International Carbon
Action Partnership

MARKET STABILITY MECHANISMS IN EMISSIONS TRADING SYSTEMS

International Carbon Action Partnership Secretariat

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Table of contents

1 Introduction

A key challenge with emissions trading systems (ETS) is that a regulator needs to impose a cap on greenhouse gas (GHG) emissions without knowing future abatement costs. By contrast to other markets, the number of allowances in circulation is fixed by regulation or law and can thus not freely adjust to unexpected changes in demand (European Commission, 2014). This increases the likelihood that any exogenous shock to the demand of allowances will transform into price volatility, because the supply of allowances is inflexible. Market stability mechanisms (MSMs)[1] in ETS serve to balance the predictability of the policy – provided primarily through the emissions trajectory mandated by the ETS cap – with the flexibility to respond to new knowledge on abatement costs, unexpected shocks, or changing circumstances by adjusting the supply of allowances.

MSMs are a feature of most operating ETS. However, MSMs differ in how they are triggered, how they are managed and how they operate. Those differences arise from different rationales for the establishment of the ETS in general and the goals of the particular MSMs, and from the fact that some MSMs were added or revised in the context of already-operating programs. On one end of the spectrum, during periods of low demand and excessive supply resulting in low allowance prices, stability provisions seek to balance the market and hence maintain incentives for abatement and reduce risks for low-carbon investments. On the other end, in cases of excessive demand resulting in high allowance prices, they are intended to contain costs for market participants and the economy and ensure continued support for the system by increasing short-term allowance supply or through the provision of additional compliance units.

Similar to the decision between a carbon tax and an ETS, the choice between different stability mechanisms comes with a trade-off between emission certainty –guaranteeing environmental integrity- and price certainty – providing assurance over costs. Key to this choice is whether supply adjustment is temporary with allowances being moved to a reserve available for future compliance – or permanent, where the cap is adjusted based on the invalidation or addition of allowances.

A further decision pertains to the governance of the mechanism. MSM can be rule based, which means the processes of determining price or quantity triggers follows certain predetermined rules (Grosjean et al., 2014). Rules can also govern how triggers evolve over time, or this can be done through periodic review. Most existing MSMs are governed by a rule-based approach. On the other side of the spectrum one can find MSMs whose parametrization is delegated to a certain independent body, which determines price or quantity levels independently. In some cases, delegation to decide when and how to intervene has also occurred.

The aim of this note is to provide an overview of the conceptual considerations regarding MSMs and their design choices as well as the empirical use of and experience with them. MSMs are grouped into those that are triggered by price thresholds (Chapter 2) and those that are triggered by quantity thresholds (Chapter 3). The following systems are considered: the European Union ETS (EU ETS), the New Zealand ETS (NZ ETS), the Western Climate Initiative (WCI) systems of California and Québec, the Regional Greenhouse Gas Initiative (RGGI), Massachusetts, Nova Scotia, the Chinese Pilot ETSs,[2] and the Korean ETS (KETS).[3] A summary table is provided at the end of this note.

[1] Market stability can also be provided by allowing intertemporal trade through banking and borrowing or multi-year compliance period (See Chapter 5 of PMR-ICAP (2016)). In this note we focus on mechanisms that adjust allowance supply.

[2] The Chinese Pilot ETSs include: Beijing ETS, Chongqing ETS, Guangdong ETS, Hubei ETS, Fujian ETS, Shanghai ETS, Shenzen ETS, and Tianjin ETS.

[3] Operated by the Republic of South Korea

2 Price-based mechanisms

2.1 Responding to low prices

Where abatement costs in a system turn out to be cheaper than expected, allowance supply may outstrip allowance demand resulting in downward pressure on allowance prices. Low prices on emissions create weak (if any) incentives to invest in low-carbon technology and emissions abatement action as abatement options are likely more expensive than buying emission allowances (Salant, 2015: 2; Fankhauser & Hepburn, 2010: 5). Uncertainty as to whether prices will drop significantly generally leads firms to take a "wait and see" approach and delay any long-term investments in low-carbon technology (Edenhofer et al., 2017: 6; Wood & Jotzo, 2011: 9). These reasons provide a rationale for price stabilization measures at the lower bound. MSMs in existing ETS have responded to the risk of low prices by setting a price floor - either an **auction reserve price** or a **hard price floor** for allowances - and via an **emission containment reserve** (ECR).

2.1.1 Price floor

Auction reserve price (soft price floor)

One option to support falling allowances prices is to set a minimum reserve price at allowance auctions, where bids below the defined reserve price are not accepted. This can result in some or all of the allowances offered for sale in an auction remaining unsold. The resulting reduction in allowance supply supports the allowance price until bids above the reserve price are again forthcoming. Unsold allowances are either returned to the market, normally after a number of consecutive auctions have sold out, are transferred to a reserve or in some cases retired. While this sets a minimum price for allowances purchased at auction, it does not necessarily establish a hard, or absolute, floor on the market price. Prices in the secondary market could temporarily fall below the auction reserve price. A price floor at auction is rule-based, as rules are required to set the reserve price and to reintroduce allowances that are not initially sold.

Hard price floor

Establishing a hard price floor ensures that prices in the market cannot drop below a certain level. To this end, the government may commit to buy back as many allowances as needed at a predetermined price. This provides more price certainty than a reserve price at auction, where the market price can fall below the reserve price (Wood & Jotzo, 2011: 11). However, compared to a reserve price at auction, this approach has additional fiscal implications for governments (i.e. could potentially be quite costly when intervention is needed) and is not a common feature of ETS established to date.

Where should the price floor be set?

A price floor may deliver a minimum level of abatement, to reduce regulatory risk for investments in low-carbon technologies, or to establish a minimum fee in the face of potential exogenous shocks (Acworth et al., 2017).[4]

Where a price floor is designed to ensure a minimum level of abatement and reduce risks for low carbon investments, it will need to be set with an understanding of technology costs and the resulting efficient abatement pathway. Policymakers may make such an assessment based on: (i) an assessment of the fuel mix and the price level that would make the most carbon intensive fuels no longer competitive in wholesale markets (i.e. coal-gas switch price); or (ii) intertemporal energy system optimization models that can be used to provide a quantitative assessment of efficient price trajectories for a given reduction target (see also Fuss et al., 2018). Often, floor prices

[4] In this case, the actual price level may be of less importance. An example of this is the low, yet binding, reserve price that existed within RGGI in the second compliance period. While the price floor did not likely drive much abatement, it maintained significant revenues used to fund climate action and prevented the price from falling to zero.

increase at a fixed rate per annum, providing confidence to the market that the minimum allowance cost will steadily increase over time.

What happens with allowances that are held or bought back by governments?

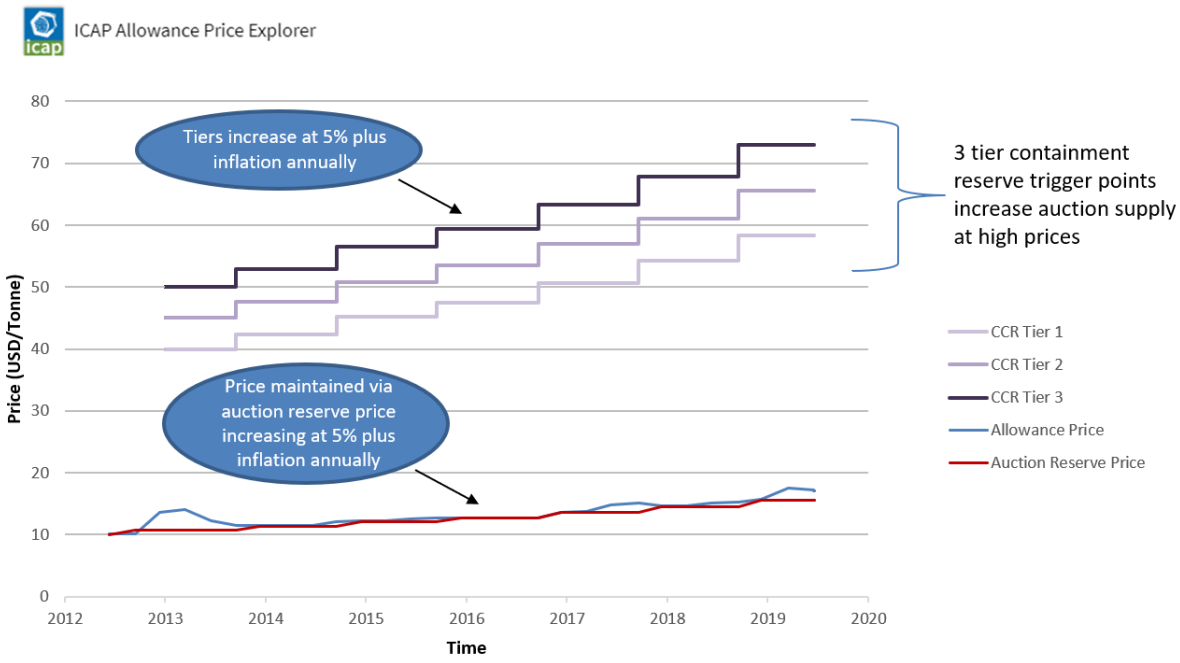
Under a reserve price at auction, allowances may be withheld from the market if bids above the floor price are not forthcoming. These allowances can either be transferred to future auction volumes, transferred to other reserves (e.g. cost containment reserves), or cancelled. If allowances are simply placed in a reserve and are to be auctioned in future periods, the mechanism is cap neutral. However, if unsold or withheld allowances are at some point permanently retired, then the instrument may also contribute to tackling structural supply imbalances.

Practical experience with price floors

Auction reserve prices have been implemented in RGGI, California, Québec, Nova Scotia, Massachusetts, the Republic of South Korea, and some Chinese Pilots, which makes it the most commonly used MSM with established ETS.

Both California and Québec, the two active jurisdictions comprising the WCI, have implemented an auction reserve price from their inception prior to their link in 2014 and have continued operating one since. In 2016 and 2017, prices in the WCI market tracked close to the price floor. In 2016, all auctions in WCI were not fully subscribed and settled at the auction reserve price. This was also true for the first auction of 2017. This was a reflection of the market price dropping slightly below the auction reserve price in periods of 2016 that some experts attributed to uncertainty in the market stemming from legal challenges and partial missing clarity about the continuation of the system post 2020 (Diodati and Purdon, 2016). The price rebounded once these uncertainties were clarified and since then every auction has settled above the reserve price. Figure 1 below shows price stability mechanisms in the California Cap and Trade Program.

Figure 1: Price stability mechanisms in the California Cap and Trade Program



Note: California will adjust the Cost Containment Reserve from 2021 to a system with Two Reserve Tiers and Price Ceiling, as discussed in Table 1 below.
Source: ICAP Allowance Price Explorer, 2019.

Since its inception, RGGI has operated with an auction reserve price (RGGI, 2008)[5]. The reserve price was set at USD 1.86 in 2008 and increased at a rate of 2.5% from 2014 onwards. The minimum price was binding between June 2010 and December 2012. During this time, a proportion of allowances were withheld from auction and moved to a government reserve. The mechanism was effective in the sense that the secondary market price did not fall below the reserve price even during a period of excess supply. However, even with the auction reserve price, it is estimated that a surplus of 140 million allowances accrued in the holding accounts of private entities. This "private bank" together with a substantial "public bank" that accrued as a result of auctions not selling out when the bid was below the minimum price resulted in a large allowance surplus in the RGGI market. The allowance surplus (referred to as 'bank' by RGGI) created some uncertainty for market participants surrounding the future supply schedule. This was addressed as part of the scheduled 2012 review, where the RGGI cap was revised downwards for the years 2014-20, effectively cancelling the surplus (bank) allowances. This was done via two adjustments.

1. First Control Period Interim Adjustment for Banked Allowances ("FCPIABA") – a reduction in the allowance cap over the period 2014-20. The reduction was designed to offset the private bank that accrued in the years 2009, 2010 and 2011 and amounted to ~8.2 million allowances per year between 2014 and 2020 (RGGI Inc., 2014).

2. Second Control Period Interim Adjustment for Banked Allowances ("SCPIABA") – a reduction in the allowance cap over the period 2015-20. The reduction was designed to offset the private bank that accrued in the years 2012 and 2013 and amounted to ~13.7 million allowances per year between 2015 and 2020 (RGGI Inc., 2014).

[5] A reserve price at auction was included in RGGI design based on advice of auction experts to deter collusion among auction bidders. While it was not originally intended to achieve a minimum price, it ended up playing this role.

Several of the Chinese Pilot systems have also had experience with an auction reserve price. In Guangdong in 2013, there was a reserve price of 60 Yuan (9.68 USD) whereas in 2014 there were quarterly auctions with tiered reserve prices of 25, 30, 35, and 40 Yuan (4.07, 4.88, 5.70, and 6.51 USD) respectively. Through 2015-2017 the reserve price was linked to the spot market prices. There were no auctions in 2018.

The Korean Emissions Trading System (KETS) began monthly auctions in 2019 which also include an auction reserve price. The auction reserve price fluctuates and is set by the following formula, "the average price over the previous three months + the average price of last month + the average price over the previous three days/3"[6] (ICAP, 2019). While bids have generally been above the auction reserve price, some auctions have failed to sell out due to rules that limit maximum amount of allowances a single entity could purchase. Unsold allowances are added to the next month's auction volume.

There is currently no experience with a true hard price floor. The KETS as well as some Chinese pilots include provisions to buy back allowances where deemed necessary by the competent authority but are not required to do so. As an example, in Hubei, the exchange limits day-to-day price fluctuations to between -10% and +10% respectively; between 15 July and 25 December 2016, the limit was temporarily adjusted to between -1% and +10% as a response to the decreasing carbon price at that time. In addition, in Shenzhen, in some cases, the Shenzhen DRC has the authority to intervene in the market, which under strict guidelines, has been delegated to the local exchange (see Wang, Boute and Tan, 2020)

2.1.2 Emissions Containment Reserve (ECR)

An ECR is designed to automatically reduce a fixed quantity of the allowance supply when allowance prices fall below the established trigger price, with – unlike the auction reserve price - withheld allowances not intended to be available for future sale. This mechanism was developed in order to increase the stringency of the RGGI cap if the cost of reducing emissions was lower than anticipated during the periodic program reviews. The ECR price threshold is set above the auction reserve price, such that if prices continue to fall, then the auction reserve price is triggered, and allowances will be withheld from auction until bids above the auction reserve price are forthcoming. An ECR can consist of one or multiple steps with according trigger prices. RGGI will operate with an ECR post 2020, with a single trigger point set at USD 6 in 2021 increasing at 7% per annum thereafter (see Table 1).

How are the thresholds set and updated?

The ECR is justified as an adjustment tool with reference to imperfect foresight regarding future abatement costs and ambition. If the allowance price fell beyond the trigger level, this would be indicative of an overestimation of the cost of emissions reductions, thereby shifting the cost-benefit optimality to a higher abatement level. The considerations for setting trigger points are therefore similar to those for a price floor, depending on the expected abatement technologies and costs. The decision about the number of ECR steps balances considerations of simplicity (in favor of a single step ECR) and the sharing of benefits between the economy and the environment (which is more even for the case of a multistep ECR) (Burtraw et al., 2017: 22).

The price trigger could be set based on modelling the emissions impact of different scenarios, for example, in line with a "low emissions scenario," which might eventuate due to lower technology costs, reduced economic activity, or companion policies. To determine the quantities of allowances withheld at each step, considerations of the quantities provided by other existing tools (such as a Cost Containment Reserve), as well as prior cap adjustments necessary in the system can provide useful touch points (Burtraw et al., 2017: 22). In RGGI, the size of the adjustment of the ECR[7] is set at 10% of the annual cap.

[6] Price here refers to the secondary market price.

[7] At this point Maine and New Hampshire do not intend to participate in the ECR: https://www.rggi.org/program-overview-and-design/elements

Practical experience with ECR

The RGGI ECR will begin operation in 2021. As such, there is currently no practical experience with this MSM.

2.2 Responding to high prices

Prices that are too high can undermine the economic and political viability of an ETS, providing a rationale for setting an upper bound on prices. This can help reassure market participants that the ETS is not going to impose costs perceived as excessive. To tackle undesirably high prices, policymakers can seek to moderate price spikes by providing additional supply at pre-defined price triggers through access to an additional Cost Containment Reserve (CCR) or through the provision of "additional compliance instruments" via a hard price ceiling. These MSM are discussed below.

2.2.1 Cost Containment Reserve

A CCR acts as a soft price ceiling as a fixed amount of allowances is offered to the market at the tier prices. Allowances are either offered through additional auctions for allowances from the CCR or through an automatic increase to the auction budget once the trigger price is reached.

The rules designating when allowances are made available from the containment reserve vary between systems and even within linked systems. For example, in California a reserve sale is offered once a year immediately preceding the compliance deadline and additionally in the case that a quarterly auction resulted in a "settlement price greater than or equal to 60% of the lowest reserve tier price". If and when allowances are offered from the CCR, the price tier acts as a reserve price for that specific auction (CARB, 2019: 250-251). In Québec, reserve sales are scheduled through a process of mutal agreement and may occur up to four times a year at the discretion of the Environment Minister (Légis Québec, 2019). Allowances purchased from a CCR in WCI can not be traded. In RGGI allowances are made available immediately when the auction price reaches the trigger price (IETA, 2014).

However, allowance prices are not bound by the CCR tiers. Therefore, the instrument can provide some reassurance to the market in terms of cost containment but also balances environmental integrity concerns given the limited size of the reserve.

Where do the allowances come from?

For populating the reserve, allowances can either come from within the cap or be in addition to it. If the CCR is filled by allowances from within the cap, at least three options are possible:

- transferal of unsold (surplus) allowances;
- as a proportion of the annual allowance budget; or
- bringing allowances forward from future budget allocations.

In the instance that these allowances would have been available for compliance, filling of the CCR from the allocated budget can place upward pressure on prices. Where allowances are in addition to the cap (e.g. RGGI), the frequency of release from the CCR will have implications for the environmental stringency of the program.

Determining CCR price tiers

The price tiers are usually set to rise over time at a rate comparable with the market rate of return for other investments with similar risk profiles (e.g., a 5% interest rate plus inflation). Therefore, prices rise over time in real terms, but not enough to encourage speculative buying or selling.

Setting price tiers requires balancing different considerations. Setting low price tiers may dampen the long-term signal for investment and delay technological learning. Setting price tiers significantly above the estimated marginal cost of abatement for a given reduction target could result in concerns surrounding consumer impacts, potentially disrupting support for the program.

Moreover, where a hard price ceiling is also in place, setting soft price triggers too close to the hard price ceiling might not result in sufficient control for short term price spikes. Conversely, setting soft price triggers too close to the auction reserve price could suffocate price development and mute the carbon price signal and the associated incentive for low carbon investment. One approach is to set a reasonably narrow collar in the early years of system implementation where there might be higher uncertainty surrounding abatement costs and supply demand balance, but then to broaden the collar – particularly the upper bound – in subsequent phases to allow a stronger role for the market in price determination when participants have gained market experience.[8] This would occur naturally when both the floor and ceiling tiers increase at a fixed rate.

How big should the reserve be?

To determine the size of a CCR, modelling can assist policymakers in understanding how many allowances would be required to maintain a certain price bound under different scenarios (Golub & Keohane, 2012: 2). In conducting the analysis, it is important to consider:

(i) how much additional abatement will be achieved at higher allowance prices;
(ii) where offsets are allowed, how offset supply will respond to increasing prices (CARB, 2010: 7); and
(iii) potential environmental impacts of triggering the CCR (where these allowances are in addition to the cap).

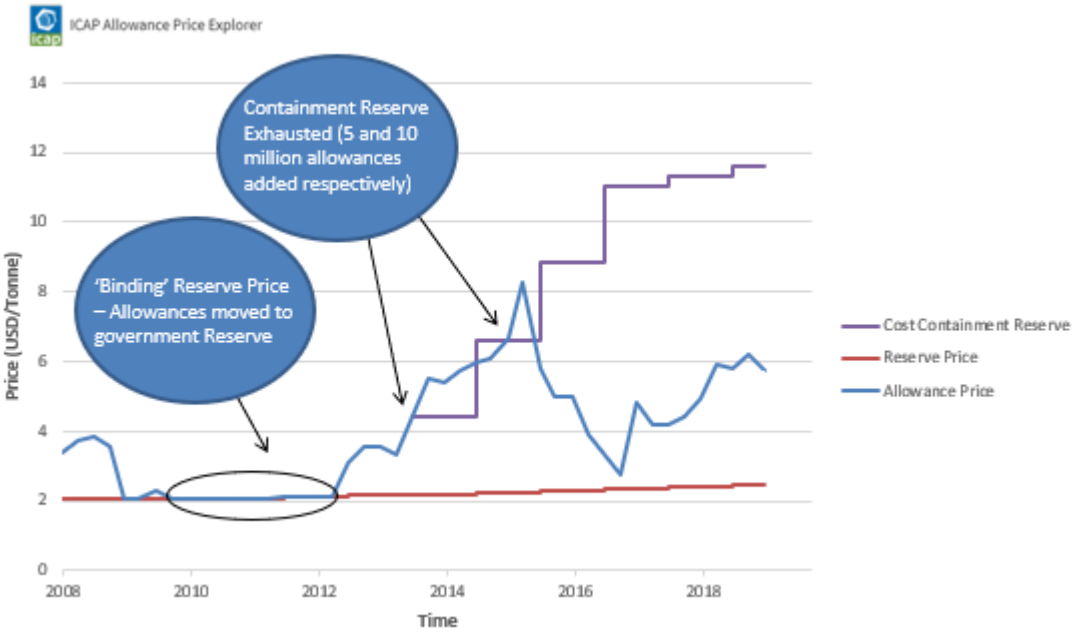
Practical experience with Cost Containment Reserves

RGGI, the KETS and some Chinese Pilots offer practical experience with CCRs. The CCRs contained within the WCI markets have to date not been triggered.

Since 2014, RGGI has operated with a CCR that releases a fixed quantity of allowances (5 million in 2014 and 10 million thereafter) when specific trigger prices are reached (USD 4/t in 2014; USD 6/t in 2015; USD 8/t in 2016; USD 10/t in 2017, increasing 2.5% each year thereafter). The CCR was triggered in 2014 and 2015, releasing 15 million additional allowances to the market. As these allowances are not sourced from within the cap, triggering of the CCR effectively increases the allowance cap. It is difficult to assess the impact the CCR has had in terms of price control. While the first intervention likely placed downward pressure on allowance prices, allowance prices continued to rise, albeit at a slower rate than before the CCR was triggered. The CCR was again triggered in 2015, as prices rose marginally above the CCR in the third quarterly auction. The last auction of 2015 saw prices rise 25% to an all-time high despite the injection of 10 million allowances from the CCR at the previous auction. Prices declined soon after. The decline in prices has also been attributed to the legal challenge to the Clean Power Plan, a proposed federal program that would have required states to reduce CO_2 emissions (EIA, 2016). Figure 2 below shows RGGI's experience with price stability mechanisms.

[8] Specifically, Australia launched the Carbon Pricing Mechanism with a fixed price for the first three years, which was followed by a period with both a floor price and price ceiling. The floor price was set to increase at 4% (real) per annum and the ceiling at 5% (real) per annum. This meant that the corridor would expand over time. Similarly, the width of California's price corridor increased over the years 2013-20 given the real rate increase of 5% p.a. applied to both the upper and lower bounds. However, in latest program review, the structure of the upper and lower triggers was adjusted such that a fixed corridor of USD 60 is maintained.

Figure 2: Price stability mechanisms in RGGI*



Note: *RGGI uses short tons; for the purpose of comparability, prices have been converted into metric tonnes.
Source: ICAP Allowance Price Explorer, 2019.

Though not a CCR triggered at a certain price, the Korean ETS has an allowance reserve which they can utilize to release compliance instruments from in order to enhance short term supply. In June 2016, 0.9 $MtCO_2e$ from the allowance reserve were auctioned. In 2018, the Allocation Committee made an additional 5.5 million allowances available from the stability reserve in an attempt to ease the market in the lead-up to the 2017 compliance deadline. Of these 5.5 million allowances, 4.6 million tonnes were sold (Ecoeye, 2019).

In Shanghai, a small share of the annual cap can be auctioned. The purpose of auctions is not to allocate allowances but to provide compliance entities with additional supply to meet their compliance demand. Shanghai auctioned two million tonnes from the government reserve in July 2018, with a floor price set at two times the weighted on-exchange allowance price from 18 November 2016 to 30 July 2018—CNY 41.54 (USD 6.28). The auction cleared at the floor price and a total of 305,237 tonnes (15% of total auction volume) were sold. An auction of two million allowances was held in June 2017. 2% of allowances were sold at the floor price of CNY 38.77 (USD 5.86).

2.2.2 Hard price ceiling

A hard price ceiling sets an absolute limit on the price that entities pay for allowances. This can be achieved if an unlimited number of compliance instruments will be made available at the upper price limit. Hence, a system with a hard price ceiling may allow emissions to rise above the level of the cap as long as emissions abatement is costlier than the ceiling price. This gives a very high degree of price certainty, but total emissions cannot be known ex ante. An option to obtain a certain level of (global) environmental integrity is to require any additional compliance units sold under a hard price ceiling be offset with verified additional offset credits or additional units for other carbon markets. This can be done for example by investing the revenue from additional emissions units in offsetting projects.

In some cases (e.g., New Zealand ETS), entities can pay a penalty or other fee to the government instead of submitting allowances. This will effectively operate as a price ceiling. Similarly, if the ETS enforcement arrangements include a penalty set with reference to the price but do not require entities surrender the missing allowances, the penalty will also act as a price ceiling.

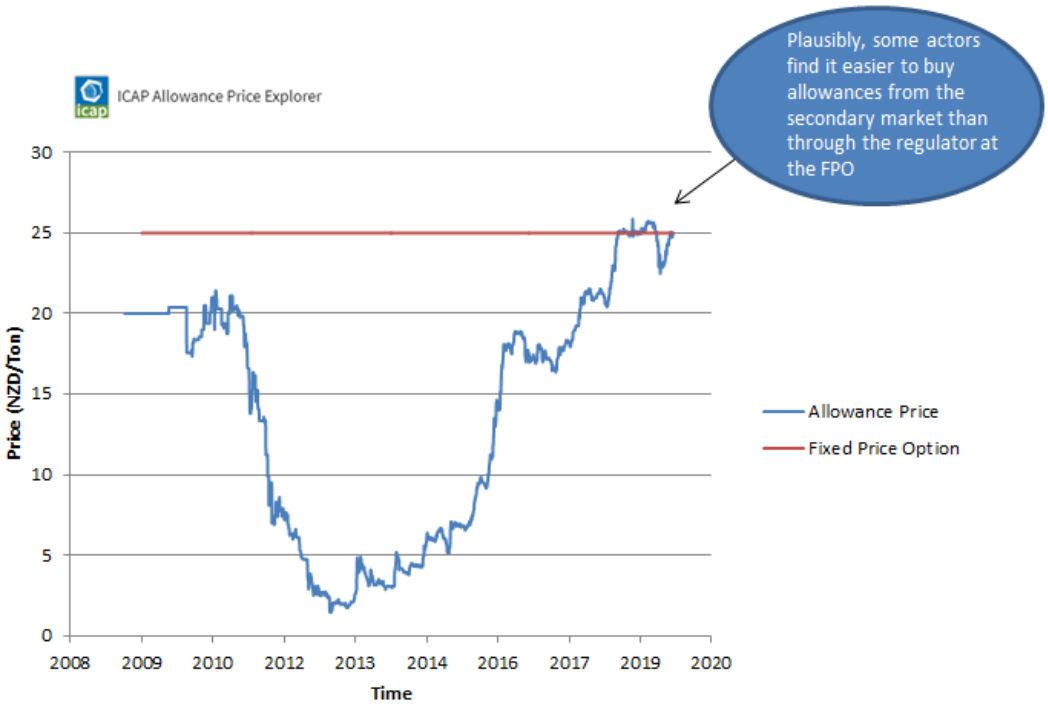
Where should the price ceiling be set?

Price ceilings are set by a combination of political and economic considerations. On the one hand, policymakers seek to instill confidence that the ETS will not create undue economic burden during periods of scarcity and hence spiking prices. On the other, given an unlimited number of allowances are made available to the market at the ceiling, the system will no longer guarantee the reduction target for the covered sectors. Furthermore, even though investment decisions are generally made considering expectations of future prices, by placing an upper limit on the allowance price, a price ceiling constrains revenues that stem from low carbon investments and the market advantage of low carbon products, dampening the incentive for low carbon investments or innovation. Where a hard price ceiling is set below expected abatement costs, the ETS will effectively operate as a carbon tax at the level of the ceiling price.

Practical experience with hard price ceilings

Currently, only New Zealand operates with a hard price ceiling, referred to as a fixed price option (FPO). The FPO has been set at NZD 25 since it was introduced in 2009. The FPO in NZ has occasionally been used by participants that needed to surrender a very small number of allowances and found it more convenient to purchase these at a fixed price than sourcing units from the market at lower prices. Simultaneously, the market price sometimes rises above the FPO, as was the case during several instances in 2019, implying that some actors find it equally convenient to purchase allowances above the FPO. The FPO will soon be replaced by a CCR (New Zealand Ministry for the Environment, 2019).

Figure 3: Price Stability Mechanisms in the NZ ETS*



*Prices reported in NZD to see the NZ ETS Prices in USD or EUR please visit https://icapcarbonaction.com/en/ets-prices

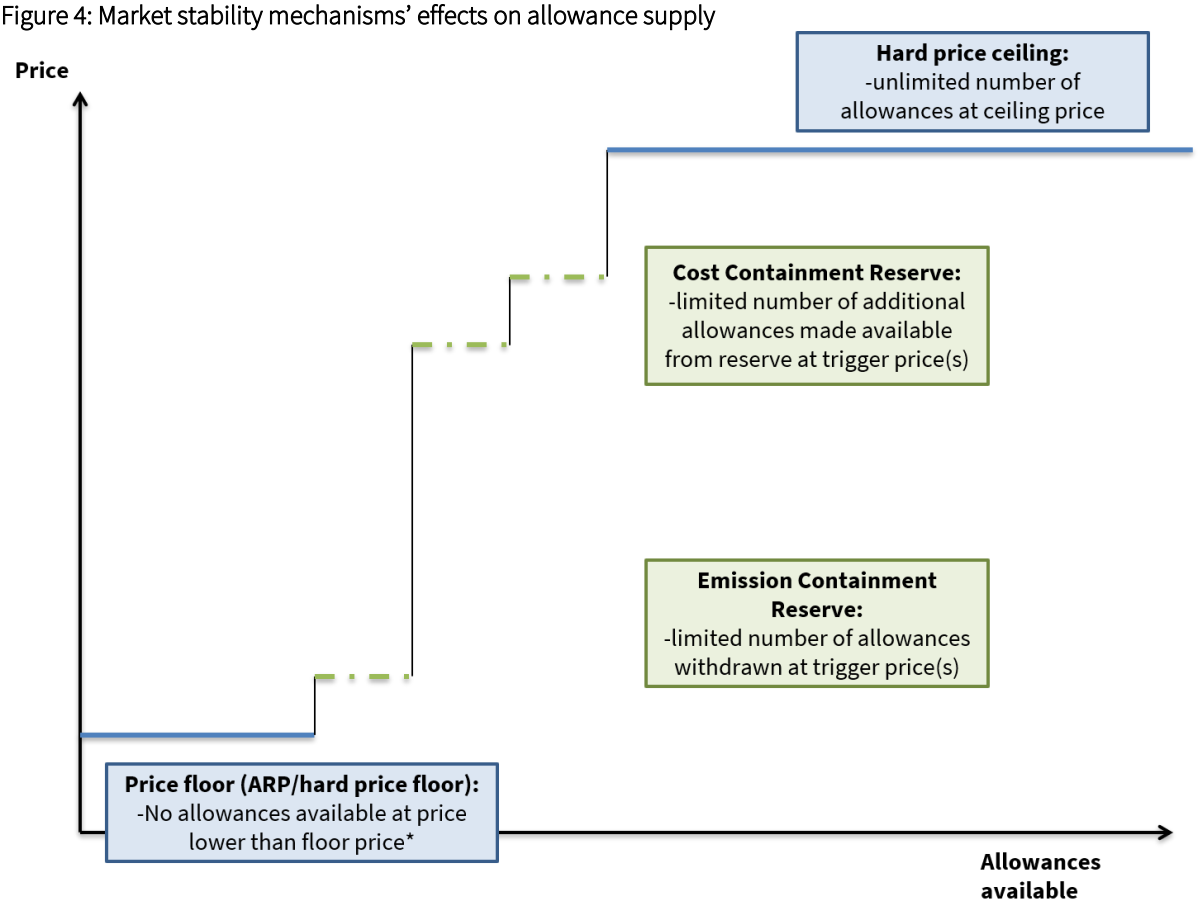
Post-2020, California will (additionally to its CCR) operate a hard price ceiling. If prices continue to rise after the triggering of the CCR, they will ultimately be constrained by a price ceiling. At this level, if all allowances from the CCR are sold, additional compliance instruments, called price ceiling units, can be bought. These price ceiling units represent valid reductions but are not allowances issued under the cap (see Taylor, 2017). Revenues from

the sale of price ceiling units are to be invested in real and additional emission reductions on at least a metric tonne for metric tonne basis, thereby ensuring the environmental integrity of the program (CARB, 2019: 45).

2.3 Combining price-based mechanisms

Any of the upper and lower price mechanisms may be combined to create a "corridor" within which allowance prices are free to move. For example, RGGI operates with an auction reserve price and a CCR. As of 2021, RGGI will also introduce an ECR. The WCI systems operate with both an auction reserve price and a CCR. As of 2021, California will also introduce a hard price ceiling. The combination of different price based MSM options discussed in this note is represented in Figure 4 below.

Figure 4: Market stability mechanisms' effects on allowance supply



Note: * An Auction Reserve Price only poses a price floor at allowance auctions, therefore the share of allowances auctioned is important for the overall effect on the supply of allowances and the resulting price effects for this tool. In secondary markets prices could still fall below the auction reserve price.

Source: Authors own illustration.

3 Quantity-based Mechanisms

A quantity-triggered reserve responds to external shocks by adding or subtracting allowances from a reserve based on predefined, non-price-based triggers. Analysts have suggested a variety of potential triggers for regulating allowance volumes offered at auction, including allowance volumes in circulation, as well as changes in production and other economic conditions. These approaches vary in their ability to provide price predictability, respond to shocks, provide certainty of adjustment, reduce oversupply, and prevent potential manipulation (see Gilbert et al., 2014).

3.1 The EU Market Stability Reserve

The Market Stability Reserve (MSR) is an automatic adjustment mechanism that alters auction volumes when the Total Number of Allowances in Circulation (TNAC) – a measure of allowance surplus – is above or below pre-defined triggers. The MSR, as now established in the EU, aims to maintain a certain supply-demand balance to keep the carbon price signal at levels necessary to achieve the long-term decarbonization target in a cost-effective manner (European Commission, 2014a). It was designed to address the current surplus of allowances and "improves the system's resilience to major shocks by adjusting the supply of allowances to be auctioned" (European Commission, 2019).

In practice the MSR works as follows. When the TNAC is above 833 million[9], 12% (24% up to 2023) of the surplus is withheld from auctions. Actual adjustments to auction volumes take place over the subsequent calendar year. When the TNAC is less than 400 million allowances, 100 million allowances are taken from the reserve and added to auction volumes in the subsequent calendar year. The parameters of the MSR will be subject to periodic review, with the first review foreseen for 2021 and then every five years thereafter (European Union, 2015). As part of the negotiations on the structural reform of the EU ETS for Phase 4, it was also agreed that the number of allowances held in the MSR will be limited to the previous year's auction volume from 2023 onwards - allowances in the MSR exceeding this volume will become invalid.[10]

The European Commission publishes the TNAC before 15 May each year such that market participants understand whether allowances will be placed into or taken out of the reserve. In line with the agreed MSR rules, over the first 8 months of 2019 starting as of 1 January a total of 264 731 936 allowances was placed in the MSR. The most recent publication was made in May 2019[11] to determine reserve feeds from 1 September 2019 until August 2020.

[9] Around 45% of the annual allowance cap in 2019, the first year of operation.

[10] Depending on the emissions forecast assumed, this could result in about 2 billion allowances - roughly the allowance cap of one year - being cancelled in 2023. See Weinreich, D., Monzel, H., Schmid, L.K. and Smuda, A. A Resilient System to Support Long-Term Decarbonization. In ICAP. (2018). Emissions Trading Worldwide Status Report 2018. Berlin.

[11] https://ec.europa.eu/clima/sites/clima/files/ets/reform/docs/c_2019_3288_en.pdf

How is the number of allowances that triggers the reserve determined?

The MSR is built on the assumption that the scale of the allowance surplus matters for market effectiveness. That is, the EU ETS will operate effectively only if the surplus is maintained within a specific range. This range is defined by the hedging requirements of firms operating under the EU ETS referred to as the "hedging corridor" (see for example Neuhoff et al. 2012; Salant, 2015: 12), as well as the banking demand non-power entities. It is necessary to understand what the efficient hedging and banking response of entities would be in order to determine the TNAC that should trigger the MSR. If the surplus is reduced and held significantly below the level of hedging demand plus industrial banking, there is a risk that firms reduce their emissions beyond what is cost-optimal in order to stick to their hedging strategy, reducing the cost effectiveness of the ETS (Gilbert et al., 2014: ix).

In Europe, hedging of CO_2 allowance prices is mostly used by power companies when they sell power on forward contracts. Contracts for fuel and the associated allowances are often signed in parallel, creating a hedging demand for allowances. In addition to the power sector, there are likely some hedging needs from industrial operators that purchase allowances for future compliance as well as institutional investors when they expect allowance prices to increase above rates equivalent from other investments (Neuhoff et al., 2015: 26).

These considerations are specific to the EU, given the scope of its ETS and the allowance demand of its covered entities. Setting quantity triggered MSM in other jurisdictions will require an understanding of the surplus required for the market to function well. This will likely be driven by the hedging and other banking strategies of covered entities or other market participants.

How are withdrawal and injection rates determined?

The 12% was selected such that monthly auctions could be adjusted by 1% each, ensuring a simple and gradual adjustment when the MSR was triggered. This rate was subsequently confirmed in modelling exercises as a suitable rate to ensure speedy adjustment to shocks without creating risk of overshooting (European Commission, 2014b)

The upper threshold of 833 million allowances then ensures that when the MSR is triggered, the resulting adjustment would be greater than 100 million allowances per year (i.e. 12% * 833 = 100).

The higher withdrawal rate of 24% for the initial years was subsequently proposed and adopted, to accelerate the return of the surplus volume towards the corridor indicated by hedging demand. This decision resulted from the negotiations between the European institutions part of the review of the EU ETS for Phase 4.

How are triggers and thresholds updated?

The MSR has a first review foreseen for 2021 and a second one for 2026. According to the EU decision to adopt the MSR (2015), the review *"should include an analysis of the market balance, including all relevant factors affecting supply and demand, and of the appropriateness of the predefined range triggering adjustments to annual auction volumes, as well as the percentage rate applied to the total number of allowances in circulation"*. In effect, the review will assess whether or not the MSR has resolved the excessive surplus in the market as well as its future ability to respond to external shocks. In doing so, it will make a recommendation on whether or not the key design parameters of the MSR should be adjusted. Data on hedging positions of market participants could be a useful input for such a review. Marcu et al (2019) provide further indicators that could be applied to review the MSR.

4 Conclusion

A diverse set of MSMs are in place that provide flexibility to respond to imbalances in allowance supply and demand. In terms of practical experience, MSMs that seek to support prices at the lower bound or remove excess surplus from the market have been triggered more often than those that seek to mitigate excessive price developments. This indicates that abatement costs and resulting allowances prices have in general been lower than expected across ETS to date.

MSMs that seek to support prices during periods of excess supply do so mostly by withholding allowances from auction when price or quantity thresholds are triggered. Therefore, the share of allowances auctioned is important for the implementation of such MSMs. Where allowances are returned to the market in the face of rising demand and as a result lead to increased scarcity and allowance prices, the environmental effectiveness of the ETS will not be affected. Where allowances are permanently retired or invalidated, an MSM can also contribute to increasing the environmental stringency of an ETS. Increasingly, such provisions are included within the automatic adjustment rules that govern MSMs. An open question that is receiving increasing attention is the ability of an MSM to respond to structural changes in allowance supply and demand (driven by e.g. coal phase out) as opposed to responding to short term imbalances.

While experience with hard price ceilings and CCR has been limited, these MSMs will likely receive growing attention as systems move to stricter targets in line with long-term decarbonization plans. How many allowances are reserved for cost containment, whether these allowances are sourced from within the cap or in addition to it, and the setting of the price tiers, particularly hard price ceilings, are key design choices that will need to balance assurance for compliance entities with the environmental effectiveness of the program. Consensus surrounding the ambition of climate policy as well as the role of the ETS within the broader policy mix will be important for assessing this trade off. Where additional compliance units are added to the market, investments in emission reductions outside of the ETS could to some extent alleviate concerns surrounding environmental effectiveness.

Table 1: Market Stability Mechanisms across ETS Jurisdictions:

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
California Cap and Trade Program	Auction Reserve Price (ARP) (applied in joint Californian-Québec auctions)	Lower bound	Bids below the reserve price are not accepted. Unsold allowances are reoffered at auction after two consecutive auctions result in settlement prices above the reserve price.	USD 10 in 2012, increasing at 5% p.a. plus inflation thereafter.	If allowances remain unsold at auction, they will be held in the Auction Holding Account and returned to auction after two consecutive auctions have resulted in a settlement price over the ARP. The maximum number of unsold allowances that can be returned is 25 percent of the California allowances offered at that auction. Any unsold allowances above that amount remain in the Auction Holding Account. If allowances remain unsold for more than 24 months, they are placed into the Allowance Price Containment Reserve.	Between 2014 and 2016, several auctions were not fully subscribed and settled at the auction reserve price.
	Allowance Price Containment Reserve (Through 2020)	Upper bound	A pre-defined number of allowances are offered for sale from a reserve quarterly. Since they are available at fixed tier prices, entities are expected to access the reserve when market prices reach tier levels. The reserve is filled from within the allowance cap and is set at ~5% of the 2012-20 allowance budget.s	Three tiers set in 2013 at USD 40, USD 45 and USD 50. Increases at a rate of 5% p.a. plus inflation. Allowances from the reserve are offered for sale quarterly at three tier prices, and at two tier prices after 2020. The two-tier prices start at USD 41.40 and 53.20 in 2021.	N.a.	No entity has requested a sale from the Allowance Price Containment Reserve.
	Two Reserve Tiers and Price Ceiling (From 2021)	Upper bound	The existing Allowance Price Containment Reserve is replaced by two price tiers at which allowances are released for sale when market prices reach tier levels. Allowances available at these tiers are from within the allowance cap. Above these price	In 2021, the two cost containment reserve tiers and the price ceiling will be set at USD 41.40, 53.20, and 65.00, respectively. These prices increase at 5% p.a. plus inflation.	N.a.	N.a.

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
			points will sit a "hard price ceiling". At this price ceiling, (if allowances are exhausted) an unlimited number of **price ceiling units** will be made available to covered entities. Price ceiling units represent valid reductions and are not issued under the cap. Revenues from the sale of price ceiling units are to be invested in real and additional emission reductions on at least a metric tonne for metric tonne basis.			
Québec Cap and Trade Program	Auction Reserve Price (applied in joint Californian-Québec auctions)	Lower bound	Bids below the reserve price are not accepted, with unsold allowances being transferred to an allowance reserve and slowly re-offered at future auctions (after two consecutive auctions closing above floor-price).	CAD 10 in 2012, increasing at 5% p.a. plus inflation thereafter. For 2019, Québec's annual minimum price is CAD 15.31 (California's minimum price is USD 15.62) The joint California-Québec auction reserve price is the higher of the two reserve prices.	Unsold allowances are returned to auction after two consecutive Current Auctions have resulted in a settlement price above the ARP.	At times the auction reserve price has been binding, resulting in auctions that are not fully subscribed. As a result, market prices kept increasing on a yearly basis as they stayed close to, or above, the minimum auction price.
	Reserve Account	Upper bound	A pre-defined number of allowances are available in three categories of prices. To access these allowances, an entity has to subscribe to a reserve sale, called "sale by mutual agreement" in the regulation.	The three categories of prices (A, B, C) are set at CAD 60.79, CAD 68.38, and CAD 75.97 in 2020 respectively. These prices increase at 5% per annum plus inflation.		No sale by mutual agreement has occurred yet.
RGGI	Auction Reserve Price	Lower bound	Bids below the reserve price are not accepted, with unsold allowances being transferred to an allowance reserve.	USD 1.86 in 2008 and increased at a rate of 2.5% from 2014 onwards.	Withheld allowances have not been reoffered.	At times the auction reserve price has been binding, resulting in auctions that are not fully subscribed and surplus of allowances. To address this surplus, the RGGI cap was revised downwards for the years from 2014-20. Withheld allowances have not been re-offered.
	Emission Containment Reserve (from 2021)	Lower bound	Participating states[12] will withhold up to 10% of their state allowance budgets when minimum price threshold is triggered. Withheld	Set at USD 6 in 2021 increasing at 7% per annum thereafter. Its size will be 10% of the budgets of the states implementing the ECR.	N.a.	N.a.

[12] At this point Maine and New Hampshire do not intend to participate in the ECR: https://www.rggi.org/program-overview-and-design/elements

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
			allowances will not be available for future sale.			
	Cost Containment Reserve	Upper bound	A pre-defined number of allowances are released from a reserve when an upper price threshold is triggered. Allowances are in addition to the allowance cap.	USD 4/t in 2014; USD 6/t in 2015; USD 8/t in 2016; USD 10/t in 2017, increasing 2.5% each year thereafter until 2020. Reset at USD 13/t in 2021, increasing 7% thereafter. Injection rate is 5 million in 2014 and 10 million thereafter, which corresponds to ~12% of the 2020 allowance cap. Post 2020 the CCR injection rate will be set at 10% of the allowance cap.	N.a.	In 2014 and 2015 the CCR was triggered resulting in the release of 15 million additional allowances.
NZ ETS	Fixed Price Option	Upper bound	A fixed fee is charged for emissions at the trigger price.	NZD 25 (USD 17.20).	N.a.	The FPO has occasionally been used by participants that needed to surrender a very small number of allowances and found it more convenient to purchase these at a fixed price than sourcing units from the market at lower prices.
	Cost Containment Reserve (legislation expected in 2020)	Upper Bound	FPO will be replaced by a CCR, whereby a set volume of allowances will be auctioned onto the market when a predetermined trigger-price is reached. Any units released from the CCR will be backed by an equivalent tonne of emission reductions.	Specifics of the CCR design (such as trigger price and volume) will be set by regulation and determined after further consultation this year.	N.a.	N.a.
EU ETS	Market Stability Reserve	Upper and lower bound	Auction volumes are increased or decreased when the Total Number of Allowances in Circulation (TNAC) -- a measure of allowance surplus -- is above or below pre-defined triggers. The European Commission will publish the TNAC by 15th May each year such that market participants are informed about whether allowances will be placed into or taken out of the reserve. The number of allowances held in the MSR will be limited to the previous year's auction volume from 2023 onwards - allowances in	When the TNAC is above 833 million, 12% (24% up to 2023) of the surplus is withheld from auctions. Actual adjustments to auction volumes take place over the subsequent calendar year. When the TNAC is less than 400 million allowances, 100 million allowances are taken from the reserve and added to auction volumes in the subsequent calendar year.	After 2023, the size of the reserve is limited by the previous year's auction volume (MSR_N=MSR_{N-1} - Auction $Volume_{N-1}$) with any allowances above this level invalidated.	The MSR began operation in 2019. On 15 May 2018, the European Commission published the total number of allowances in circulation amounting to some 1.65 billion allowances. As a result, the 2019 auction volumes will be reduced by close to 265 million allowances over the first 8 months of 2019, corresponding to 16% of the surplus.

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
			the MSR exceeding this volume will become invalid.			
KETS	Auction Reserve Price	Lower bound	Bids below the reserve price are not accepted.	ARPs are set by the following formula: "the average price over the previous three months + the average price of last month + the average price over the previous three days/3."	Unsold allowances will be added to the next month's auction volume.	At the third auction nine bids were made with five being above the reserve price. Given the limits of purchase, this meant that the auction was not fully subscribed. Unsold allowances were added to the April auction volume.
	Cost Containment Reserve	Upper bound	About 5 percent of the total annual allowances are retained in the reserve.	An Allocation Committee is in place to implement market stabilization measures in particular cases (e.g., when it is difficult to trade allowances due to the imbalance of supply or demand). The stabilization measures may include additional allocation from the reserve (up to 25%). There is no predetermined injection rate. Even if the price-based triggers are met, the measures will not automatically deploy unless a decision, upon a request by the Ministry of Environment, to that effect is taken by the Emission Allowance Allocation Committee (EAAC).	N.a.	N.a.
	Discretionary Price Floor	Lower bound	An Allocation Committee is in place to implement market stabilization measures in particular cases (e.g., when it is difficult to trade allowances due to the imbalance of supply or demand). The stabilization measures may include a temporary price floor or ceiling.	Even if the price-based triggers are met, the measures will not automatically deploy unless a decision, upon a request by the Ministry of Environment, to that effect is taken by the EAAC. No parameters are defined for withdrawing either of the instruments once activated.	N.a.	N.a.
Nova Scotia	Cost Containment Reserve	Upper bound	Reserve is filled with allowances set aside from the original cap.	In the first year of the compliance period (2019), the government placed 3% of allowances available under the yearly caps into the reserve. The allowances are offered for sale at set prices to participants at predetermined times throughout the year to cover their compliance obligations. Up to four reserve sales can occur in a calendar year.	N.a.	N.a.

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
				The initial price will be CAD 50 (USD 39) in 2020, rising annually by 5% plus inflation.		
	Auction reserve price	Lower bound	N.a.	The initial price is set at CAD 20 (USD 15) in 2020, rising annually by 5% plus inflation.	Unsold allowances are made available at later auctions.	N.a.
Massachusetts	Auction reserve price	Lower bound	N.a.	In the first and second auctions of 2019 allowances had a reserve price of USD 0.50 per allowance.	N.a.	N.a.
Beijing	Price Collar	Upper and lower bound	In Beijing there are additional auction-volumes if the prices are too high and a buy-back option if the prices get too low according to a fixed price corridor.	150 Yuan – 20 Yuan	N.a.	N.a.
	Cost Containment Reserve	Upper bound	Regulator can, but is not required to, release allowances from reserve if prices reach ceiling.	5-10% of total allowances set aside to keep price below ceiling	Unallocated allowances are not cancelled	N.a.
Fujian	Discretionary Price Floor	Lower bound	Low prices may trigger authorities to buy allowances from the market through governmental funds.	Discretionary	N.a.	N.a.
Guangdong	Auction Reserve Price	Lower bound	The development and reform commission can change the frequency of auctions to stabilize prices and set the reserve price.	Initially in 2013, the ARP was set at CNY 60 (USD 9.07), then it was lowered to CNY 25 (USD 3.78) and increased to CNY 40 (USD 6.05) in steps of CNY 5 (USD 0.76) with each quarterly auction. In 2015, the floor price was set at 80% of the weighted average price for allowances over the previous three months.	N.a.	In 2016, there was no restriction on the declared price, but a so-called policy reserve price was set as an effective price floor. In 2017, the policy reserve price was set at 100% of the weighted average price for allowances over the previous three months.
	Cost Containment Reserve	Upper bound	Allowances for the reserve are set aside from the general budget (within the cap).	Ca. 5% of the allowance budget of a phase are placed in the reserve. 2017 the allowance reserve held 23mt, which is equivalent to 5.45% of the overall budget	Unallocated allowances are not cancelled	N.a.
Hubei	Discretionary Price Floor	Lower bound	The Hubei DRC in consultation with an advisory committee can (but is not required to) buy allowances in case of market fluctuations (if prices fluctuate more than 10% in one day). At the same time, the Hubei Exchange can also act to change those rules (fluctuation rates that make intervention possible).	Discretionary	N.a.	Between 15 July and 25 December 2016, the limit was temporarily adjusted to between -1% and +10% as a response to the decreasing carbon price at that time.

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
	Cost containment reserve	Upper bound	In Hubei a government reserve for market stabilization is filled with allowances from within the cap (set aside from the total budget).	8%-10% of the allowances issued under the annual cap are set aside in the Government Reserve.	Hubei is the only pilot to have a system of cancellation of unused allowances at the end of each compliance year, which creates an expectation of tightening the number of allowances in circulation in the market	N.a.
	Price Collar	Upper and lower bound	In Hubei allowances release at the upper bound and buy-back at the lower bound, establish an implicit price corridor.	The Pilot's advisory committee can trigger the release/buy back of allowances if, for a period of twenty consecutive trading days, the closing prices of six trading days have reached the maximum/minimum daily bargain window (Wang et al. 2019). [13]	N.a.	N.a.
Shanghai	Auction Reserve Price	Lower bound	Shanghai does not determine the ARP following detailed pre-determined rules. The local DRC is generally responsible for price stabilization measures.	Discretionary	Small amount of allowances is set aside which are meant to provide compliance entities with additional supply to meet their compliance demand	Shanghai auctioned two million tonnes from the government reserve in July 2018, with a floor price set at two times the weighted on-exchange allowance price from 18 November 2016 to 30 July 2018—CNY 41.54 (USD 6.28). The auction cleared at the floor price and a total of 305,237 tonnes (15% of total auction volume). An auction of two million allowances was held in June 2017. 2% of allowances were sold, at the floor price of CNY 38.77 (USD 5.86).
Shenzhen	Auction Reserve Price	Lower bound	Shanghai does not determine the ARP following detailed pre-determined rules. The local DRC is generally responsible for price stabilization measures.	Discretionary	N.a.	N.a.
	Discretionary Price floor	Lower bound	The Shenzhen DRC can intervene through buying back up to 10% of the total allocation.	Discretionary	N.a.	In Shenzhen, in some cases, the Shenzhen DRC has the authority to intervene in the market, which under strict guidelines, has been delegated to the local exchange.

[13] See Wang, B., Boute, A. and Tan, X. (2020) for a lengthier discussion on price stability mechanisms in Hubei and the other Chinese Pilot Systems

System	Stability Mechanism	Bound	Operation	Parametrization	Treatment of unsold allowances	Experience
Tianjin	Discretionary Price floor	Lower bound	The Tianjin DRC can (but is not required to) buy allowance in case of market fluctuations	Discretionary	N.a.	N.a.

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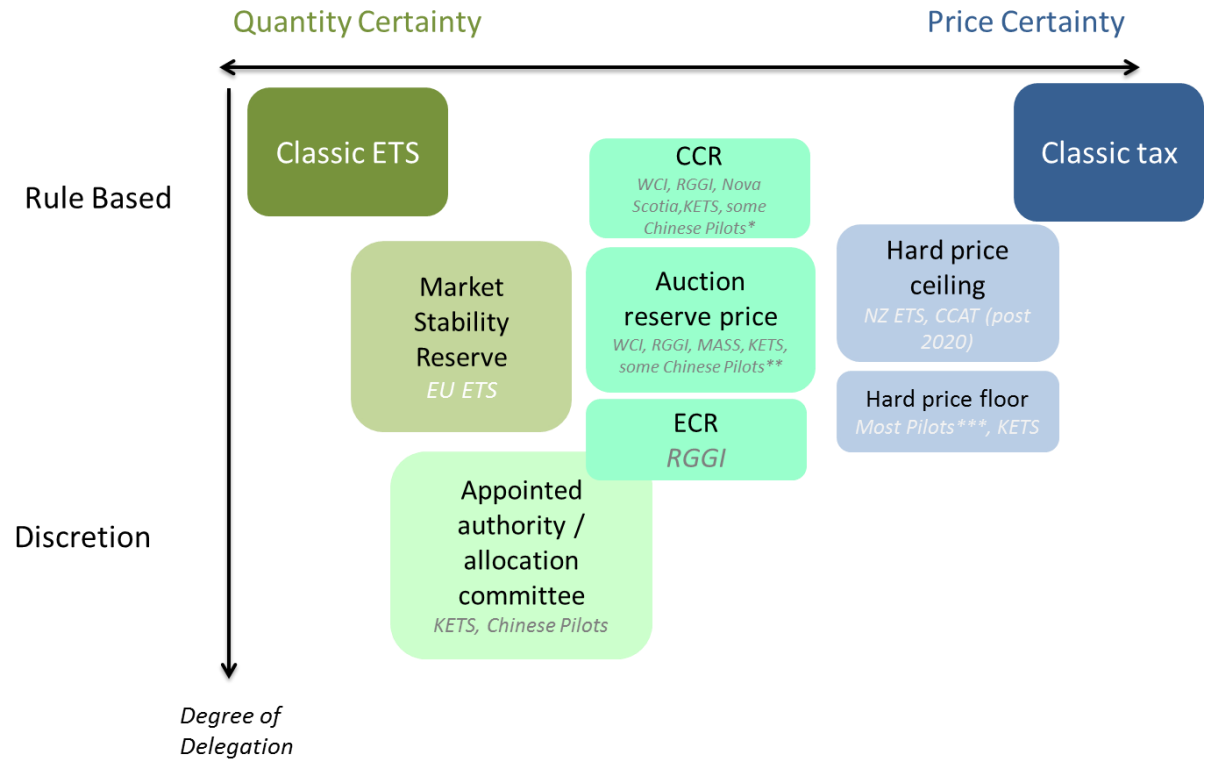
Appendix A: Characteristics of MSM

Figure B1: Characteristics of market stability mechanisms



Source: Adapted from Grosjean et al., 2014.

The market for emission reductions has a demand curve, determined by the marginal abatement costs of regulated entities, and a supply curve, which is determined by policy. Under a pure tax system, the supply of allowances is infinitely elastic. The market is effectively supplied with as many allowances as agents wish to buy at a fixed price (the tax rate). Under a pure quantity system, supply is completely inelastic as the amount of allowances is exogenously fixed. MSM in ETS aim to combine elements of both price and quantity-based regulation to result in a more efficient outcome when demand for allowances is unknown ex ante.