Should the Regulator or the Market Decide When to Reduce Greenhouse Gas Emissions?

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Cap-and-trade for greenhouse gases is center stage. It is the primary method in actual and planned use to achieve world goals under negotiation through the ongoing United Nations Climate Change Conferences. The U.S. House of Representatives has passed a cap-and-trade bill and the Senate is considering its own. The European Union has been running a cap-and-trade system for several years, and various states, regions, and countries are designing or implementing their own cap-and-trade systems. None of the systems under consideration, however, deal satisfactorily with timing issues.

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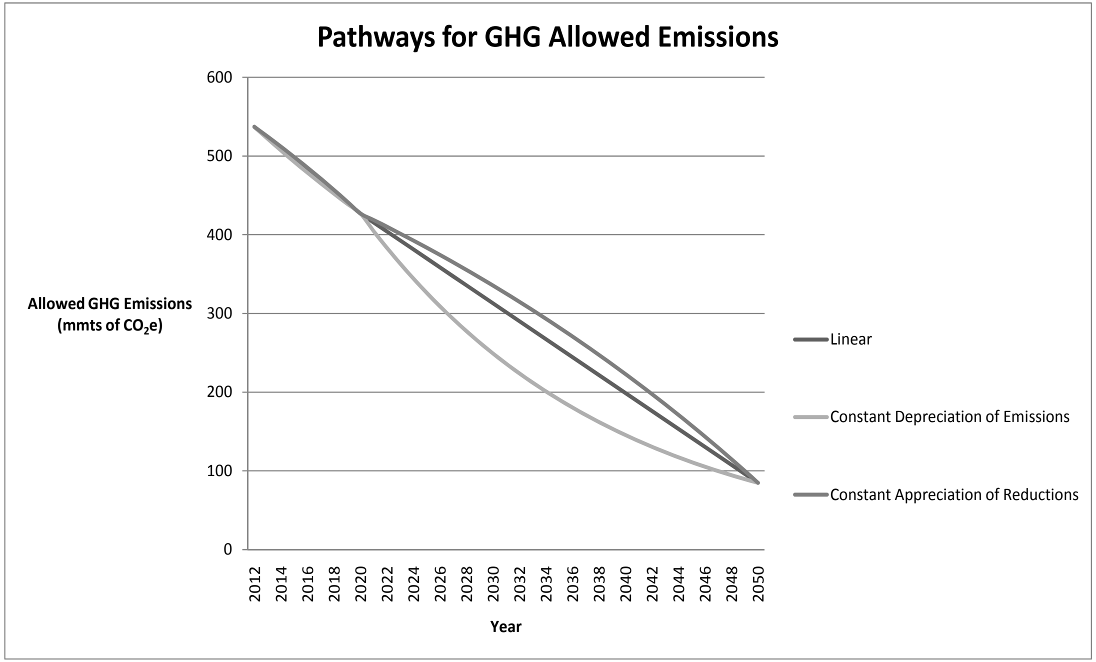
HOW AND WHY DOES THE TIMING OF EMISSION REDUCTIONS MATTER?

Allowance trading in a static setting, where those who cannot reduce greenhouse gas (GHG) emissions at low-cost pay those who can for the right to emit, ensures that reductions happen *where* they are cheapest. GHGs are ideally suited for such trading, since the location of the reductions is immaterial to the environmental consequences.

But reductions should also occur *when* they are cheapest, and the existing systems and plans fall short on this aspect. Policy design affects the timing of reductions through both the speed of allowance reductions over time and the flexibility sources have to exchange one year's allowance for another year's by saving and borrowing. GHGs are also ideally suited for this type of trading: To a first approximation, the timing of reductions within a span of several decades is also immaterial to the environmental consequences.

The environmentally meaningful value is the total allowed emissions over the next several decades, say between now and 2050. This corresponds to the sum of allowances over the years, or graphically the area beneath whatever curve connects the targets specified. There are many such curves that one could imagine. Figure 1 illustrates three example pathways drawn to be consistent with California's adopted goals for 2020 and 2050. Each pathway specifies a different total emissions budget and thus a different environmental outcome, yet each is fully compliant

Figure 1



with its announced goals in that each ends at the same place.

The chief consequence of the pathway choice is that it sets the total emissions budget. For any given budget, we seek a system to achieve the required reductions at the lowest cost. This involves leveraging allowance trading over time as well as space. As we shall show, given restrictions on borrowing, this also affects the pathway shape we should choose.

WHAT DO LEAST-COST PATHWAYS LOOK LIKE?

Actual GHG emissions are unlikely to follow a prespecified pathway. Regulators lack sufficient information about the costs of emissions reductions to identify and establish a least-cost path from the start. Therefore, unless saving and borrowing of allowances is prohibited entirely—a very bad policy—the market will reset the pathway by making use of these mechanisms.

Suppose the program begins with a very modest reduction in the first year followed by a substantial reduction in the second year. With no borrowing or saving, the price of first-year allowances (and the marginal cost of reducing emissions then) will be considerably lower than for second-year allowances. If instead participants are allowed to save some first-year allowances, this opens up a more cost-effective strategy: buy additional allowances in the first year and hold them to use in the second (reducing first-year emissions further at relatively low-cost). On the margin, this is much cheaper than paying for a second-year reduction.

This savings demand increases the overall demand for first-year allowances. It is offset by a corresponding demand reduction for second-year allowances. The price of first-year allowances rises, and that of second-year allowances falls. This will stop when it is no longer cost-reducing to save additional first-year allowances. *This least-cost solution occurs when the different vintage allowances have the same present value,* or when the ratio of first-year price to second-year price is equal to the discount factor employed by the market—a condition known in economics as the Hotelling rule. The market has reset the pathway to have fewer emissions in year one and more in year two, but total emissions are the same and costs have been reduced.

Many economic factors can change these present values in random or unexpected ways—factors like changing macroeconomic conditions, technological breakthroughs, or price changes in important fuels. For the moment we ignore these sources of uncertainty in order to focus upon another one: how the cost of extra emissions reductions changes with the quantity reduced. This pattern—termed the marginal cost of abatement curve—shapes the least-cost emissions pathway. For perhaps a surprisingly broad range of marginal cost of abatement curves, the least-cost emissions pathway will feature increasing incremental reductions. That is, each year, reductions from a constant baseline will increase by a bit more than they did the year previous. The pathway is thus generally bowed upward relative to a linear path, as illustrated in Figure 2.[1]

If unfettered saving and borrowing are allowed, the shape of a prespecified compliance pathway only matters in defining total reductions; the market will save and borrow against it and attain something very close to the Hotelling path. Given a linear path, the market would generally save in the early years, then dissave and often borrow in the middle years (and if so, repay borrowing by saving again at the end). The higher the discount rate used by sources,[2] the less saving and more borrowing there will be along the least-cost path. Similarly, the flatter the marginal cost of abatement curve (not illustrated), the less saving and more borrowing there will be.

HOW MUCH CAN SAVING AND BORROWING LOWER COSTS?

The cost reductions from saving and borrowing depend on the unknown marginal cost of abatement curve. Using a variety of assumptions about this curve, we have calculated the cost impact of allowing saving and borrowing rather than requiring rigid adherence to a prespecified path. We estimate that flexibility with respect to this one source of uncertainty reduces the total cost of compliance by anywhere from 2 percent to 21 percent.

These estimates understate the true cost-reduction possibilities from borrowing and saving, because our calculations do not take account of macroeconomic fluctuations and other random shocks that also make flexibility valuable. In an independent study that focuses upon these random shocks, Harrison Fell and Richard Morgenstern estimate that saving and borrowing can reduce costs by an additional four percent.

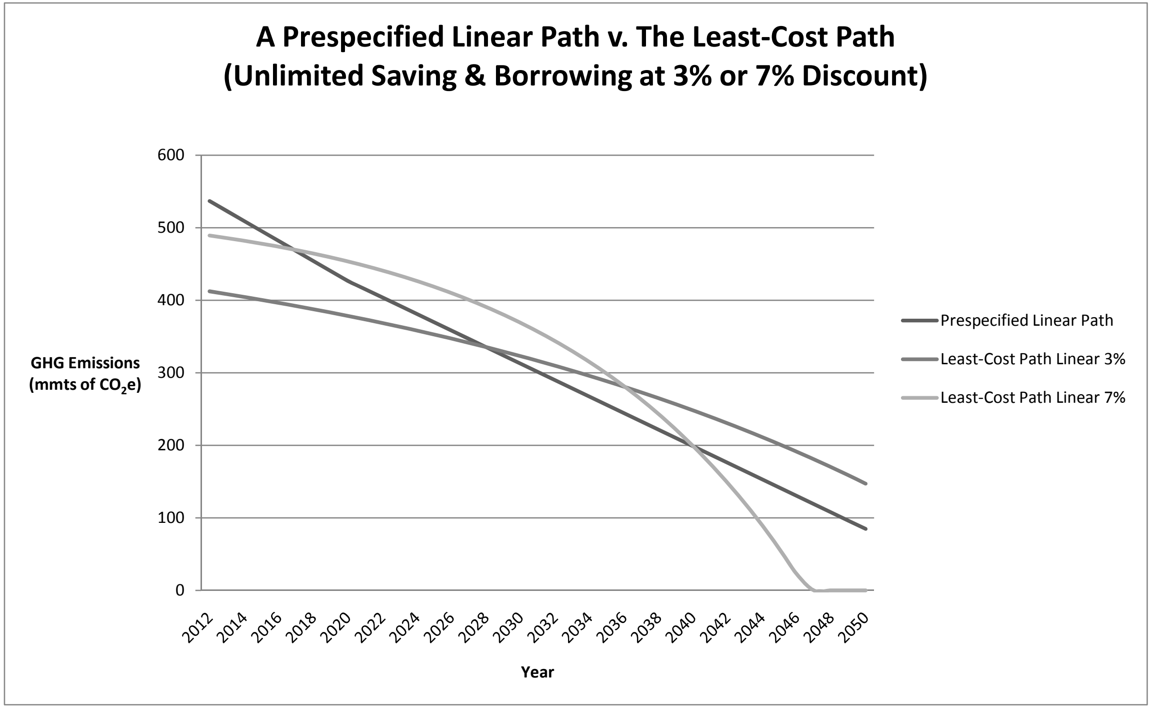
While saving is not controversial, unfettered borrowing is. To see this, imagine that a jurisdiction simply auctions off its entire emissions budget—total allowed emissions at any time between now and 2050. If many of these allowances are used in the early years, by 2020 there may be no actual reductions (emissions could increase) and the implied future reductions from that point might appear draconian. Would the world really believe that this jurisdiction will meet its reduction commitment, and that it will enforce the future draconian cuts? We think much of the world would not consider the commitment credible.

Global cooperation is paramount for achieving worldwide reductions. Jurisdictions supporting this must demonstrate real, verifiable reductions over relatively short time frames (e.g., within each decade). Moreover, if individual source borrowing is allowed from future entitlements, then there must be reasonable limits set in order to protect against market exit with unrepaid allowance debts. Policymakers should allow enough borrowing flexibility to realize the bulk of potential cost savings while putting sufficient limits on it to forestall these problems.

WHAT ARE SOUND AND EFFECTIVE POLICY DESIGNS FOR ALLOWANCE BORROWING?

We propose two solutions. The first is a multi-year compliance period. Rather than requiring each source to 'true up' emissions with allowances each year, the regulator can perform this true-up every two or three years, or even less often. Such a design effectively allows unlimited borrowing within the compliance period. Both California's Market Advisory Committee and the Waxman-Markey bill passed by the House have suggested multi-year compliance periods.

Figure 2



Our second proposed solution is not, to our knowledge, currently being widely considered. We recommend an advance auction of allowances with early use allowed. Each year, the regulator might auction future allowances equal to 20 percent of those for the subsequent year, ten percent for the following year, and five percent for each of the two years after that. These specific amounts are not critical, but seem a reasonable balance between allowing flexibility to reduce costs and restricting borrowing against the indeterminate future. The system is easy to implement even if many allowances are freely distributed simply by requiring that they be put up for auction, with proceeds going to allowance holders.

Something like this should be done for several reasons. It signals strong government commitment to the system, and provides valuable guidance about future prices to sources considering abatement investments. Many may buy advance allowances as insurance against unexpected future price increases. However, our idea is not just that some future allowances be auctioned early, but that sources be allowed to use vintages up to four years ahead to cover current-year emissions.

These borrowing systems also have great advantages as 'safety valves' that do not threaten environmental integrity. Suppose circumstances absent these mechanisms would lead to a sharp price rise. In the short run, there may be only expensive alternatives for reducing current year emissions. However, our mechanisms would permit borrowing to increase the supply of allowances available to cover the current emissions. This allows time and flexibility to make the reductions in the next few years when less-expensive methods not available in the short run can be utilized. Our mechanisms lead to a more gradual increase in the level of the price path rather than a one-time price 'spike', effectively spreading the risk from such events over the years. Furthermore, because the early use of allowances necessarily raises future prices, incentives for continued technological progress through research and development are if anything strengthened. Other safety valves such as those discussed by Douglas Elmendorf in recent Congressional testimony would artificially constrain allowance prices in the short run, but dissipate the vital long-run market signals such events should generate.[3]

We have estimated the cost impacts of our two proposals. In our base case, allowing unlimited saving and a three-year compliance period would achieve 60 percent of the cost reductions available from unfettered saving and borrowing. Instituting the advance auction would achieve 84 percent of these possible cost reductions. Doing both would achieve 87 percent of possible reductions.

Of the two, the advance auction mechanism with limited four-year ahead borrowing achieves most of the cost reductions. Still, there is no good reason that we should not do both.

HOW SHOULD THE REGULATOR SPECIFY THE COMPLIANCE PATH?

If saving and borrowing are unrestricted, the crucial consequence of the pathway choice is to determine total emissions. However, with borrowing restricted, the pathway choice has an additional implication: It likely constrains emissions away from the least-cost path.

The most common pathway choice is linear. However, as we have explained, least-cost paths are generally bowed upwards, not linear. Technological progress, which tends to lower the cost of reducing future emissions relative to current ones, reinforces this characteristic.

Thus, like Olmstead and Stavins, we do not recommend a straight linear pathway.

However, a series of decade-long linear segments with some long-term adaptability might be appropriate. These segments would be increasing in slope from one to the next, such that they approximate a Hotelling-shaped pathway.

Such a series of segments might jibe well with another policy task of guiding market expectations. We recommend a procedure along the following lines: Announce a firm path from 2012 – 2020, and a tentative compliance path for each successive decade from 2020 – 2050. Adopt by 2015 a final compliance path for 2020 – 2030, and confirm or adjust the tentative paths for the successive decades. Similarly, adopt by 2025 a final compliance path for 2030 – 2040, and so on. Such an approach will give the market valuable guidance while retaining flexibility as we learn more about this problem and how to manage it.

Moreover, a series of tentative segments could serve as incentives for other states or countries to set reduction goals of their own. Australia has recently proposed this: It pledges a certain reduction in the future regardless, but significantly increases its pledged reduction if other countries make substantial commitments of their own. Such considerations could easily be built into the sequential process described above.

In summary, policymakers should consider sound intertemporal policy options for reducing costs. An advance auction of allowances with early use permitted can do this, can help forestall the possible price fluctuations that concern many, and can do so in a manner that preserves the system's environmental integrity and provides good incentives for technological progress. A multi-year compliance period provides additional intertemporal flexibility. A rolling, transparent process of establishing decade-long segments of the compliance pathway can provide guidance for the proper long-term operation of the market while retaining flexibility to adapt to new knowledge.

Letters commenting on this piece or others may be submitted at http://www.bepress.com/cgi/submit.cgi?context=ev.

NOTES

1. In our research paper, we show the general conditions for this and that it holds true for linear, log-linear and step functions that we examine. We do find constant incremental reductions for the special case of natural log functions, although these may imply unrealistic limits on the rise in marginal abatement costs. Figure 2 is drawn with all paths allowing a total of 11,847 mmts of CO_2, an illustrative emissions budget consistent with California goals.
2. By discount rate we mean the annual rate of return that firms require to undertake an investment such as buying a permit today to use next year.
3. A safety valve is an idea for cost containment that affects the timing of emissions but also makes the quantity of allowances uncertain. Such safety valves also endanger linkages with cap-and-trade programs in other jurisdictions (where each treats the other's allowances as if they are its own). Specifically, the European Union Emissions Trading System is opposed to linkage with any jurisdiction that has a safety valve.

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