Climate Policy Initiative

Cost-Containment in Cap-and-Trade Systems: A Review of the Options

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Executive Summary

In a **cap-and-trade** system, regulated firms must use allowances (or offsets) to cover any emissions that they do not eliminate through their own abatement efforts. Firms therefore have a financial incentive to implement all abatement projects that cost less than the market price of allowances, but not projects that cost more. Through the trading of allowances, the system is able to achieve an emission limit at a lower cost than a command-and-control policy. However, concerns are sometimes raised about the chances that short-term price volatility will disrupt market signals or that allowance prices will become very high over sustained periods.

A cap-and-trade system can include a variety of features to help control allowance prices. These options include:

- **Banking and borrowing** at either the firm or system level could help contain costs stemming from temporary divergences of prices from expectations.
- A **multi-year compliance period** could help reduce price pressures by smoothing out annual energy demand fluctuations (but could also increase end-of-period price volatility and noncompliance events).
- **Delayed implementation** and a **gradual tightening of caps** could give firms time to make cost-effective adjustments.
- A "**circuit breaker**" could be triggered if costs rose too high, postponing tightening of the cap.
- **Offset credits** could help lower costs over the long-term.
- A "**safety-valve**" price could provide a ceiling for the market price of allowances but the cap would be exceeded if it were used.
- A government agency could act as a **market maker**, buying allowances and offsets when prices were low and selling them when prices were high, or it could **adjust auction sizes** as needed to hit a price target.

Among the many options for stabilizing the costs of a cap-and-trade system, the preferred choice may depend on the importance of the price stability goal relative to the objective of maintaining the compliance period and cumulative emission caps of the system.

If strict maintenance of cumulative system caps were of primary importance, a limited amount of allowance banking, borrowing, and offsets might be the top choices. A multi-year compliance period, which might increase the risk of noncompliance events, would not be needed, especially if system banking and borrowing were also allowed.

If low system costs were a greater priority, a more expansive offset program could be implemented. A circuit breaker could also be included. However, neither offsets nor a circuit breaker would be very helpful in addressing temporary price pressures within a compliance period. To make sure that allowance prices stay below a particular ceiling, a safety valve could be installed.

If predictable and stable allowance prices were a key objective, at least in the early years of a program, an agency could be authorized to adjust auction sizes to establish a target price that would help guide trading throughout a compliance period. System banking and borrowing could help facilitate this objective. Price stability could be assured if unrestricted auction sizes were allowed in the early years of the program. Target price paths could then be developed, and adjusted over time, to achieve a longer-run emission reduction goal.

Reasons for Stabilizing Allowance Prices

Cap-and-Trade as Cost Containment

As a market-based mechanism, a cap-and-trade system is itself a key means of restraining the overall economic cost of achieving a given emission goal. In such systems, regulated entities must surrender an allowance for each ton of CO_2-equivalent gas emitted during a compliance period. Depending on the design, firms can obtain allowances from free allocations, official auctions, and/or purchases in the secondary market. The total number of allowances issued in a period is the cap. Entities may reduce their needs for allowances by investing in emission abatement.

A firm subject to a cap-and-trade system has an incentive to abate emissions until the cost of reducing them by one more ton exceeds the market price of an allowance. Remaining emissions are then covered through the submission of allowances to the government. Thus, the market price of CO2 tends to equal the incremental (or "marginal") cost of emission abatement.

With allowance trading, firms with low cost abatement opportunities can sell their excess allowances to other firms that were unable to find sufficient low-cost emission reductions. Thus, all low-cost abatement projects tend to be implemented, while higher cost projects are not. The market price of allowances is the dividing line between the high- and low-cost projects. The command-and-control alternative of requiring every firm to reduce emissions would mean that some high cost projects would be implemented while some lower cost projects would not.

Typically, an emission goal also involves some efforts by sectors that are not included in the cap-and-trade system. To the extent that these outside sectors also help to achieve the overall emission goal, the caps of the cap-and-trade system could be loosened and both the allowance price and the marginal cost of abatement within the system would be lowered. The marginal cost of reducing emissions in sectors outside the cap-and-trade system may be lower or higher than the price of allowances within the system.

Sources of Surprises in Allowance Prices

The market price of allowances thus plays a key role in a cap-and-trade system. That price may diverge from expectations for a variety of reasons, including:

- Transitory price movements ("volatility") may occur because of:
    - daily fluctuations in demand and supply, as in any asset market;
    - changes in expectations of the overall demand for allowances in the compliance period or the prospective use of any regulatory flexibility measures; or
    - attempts to manipulate prices.

- Annual-average prices may move with:
    - the effects of weather and economic growth on energy-demand; or
    - large flows of investment (into or out of the market) from hedge funds and other institutional investors.
- Over longer intervals, prices may diverge from expectations because:
    - mitigation investments may take more or less time to implement than expected; or
    - emission reduction costs may be lower or higher than expected depending on the progress in achieving efficiency gains and technological advances.

Disadvantages of Price Surprises

Divergences of allowance prices from expectations could have a number of adverse consequences. Fraudulent, Enron-style manipulation of the allowance market would cause losses for market participants and severely damage the reputation of the cap-and-trade system. Volatility in prices for any reason could result in substantial differences in the costs of compliance among firms, depending on when they purchase allowances. Futures markets would develop, allowing regulated entities to pay a premium to lock in prices, but they would add to costs. Continuing price volatility would also add to longer-run uncertainties about the level of prices, which could impair confidence in the financial returns on emission mitigation investments.

Adverse consequences would also result if allowance prices remained stable, but at very high or low levels. If allowance prices were very low and expected to remain so, the incentives to undertake desirable abatement projects and technological research would be inadequate. If prices were persistently above the cost of emission reductions outside the cap-and-trade system, the overall emission goal could be achieved at lower cost by implementing more projects outside the system.

Persistently high or volatile allowance prices could also strengthen the political hand of the opponents of the program. The sustainability of the cap-and-trade system through future administrations might become questionable. Even if the program survived, uncertainty about its continuance or the strictness of future environmental targets could weaken the incentive for investments in the development and deployment of abatement technologies.

With that brief backdrop, the rest of the paper discusses various cost containment options for cap-and-trade programs. After describing each type of approach, the likely advantages and disadvantages are identified. Methods for preventing manipulation and speculative excesses in allowance markets are discussed in a separate paper entitled, "Preventing Market Disruptions in Cap-and-Trade Programs."

Shifting Allowances among Compliance Periods

Entity-Level Banking of Allowances

Allowance banking is a feature of some existing cap-and-trade systems (the Acid Rain Program, the Regional Greenhouse Gas Initiative (RGGI), and, to a degree, the Emission Trading System of the European Union). It has also been included in many climate bills (Bingaman-Specter, Lieberman-Warner, Dingell-Boucher, etc.).

With allowance banking, a regulated entity can retain excess emission allowances from one compliance period and use them to cover emissions in a future period. In the absence of banking, if regulated entities in aggregate had excess allowances in a compliance period, the market price of allowances would likely drop close to zero toward the end of the period or whenever the excess became evident. With banking, however, allowance prices tend to remain at or above the discounted expected value of allowances in future periods (plus a risk premium). Thus, banking can help prevent allowance prices from falling too low.

If regulated entities, in aggregate, reduce their emissions below the cap level, they will begin building up allowance banks. Once the banks have become sizable, they could be used to help restrain temporary surges in allowance prices. If current market prices were much higher than discounted expected future prices (plus a risk premium), firms would have an incentive to draw down their allowance banks to meet surrender requirements rather than buy any needed allowances in the market. This would tend to reduce the upward price pressures.

However, the link that banking provides between current period prices and expected future prices has some disadvantages. Changes in expectations regarding the future stringency of the cap-and-trade program can then cause volatility in the current price of allowances. Banking converts allowances from a short-term to a long-term asset. Information affecting future expectations should alter the price of a long-term asset. However, changes in the current period allowance price are not needed to motivate adjustments in plans for longer-term emission abatement investments; the altered expectation of future program tightness would itself provide the needed incentive. Feedbacks from those expectations onto current allowance prices are an additional source of price volatility, and potentially raise costs for those regulated firms that must buy allowances merely to meet their current period compliance obligations.

Banking carries other risks as well. If excess allowances are issued in the early years of a program, firms could accumulate very large banks and use them to undermine the future tightening of program caps. Also, banking could facilitate the hoarding of allowances by some firms and associated shortages for others. In addition, hedge funds and other institutional investors could potentially amass large allowance banks merely for the expected financial returns (or for the beneficial correlation properties of allowances relative to other investments). Unrestricted banking could also make it easier for firms to

engage in large enough transactions to manipulate market prices, particularly at times of low liquidity or when prices move close to regulatory trigger points.

To reduce the potential for such adverse effects, various types of limits could be placed on allowance banking. The limits could take the form of expiration dates on allowances, discounts on the value of banked allowances, or direct ceilings on the size of allowance banks. Stricter limits on banking could be imposed on speculators than on regulated firms. For instance, the Dingell-Boucher discussion draft allows the Environmental Protection Agency to place expiration dates on allowances. It also allows the Federal Energy Regulatory Commission to impose position and transaction limits on speculative trading in allowances, but not on bona fide hedging positions or transactions. Any regulatory limits on allowance banking need to be carefully designed to ensure their effectiveness and to avoid impairing the functioning of the market.

The advantages of entity-level allowance banking include:

- Allowance prices would remain at or above discounted expected future prices plus a risk premium.
- After banks were built up, price surges would be mitigated as entities draw on their banks.
- The cumulative cap on emissions over all compliance periods would be maintained.
- An incentive would be provided for early mitigation efforts.

The disadvantages of entity-level allowance banking include:

- Allowance banks may not be large enough to contain prolonged upward pressures on prices.
- The cap would be exceeded in a compliance period when more allowances are used from banks than are placed into banks.
- If excessive allowances were issued early in the program, sizable banks could develop, weakening incentives to mitigate emissions in later compliance periods.
- Unlimited banking could facilitate hoarding and speculative excess and would increase price volatility in response to changes in future expectations about the tightness of the program.

System-Level Banking (A Strategic Allowance Reserve)

With banking, regulated entities can hold a cache of allowances to be used at their discretion. The system as a whole, or the regulatory body responsible for auctions, may also hold a store of allowances to be released under specific circumstances. Each year, for instance, the auction agency may withhold from auction a certain percentage of allowances in order to build up a system-level bank, or strategic reserve. These allowances could be taken from within the cap. The system bank could even be fully stocked right from the start with its expected allocations from future years. It could also be increased over time through purchases of tradable offset credits.

Another way of building the system bank, at least in part, could be through the use of minimum prices at allowance auctions. Any allowances scheduled for auction that were not sold at or above the minimum price could be sent to the system bank.

Allowances from the system bank could be sold in auctions, if needed, to restrain unexpected upward pressures on prices. Regulations could specify the price at which the system bank would be released, or perhaps a schedule of prices at which parts of the system bank would be released. If the regular issuance of allowances were insufficient to meet all auction bids above the indicated price, the system bank (or part of it) would be released to hit those bids.

The minimum auction price and the system-bank release price would probably need to rise over time with the gradual tightening of system caps. A regulatory agency could specify in advance the price paths and release quantities or make discretionary adjustments as needed. The Lieberman-Warner and Dingell-Boucher bills each included special auctions of allowances from a system reserve above a certain threshold price. In the RGGI program, regular auctions are subject to a floor price.

The advantages of system-level banking include:

- It would allow controlled release of allowances through auctions to restrain upward pressures on allowance prices.
- A floor price on auctions could be established as a means of building the system bank.
- If allowances for the system bank were set aside from within the cap, the cumulative cap on emissions over all compliance periods would be maintained.
- Excess allowances in the system bank could be retired.

The disadvantages of system-level banking include:

- The bank may not be large enough to contain prolonged upward pressure on allowance prices.
- Allowance prices would be higher than otherwise while a system bank was being built from within the cap.
- The cap would be exceeded in a compliance period when more allowances are used from banks than are placed into banks.

Entity-Level Borrowing of Allowances

A regulated firm may be permitted to "borrow" allowances if needed to cover its emissions in a compliance period. The firm would thereby escape a noncompliance penalty. In return, it would commit to repay the borrowed allowances in future compliance periods with interest in the form of additional allowances. Regulations could specify the rate of interest, the maximum repayment period, and any limits on the amount of borrowing. Also, to avoid continuing postponement of compliance, firms might not be allowed to borrow in consecutive compliance periods. Other conditions could be imposed to ensure that borrowing entities were in good standing under the program and able to repay the allowances in future periods. A regulatory agency could be authorized

to relax the limits and other terms on borrowing, if needed, to cope with a substantial rise in allowance prices. Borrowing, subject to limits, is a feature of the Lieberman-Warner, Markey, and Dingell-Boucher bills.

A firm might choose to borrow if, late in a compliance period, it realized its allowances were insufficient to cover its emissions and allowances were no longer available in the market at a reasonable price. Regulated entities as a whole might choose to borrow allowances if temporary factors pushed market prices in a compliance period well above expected prices in future periods. It might then prove profitable to borrow and repay, with interest, using cheaper allowances bought in future periods. Regulations might prohibit borrowing by firms that hold excess allowances.

The advantages of entity-level allowance borrowing include:

- Borrowing would reduce upward pressures on allowance prices in a compliance period.
- An individual firm with an unexpected shortfall in allowances late in a compliance period might borrow to avoid having to purchase allowances in a thin market.
- Firms generally may borrow to avoid prices that are temporarily high but expected to fall in future compliance periods.
- If borrowings were repaid, the cumulative cap over all compliance periods would be maintained or even tightened if interest were also paid on borrowings.

The disadvantages of entity-level borrowing include:

- The cap would be exceeded in a period in which entities borrowed, on net.
- The repayment of borrowings and any interest would put upward pressures on allowance prices.
- A vicious circle of continuing borrowing could potentially occur, bringing calls for "debt forgiveness." Environmental goals and the credibility of the cap-and-trade program could thus be undermined.

System-level Borrowing

The agency responsible for allowance auctions could be authorized to borrow allowances in some circumstances. In a compliance period in which that happened, the sum of the allowances sold in auctions and any distributed for free would exceed the cap level. The extra auctioned allowances might be "repaid" by issuing fewer allowances in future compliance periods. This form of system borrowing could be used to contain a rise in allowance prices in a particular period. It could be combined with system banking of allowances. System borrowing is a feature of the Lieberman-Warner, Markey, and Dingell-Boucher bills.

A trigger price for system borrowings could be specified in advance, as well as the amount available for borrowing. A complete schedule of prices with the amounts to be released at each price could also be indicated. The evolution of these trigger prices over time would need to be specified. Regulations may indicate the number of periods over which the system borrowing would be repaid. There would be no need to impose a

disincentive in the form of an interest rate on system borrowing. A regulatory agency could also be authorized to exercise some discretionary authority over system borrowing and the timing of repayments.

The advantages of system-level borrowing include:

- The borrowing would reduce upward pressures on allowance prices in a compliance period.
- With repayment, the cumulative cap over all compliance periods would be maintained.

The disadvantages of system-level borrowing include:

- The cap would be exceeded in a period in which system borrowing occurred.
- The repayment of borrowings would put upward pressures on allowance prices.
- A vicious circle of continuing borrowing could potentially occur, bringing calls for "debt forgiveness." Environmental goals and the credibility of the cap-and-trade program could thus be undermined.

Compliance Scheduling

Multi-year Compliance Periods

At the end of a compliance period, regulated entities must surrender allowances to cover their total emissions during the period. Thus, an entire compliance period represents one market, which closes only on the last day of trading before allowances must be surrendered. Firms needing allowances will try to buy at the lowest price over the whole period. If the allowance price is *above* the price expected late in the period, entities needing allowances will postpone their buying. That will tend to keep prices from rising far above the expected price at the end of the period. Firms with excess allowances will try to sell at the highest price during the period. If the allowance price on a particular day is *below* the price expected late in the period, entities with excess allowances will postpone their selling. That will tend to keep prices from falling far below the expected price at the end of the period. This attempt by firms to pick the timing of their allowance trading in order to sell at high prices and buy at low prices is called "inter-temporal price arbitrage." It would help to smooth out transitory fluctuations in allowances prices. However, it would work well only if the price at the end of the period could be reliably predicted.

If compliance periods were very short, within-period price arbitrage would be limited and temporary factors affecting the demand for energy could have pronounced effects on period-average allowance prices. For instance, if a compliance period were less than a year, seasonal factors could make allowance prices quite unpredictable.

If compliance periods were very long, imbalances might develop in the distribution of allowance holding among regulated entities. At the start of a long period, a firm would be uncertain as to its emissions and the allowances it would need to hold for the period.

It might therefore delay purchasing allowances until more information became available on both its own emissions and the aggregate emissions of other firms. Some firms, however, might begin an aggressive purchasing program for speculative or hedging purposes. At the end of a long period, prices could become quite volatile. Firms generally might have to scramble to make catch-up purchases in some periods or might struggle to work down excessively large banks in other periods. Moreover, a long period would delay compliance and enforcement, perhaps increasing the risk of noncompliance events. Because of these disadvantages of multi-year compliance periods, it may be preferable to stabilize allowance prices with other means.

The compliance period for regulated emission sources in RGGI is three years, and a similar compliance period is intended for the Western Climate Initiative. However, system banking and system borrowing, as well as other means discussed later in this paper, could help stabilize allowance prices without the need for multi-year compliance periods. The compliance periods for firms in the Acid Rain Program and in the European Union Emissions Trading System are one year. The compliance period for countries under the Kyoto Protocol, however, is five years.

The advantages of a multi-year, versus single-year, compliance period include:

- Temporary influences on the demand for energy would be averaged across several years.
- The period for potential inter-temporal arbitrage would be lengthened.

The disadvantages of a multi-year, versus single-year, compliance period include:

- At the start of a long period, end-of-period prices would be very uncertain.
- The longer the period, the more volatile prices are likely to be at the end of a period.
- Compliance and enforcement would be infrequent, potentially increasing the risk of noncompliance events.

Delayed Implementation and Gradual Tightening of Caps

A delay between the passage of climate legislation and the implementation of a cap-and-trade program would give firms time to prepare for the new regime. Some contracts, such as those for energy supplies, would expire and be rewritten in light of the new system. Firms would also take the program into account when choosing investments for expansion or for replacement of aging plant and equipment. The advance warning of the new system would thereby help to restrain the costs of transition. By contrast, an abrupt switch to a new set of market price signals would involve more costly, rapid adjustments.

The costs of the program would also be held down by a gradual tightening of emission caps. The alternative of abrupt imposition of a severe emission cap would leave regulated firms with fewer and more expensive options for immediate adjustment.

Average allowance prices probably would rise gradually as the caps were tightened over time (unless technological advances rapidly reduce the costs of emission mitigation). However, a path of gradually rising *average* prices would not mean elimination of the

temporary factors that produce transitory volatility of allowance prices around any average price trend.

If allowance banking is permitted, special care must be taken in setting a declining cap; less stringent caps in the early years of the program would allow firms to build banks that could help limit costs later on when the cap is tightened. However, excessively loose caps early in the program would generate very large banks that would make it more difficult to achieve emission reduction goals in later years.

The advantages of delayed implementation and a gradual tightening of caps include:
- Time is allowed for existing contracts to expire before new contracts with lower-emission features are written.
- Time is allowed to implement investments in lower-emission plant and equipment.
- Costs are reduced relative to requiring abrupt emission reductions.
- Firms could build banks, if allowed, which could subsequently restrain price pressures.

The disadvantages of delayed implementation and a gradual tightening of caps include:
- Emission reductions are delayed.
- With banking, excessively large banks could be built if caps are too loose.

A Circuit Breaker

As noted above, with gradually tightening emission caps, average allowance prices would be expected to rise over time. However, step-by-step increases in the severity of the program could be postponed with the use of a "circuit breaker." If prices move above a threshold level for a specified period of time, the circuit breaker would be triggered. In that case, the cap for the next compliance period would be kept unchanged, rather than reduced. Activation of the circuit breaker would reduce expected future allowance prices. The RGGI program includes a circuit breaker feature.

Regulations are needed to specify a path for the circuit-breaker's trigger price. The time interval for averaging market prices to compare against the trigger price also needs to be indicated. Once a circuit breaker has been activated, the trigger price path might need to be adjusted. Instead of an automatic price trigger, a regulatory agency could be authorized to postpone tightening under a cap-and-trade system based on judgmental factors.

The key advantage of a circuit breaker:
- Price pressures would be reduced because of a delay in reduction of the cap.

The disadvantages of a circuit breaker include:
- The environmental benefits of reducing the cap would be delayed.
- Activation of a circuit breaker would not reduce price pressures in the period in which it was triggered.

- Prices might be high for temporary reasons (weather or a surge in economic growth), that may not persist in the subsequent compliance period.

Offset Credits

Firms subject to cap-and-trade may be permitted to buy credits from projects implemented outside the cap-and-trade system that "offset" their obligations to surrender allowances. Offsets can spur emission reductions in unregulated sectors and lower the costs of the cap-and-trade program. However, the marginal cost of compliance within a cap-and-trade system might be lowered even more if sectors that might otherwise earn offsets were instead included under the cap. Although special procedures would be needed to include agriculture, forestry, and landfills in a cap-and-trade program, a greater volume of emission reductions could then be obtained from those sectors than with an offset program. Inclusion of those sectors in the cap-and-trade system thus would likely result in lower allowance prices and lower overall costs to the economy of achieving a given amount of emission reductions.

When an offset program is implemented, special procedures are needed to ensure that offset projects generate real, additional, and permanent reductions in emissions. In some sectors, protocol standards can be used for expedited approval of projects, rather than more costly case-by-case analysis procedures. Geographical and quantitative limits on offsets can also be imposed to help ensure that regulated entities under the cap-and-trade system implement emission reductions in their own operations, rather than relying exclusively or largely on buying credits from outside sectors. Such limits diminish the power of offsets to contain costs, however. Additional complications and risks are involved in verifying international offset projects.

Compared with the alternative of no emission reduction efforts in agriculture, forestry, and landfills, an offset program would lower compliance costs in a cap-and-trade system. However, the advantage of offsets for the system is primarily in reducing overall, longer-term compliance costs. Offset programs are generally not flexible enough to help alleviate temporary price pressures. Their flexibility could be increased if a regulatory agency were authorized to loosen limits on offsets when allowance prices exceed a threshold level. The effectiveness of this flexibility would depend on the duration of the allowance price pressures, the pipeline of available offset projects, and the processing capacity of the offset approval agency.

Most existing and proposed cap-and-trade programs provide for offsets. The Joint Implementation and Clean Development Mechanism of the Kyoto Protocol are prominent examples. The RGGI program includes a price trigger at which the limits on offsets are relaxed. Problems with offsets under the early years of California’s RECLAIM program demonstrated the importance of verifying their environmental benefits.

The advantages of offsets include:

- They provide support for emission abatement projects not easily included in a cap-and-trade system.
- They reduce overall compliance costs for regulated entities in the system.

The disadvantages include:

- Greater emission reductions could potentially be achieved if the sectors that typically earn offset credits (agriculture, forestry, and landfills) could instead be included under the cap of the cap-and-trade system.
- Offsets allow regulated entities to exceed the emissions cap in their own operations.
- If the projects do not result in real, additional, and permanent abatement of emissions, they would tend to undermine achievement of environmental goals and the reputation of the program.
- The administrative costs of certifying and verifying offset projects may be substantial, even using a streamlined standards approach.
- The time required to develop and verify offset projects would likely undermine their ability to respond effectively to temporary price fluctuations.

Prioritizing Price Stability

Safety Valves

Many cap-and-trade programs include a steep penalty if a regulated firm fails to surrender sufficient allowances to cover its emissions during a compliance period. The firm may also suffer a reputation loss for non-compliance. If a program has a "safety valve," however, no steep penalty is applied. A safety-valve mechanism allows a firm to pay a given price for a ton of emissions in lieu of surrendering an allowance. It could also be implemented through the sale of allowances by the regulatory agency, on demand, at the indicated price. Unlike system borrowing, these extra allowances would not be repaid in a future period. The safety-valve price acts as a ceiling on the market price of allowances. With gradually tightening caps, a rising path for the safety-valve price would need to be specified. The ceiling price path would provide reassurance to firms regarding limits on future abatement costs. The Bingaman-Specter bill included a safety valve mechanism.

If the safety-valve price were set very high, it would have little effect and allowance prices could fluctuate over a wide range. If a safety-valve price were set very low, allowance prices might remain stuck at that ceiling level. The cap-and-trade system would then become equivalent to an emissions tax. Whenever the safety valve is used, emissions would exceed the cap. A safety valve would clearly be too low if it shifted the burden of meeting the overall emission goal to other economic sectors that could reduce emissions only at higher long-run average costs.

Indeed, a cap-and-trade system could potentially be gamed for financial returns if it included both banking and a safety valve. For instance, suppose allowance prices

remained at the safety-valve level through the current and the subsequent period. If the safety-valve price rose at a faster rate than the general rate of interest in the economy, anyone would be able earn profits by borrowing money, buying an allowance, and then selling it in the next period. Regulated firms might even hold onto their allowances in the current period, paying the safety-valve price instead, with the intention of selling their excess allowances in the next period. To prevent such behavior, discounts could be applied on banked allowances and firms with excess allowances could be prohibited from using the safety valve.

As discussed above, a safety valve involves an unlimited supply of allowances, or payments in lieu of allowances, at the threshold price. A modified safety-valve mechanism could be designed to provide for a limited release of additional allowances if the market price reached a given threshold. With this type of safety valve, the emissions cap for the compliance period would be loosened, but not eliminated, if prices rose to the trigger level. Indeed, a schedule of prices could be specified along with the amount that the period cap would be loosened at each price level. Regulations would need to specify what time-averaging would be used in calculating the trigger prices and how they would evolve over time. A modified safety valve of this nature is similar in some respects to the special auctions of allowances (above threshold prices) in the Lieberman-Warner and Dingell-Boucher bills.

The advantages of a safety valve include:

- Reassurance to regulated entities that allowance prices would not exceed the safety-valve price path.
- Temporary price pressures could be alleviated without laying the seeds for greater price pressures in future periods, as would be the case under borrowing.

The disadvantages of a safety valve include:

- The cap-and-trade system's emissions cap would be exceeded when the safety valve was used, requiring greater emission reductions outside the system to achieve an overall emission goal. A modified safety valve with a stepped approach to the loosening of a compliance-period cap would limit this problem.
- Under the safety-valve ceiling, prices could remain volatile.
- Procedures would be needed to limit banking if it were combined with a safety valve.

A Market-Maker

Some observers have proposed a more active role by the government to stabilize prices in allowance markets. For instance, some advocate that a government agency trade allowances and offsets on a daily basis in secondary markets and even act as a market maker, which would mean continuously posting prices at which it was ready to buy or sell allowances (ETAAC, 2008). The agency's ability to stabilize prices would depend on the limits of its resources, including the number of allowances it could offer to sell when market prices were high and its available funds to purchase allowances and other credits when prices were low. System banking and borrowing would increase its potential scope of operations. Once its resources were fully employed to prevent a

movement of prices in one direction or the other, however, it would lose its ability to function. Thus, the agency would have to be confident that it was not trying to stabilize prices far away from the equilibrium level.

The advantages of a government agency acting as a market-maker include:

- Up to the limits of the market-maker's resources, the market price of allowances could be kept predictable and stable.
- Regulated entities could be more confident about the future path of prices.
- Temporary price pressures could be alleviated.

The disadvantages of a government agency acting as a market-maker include:

- Specialized expertise, which normally commands very high salaries in private markets, would have to be developed and employed in order to undertake frequent market interventions.
- If attempts were made to stabilize the price far from its equilibrium, the market maker would eventually run out of resources and no longer be able to operate.

Auction Size Adjustments

The government could stabilize the price of allowances without the necessity of daily interventions or the burden of taking on a market-maker role. It could do so by taking advantage of the within-period price arbitrage by market participants mentioned above (in the section on multi-year compliance periods). As noted there, if firms are confident of the allowance price that will prevail on the last day of trading for a period, they will tend to keep prices at that level throughout the period. The agency could largely determine the price on the final days of trading by adjusting the size of the final auction for the period and scheduling it near the end. Announcement of the agency's target price before the period began would also help. This procedure is similar to that used by the Federal Reserve and other central banks to hit interest rate targets as a means of implementing monetary policy.

For the procedure to work, regulated entities would need to be active bidders in the final auction. The auction could fail if firms already had enough allowances to cover their emissions. Allowance prices might then remain below the target even if the final auction were cancelled. Limits on offsets and retention of sufficient allowances for the final auction could help eliminate this problem.

Market participants would also need to be confident that the agency had enough allowances to offer in the final auction to be able to achieve the target price. Along with the allowances available from the allocation for that period, system banking and system borrowing could contribute to the potential supply. If traders thought those resources were insufficient, however, the price-smoothing benefits of within-period arbitrage would not be achieved. The agency could be authorized to issue additional allowances, if needed, to hit its target price.

If price stability were deemed of sufficient importance, the size of auctions could be unrestricted in the early years of implementation of the cap-and-trade system. With unrestricted auction sizes, banking and borrowing of allowances would not be necessary. An additional advantage of unrestricted auction sizes is that the price stability they could engender would help prevent market manipulation and speculative excesses. The auction agency, however, could not generally hit both a price and a quantity target in the same period. If the quantity caps were considered non-binding in the early years, the agency's target price path could nevertheless be designed to achieve an intermediate-term emissions goal. With experience, the target price path could be adjusted to maintain appropriate progress toward achieving the emission goal. (The CCAP paper on "Preventing Market Disruptions" includes further discussion of how to arrange an initial period of stable prices in a cap-and-trade system.)

The advantages of auction size adjustments include:

- Market participants could develop confidence that the agency would hit its target price in the final auction, especially if the auction size were unrestricted.
- Within-period arbitrage would help keep prices close to the target.
- A market-making role by a government agency would not be necessary.
- Regulated entities could be more confident about the future path of prices.
- Temporary and persisting price pressures could be alleviated.
- With unrestricted auction sizes, speculators would not be able to manipulate market prices.

The disadvantages of auction size adjustments include:

- If the agency's resources were restricted, it might miss its target price in the final auction, undermining confidence in the price targeting.
- If auction sizes were unrestricted in the early years of the program, emission caps could be exceeded.
- The target price path needed to achieve the intermediate-term emission goal would be uncertain and might have to be altered substantially over time.

Conclusion

Among the many options for stabilizing the costs of a cap-and-trade system, the preferred choice may depend on the importance of the price stability goal relative to the objective of maintaining the compliance period and cumulative emission caps. If the system caps were exceeded, other sectors outside the cap-and-trade system would have to make greater emission reductions for the overall emissions goal to be achieved. If strict maintenance of cumulative system caps were of primary importance, a limited amount of allowance banking, borrowing, and offsets might be chosen. Also, care should be taken to avoid setting initial caps too high, which could result in the buildup of excessively large allowance banks. A multi-year compliance period, which might increase the risk of noncompliance events, would not be needed, especially if system banking and borrowing were also allowed.

If low system costs were a greater priority, a more expansive offset program could be implemented. A circuit breaker could also be included. However, neither offsets nor a circuit breaker would be very helpful in addressing temporary price pressures within a compliance period. To make sure that allowance prices remained below a particular ceiling, a safety valve could be installed. If predictable and stable allowance prices were a key objective, at least in the early years of a program, an agency could be authorized to adjust auction sizes to establish a target price that would help guide trading throughout a compliance period. System banking and borrowing could help facilitate this objective. Price stability could be assured if unrestricted auction sizes were allowed in the early years of the program. Target price paths could then be developed, and adjusted over time, to achieve an intermediate-term emissions goal.

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