from moderating temperatures and the smaller will be the loss. However, even if the threshold is raised from $6,574 to $7,500, the net loss of world GDP in 2100 is still over 2 percent.

century's end.[11] The implied lower sensitivity to CO_2 means that the 4.5 degree estimate is too large, as is the expected temperature-moderating impact of carbon-reduction policies. In other words, the net impact of carbon policies would be even worse than shown in this paper because the cost of reducing CO_2 would not change, but the benefits of reducing CO_2 would decline.

On the other hand, the economic costs of sea-level rise were not fully included in the Dell analysis and would not be reflected in our derivative analysis. However, there is reason to believe that this omitted cost would not change the sign of the policy impact.

In a widely publicized paper, Frank Ackerman and Elizabeth A. Stanton used a projected average world temperature increase of 7.2 degrees Celsius and entirely ruled out any adaptive behavior.[12] They found the impact of sea-level rise, hurricane damage, real-estate damage, and agricultural losses totaled 1.8 percent of U.S. GDP in 2100. If the damage of a 4.5 degree rise were proportional—many would argue for a less than proportional impact—to the damage from a 7.2 degree increase, then the total impact would be 1.1 percent of GDP. However, the carbon policy analyzed would reduce the temperature by only about one-tenth of the increase. Thus, the calculated benefit of the carbon policy in moderating sea-level, hurricane, real-estate, and agricultural damage would be about 0.1 percent of GDP. Further, some of this damage would already be included when applying the Dell factor to GDP growth. Since the carbon policy reduces world GDP by over 2 percent, it would not be redeemed by an uncounted beneficial impact of 0.1 percent of world GDP.[13]

What Should Congress Do?

A policy promoting economic growth would better insulate the United States and the world from the impacts of global warming than a policy to cut CO_2 emissions by 70–80 percent over the next four decades would. Carbon dioxide cuts in the 70–80 percent range—as proposed in the Lieberman–Warner and Waxman–Markey cap-and-trade bills and the Boxer–Sanders carbon-tax bill[14]—would reduce U.S. national income by tens of trillions of dollars by 2050 and hundreds of trillions of dollars by 2100. Gains to other countries would only partially offset these phenomenal losses.

Conclusion

Warming of the world may have economic costs that exceed benefits, but cutting CO_2 emissions will not necessarily improve matters. Warming alone may have net negative impacts. However, warming caused by human activity cannot be divorced from the benefits that human activity generates. Cutting CO_2 emissions will have clear economic costs.

The question for policymakers is how the costs of cutting CO_2 compare with the benefits. We find that the costs vastly exceed the benefits. In particular, we analyzed a regime to reduce CO_2 emissions of the magnitude found in the Boxer–Sanders carbon-tax bill and the Lieberman–Warner and Waxman–Markey cap-and-trade bills. These reductions would have a decidedly negative economic impact on both the U.S. and the world as a whole, with net losses reaching hundreds of trillions of dollars by the century's end. On the other hand, faster growth could insulate the economy from the impacts of global warming.

—David W. Kreutzer, PhD, *is Research Fellow in Energy Economics and Climate Change in the Center for Data Analysis at The Heritage Foundation.* *The author would like to thank Robert Murphy and Roy Spencer for comments made on an earlier draft. Of course, this does not imply any endorsement on their behalf. Any errors are the author's responsibility.*

11. There is a widely acknowledged and great uncertainty regarding the impact of projected CO_2 emissions on global warming. A post regarding a recent study from the Research Council of Norway and the thoughtful comments on the post illustrate this uncertainty and the reduced likelihood of reaching and exceeding the 4.5 degree Celsius increase in average world temperature. Andrew C. Revkin, "Weaker Global Warming Seen in Study Promoted by Norway's Research Council," *The New York Times*, Dot Earth blog, January 26, 2013, http://dotearth.blogs.nytimes.com/2013/01/26/weaker-global-warming-seen-in-study-promoted-by-norways-research-council/ (accessed February 5, 2013).
12. Frank Ackerman and Elizabeth A. Stanton, "The Cost of Climate Change," National Resources Defense Council, May 2008, http://www.nrdc.org/globalwarming/cost/cost.pdf (accessed May 14, 2013).
13. We assume the cost of losses outlined by Ackerman and Stanton for the U.S. would be in similar proportion for the rest of the world. See ibid.
14. Climate Protection Act of 2013, S. 332, 113th Cong., 1st Sess.

Appendix

The International Monetary Fund World Economic Outlook 2011 is the source of initial (2011) GDP, the list of countries analyzed, and the initial (2011) population per country.[15] Per capita income for 1976 comes from the United Nations National Accounts Main Database.[16] Population projections come from the World Bank's HNPStats.[17] Per capita income growth projections come from PricewaterhouseCoopers "The World in 2050."[18]

Per capita income is projected using the rates for different categories of income found in "The World in 2050." Those rates are applied as follows (by 1976 income in 2011 dollars):

Income Definitions (2011 Dollars)	Income	Growth Rate
Low	$1,025 or less	4.0%
Lower Middle	$1,026–$4,035	4.0%
Upper Middle	$4,036–$12,475	3.0%
High	$12,476 or more	2.0%

These growth rates remain constant for each country once assigned, except as modified for warming.

GDP for each year is the projected per capita income times the projected population. For each year that a country is below the $6,574 threshold the income growth rate is reduced by the product of Dell's factor (1.3 percent reduction in growth per degree Celsius) times the increase in temperature since the first period (2011).

15. International Monetary Fund, World Economic Outlook Database, http://www.imf.org/external/pubs/ft/weo/2011/01/weodata/index.aspx (accessed February 22, 2013).
16. U.N. Statistics Division, National Accounts Main Aggregates Database, http://unstats.un.org/unsd/snaama/introduction.asp (accessed May 14, 2013).
17. The World Bank, "Population Projection Tables by Country and Group," http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTHEALTHNUTRITIONANDPOPULATION/EXTDATASTATISTICSHNP/EXTHNPSTATS/0,,contentMDK:21737699~menuPK:3385623~pagePK:64168445~piPK:64168309~theSitePK:3237118,00.html (accessed February 22, 2013).
18. John Hawksworth, "The World in 2050: How Big Will the Major Emerging Market Economies Get and How Can the OECD Compete?" PricewaterhouseCoopers, March 2006, http://www.pwc.com/gx/en/world-2050/pdf/world2050emergingeconomies.pdf (accessed February 22, 2013).