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Remove or reserve? Allowance prices and design choices in Phase IV of the EU Emission Trading System

Grischa Perino[1,*] and Maximilian Willner[1]

Abstract

The final design choices for Phase IV of the EU ETS are about to be made. With the introduction of the market stability reserve several additional design parameters have been introduced into the EU ETS. This paper explores how changes in these parameters impact on allowance price paths. Four parameters are investigated. They differ substantially in whether, how and when they affect allowance prices. Finally, the proposal by the environmental committee of the European Parliament from December 2016 is projected to unambiguously increase prices at all points in time but to render the market stability reserve (almost) redundant.

Introduction

The European Union (EU) is in the process of reforming the Emission Trading System (ETS) that covers about 45% of its greenhouse gas emissions. In 2019 the market stability reserve will be introduced. Based on the number of unused allowances in the market, it postpones their auction date but does not itself affect the long-run cap on emissions. The aim of the reserve is boosting investment incentives in low-carbon technologies and increasing both resilience to

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demand shocks and synergies with climate policies overlapping the EU ETS (EU, 2015). In December 2016 the environmental committee of the European Parliament (ENVI) proposed further amendments to the ETS and the market stability reserve (European Parliament, 2016). The contribution of this paper is to show how changes in design parameters affect price paths in the EU ETS with a market stability reserve using an analytically tractable model. The committee's proposal raises the price path above those without the market stability reserve and the original market stability reserve. This is driven by the reduction in the overall cap and not by adjustments to the market stability reserve's design.

For most of its history the EU ETS has experienced price levels well below regulatory expectations (Böhringer, 2014). In contrast to the early phases of the Acid Rain Program, the perception in the scientific and policy communities has been that this is an indication of the scheme's weakness rather than of an unanticipated but welcome cost saving in achieving a given policy objective. In 2015 the European Union decided to introduce the market stability reserve and proposed to increase the linear reduction factor from 1.74 to 2.2 percent. The latter determines reduction in the number of allowances issued each year. It tightens the long-run cap.

In its 2015 version, the market stability reserve is expected to temporarily increase prices. Setting aside a substantial amount of allowances and slowly re-introducing them at a later date increases short-run scarcity. Later, when allowances are fed back into the market, prices drop below the baseline level. Figure 1 illustrates this. In the long run, when the market stability reserve is empty, the price path remains unaffected. Recent contributions provide a detailed analysis of how its introduction affects price paths and to what extent it will achieve the EU's objectives (Perino/Willner, 2016, Richstein et al., 2015, Salant, 2016). In 2017 the EU plans to finalise the rules for Phase IV (2021-2030) of the ETS potentially including last minute adjustments to the design of the market stability reserve.

This paper assess how the following design parameters affect allowance prices:

- an increase in the linear reduction factor
- cancellation of allowances from the reserve
- an increase of the intake rate of the market stability reserve
- a reduction in its re-injection rate.

Methods

Consider an intertemporal allowance market with banking but without borrowing that includes a market stability reserve (Perino/Willner, 2016, Rubin, 1996). There is a continuum of polluting firms with mass one in a perfectly competitive market for emission allowances, where the representative firm is characterized by an abatement cost function, $C(u-e(t))=c/2[u-e(t)]^2$ if $e(t) \leq u$ and equals zero otherwise, with abatement being denoted by the difference in baseline emissions $u > 0$ and actual emissions at time t, $e(t)$.

The time path of auctioned allowances $S(t)$ is set to decline at a constant rate $a > 0$, i.e. $S(t) = S_0 e^{-at}$, where $S_0 > 0$ is the number of allowances issued at $t = 0$. The EU ETS exhibits a "linear reduction factor" which reduces the annual cap on emissions by a constant amount. Given that an infinite time horizon is used in this model, a linear representation is not appropriate. In aggregate, sales of firms equal the number of allowances auctioned at time t.

The market stability reserve is represented as follows: the number of allowances in the reserve, $R(t)$, increases by γ percent of the size of the bank, $b(t)$, if and only if $b(t) > b_{high}$. If the bank is below b_{low} and the reserve is not empty, *I* allowances are re-injected into the market. In all other cases, the reserve is inactive.

The reserve will be seeded with an initial stock of allowances $R^0 > 0$ as currently backloaded allowances together with other reserved amounts will be put directly into the reserve (EU, 2015).

The optimization problem of the representative firm is

$$\min_{e(t),x(t)} \int_{t=0}^{\infty} e^{-rt} \left[\frac{c}{2}\left(u - e(t)\right)^2 + p(t)x(t)\right] dt$$

s.t.: $\dot{b}(t) = x(t) - e(t)$, $b(t) \geq 0$ for all t

The corresponding equilibrium conditions are:

$$p_{MSR}^0 e^{rt} = c(u - e_{MSR}(t)) \text{ for all } t < \tau_{MSR}$$

$$\int_{t=0}^{\tau_{MSR}} e_{MSR}(t)\, dt = b_{MSR}^0 + \frac{S_0}{a}(1 - e^{-a\tau_{MSR}}) + R(0) - R(\tau_{MSR})$$

$$\int_{s=0}^{t} e_{MSR}(s)\, ds \leq b_{MSR}^0 + \frac{S_0}{a}(1 - e^{-at}) + R(0) - R(t) \quad \text{for all } t < \tau_{MSR}$$

$$e_{MSR}(\tau_{MSR}) = S_0 e^{-a\tau_{MSR}} - \dot{R}(\tau_{MSR})$$

where the subscript *MSR* indicates the equilibrium value or path of variables determined by the model and τ_{MSR} is the point in time when the aggregate bank is depleted for the first time (τ_{MSR} = inf {t:b_{MSR}(t) = 0}).[2] The banking phase is not unique if the market stability reserve affects price and emission paths (Perino/Willner, 2016).

[2] Unless specified otherwise, the following parameter values are used: *a = 0.022, c = 0.0504414,* S_0 *= 1.9 billion, u = 1.9 billion,* b^0_{MSR} *= 1.1 billion,* R_0 *= 1.5 billion, r = 0.1,* b_{high} *= 833 million,* b_{low} *= 400 million, ɣ = 0.12, I = 100 million.*

The equilibrium conditions already reveal how policy parameters affect price paths in the period when there are still unused allowances in the market ($t < \tau_{MSR}$):

- An increase in the linear reduction factor (here: *a*) affects the last three conditions. At any point in time, fewer allowances are available.
- Cancellation of allowances from the reserve affect the last term in the second and third condition.
- An increase in the intake rate γ only substantially affects *R(t)* during the first years. If the total number of allowances placed in the reserve is not changed substantially, this will not change the equilibrium much.
- Reducing the re-injection rate *I* affects the last three conditions. The banking phase ends earlier and equilibrium prices increase initially.

For $t > \tau_{MSR}$ the price path is determined by the now binding number of allowances issued each year. To avoid a discrete jump in the price level at the point in time the market stability reserve stops re-injecting allowances, there is a brief second banking phase.

A caveat is that the model uses a continuous representation of time. This is relevant for the market stability reserve which operates on a year-by-year basis. The analysis therefore does not capture its discrete nature and ignores the delay of more than a year in the reserve’s responsiveness. With intertemporally optimising firms both simplifications do not have substantial impacts on results because intertemporal arbitrage smooths price paths over discrete but anticipated events.

Results and discussion

Reference cases

In 2015 the EU ETS had 1.78 billion unused allowances on firms' accounts plus another 900 million put aside as part of the 'back-loading' of Phase III that were initially scheduled to return to the market in 2019 and 2020. This 'surplus' is not expected to be depleted before the end of Phase IV. Firms bank allowances for future use as they anticipate that the cap will be more stringent in the future and to hedge against unexpected spikes in demand. Intertemporal arbitrage results in firms being indifferent between using (or acquiring) an additional allowance now or at any point while holding a strictly positive bank of allowances. In Figure 1 the length of this initial banking phase corresponds to the left part of the price paths were prices increase exponentially with the interest rate.

Two reference cases are specified. The price path without the market stability reserve (grey dashed in Figure 1) indicates that the surplus would be depleted by around 2042. Afterwards, emissions match the number of allowances issued per year and the price path rises at a rate below the interest rate. Introducing the 2015 version of the market stability reserve (bold black in Figure 1) initially raises prices. The scarcity of allowances has increased temporarily since a substantial number has been placed in the reserve and is only released at a rate of 100 million a year once the number of unused allowances in the market drops below 400 million[1]. The cap becomes binding earlier and prices increase more slowly due to the reserve. They drop below the baseline level while allowances held in the reserve are re-injected. In the 2015 version of the market stability reserve all allowances placed in the reserve will eventually return to the market. Any increase in scarcity due to the reserve reduces scarcity later on (Perino/Willner, 2016, Salant, 2016). Once the reserve is depleted price paths converge.

Insert Figure 1 about here.

Linear reduction factor

The linear reduction factor directly affects the number of allowances available in the short and the long run. In Phase III it was set at 1.74 percent. The European Commission (EC) proposed an increase to 2.2 percent for Phase IV and ENVI supports 2.4 percent. Figure 2 presents price paths of four scenarios based on the 2015 version of the market stability reserve. The black bold line represents a linear reduction factor of 2.2 percent. It is identical to the black bold paths in Figures 1, 3 and 4. The grey continuous path shows the impact of increasing the linear reduction factor to 2.4 percent as proposed by ENVI. The two dashed grey paths are based on linear reduction factors of 2.7 and 3.0 percent, respectively. Increasing the linear reduction factor unambiguously increases the price level at any point in time reflecting the increase in scarcity of allowances.

Insert Figure 2 about here

Cancellation of allowances from reserve

ENVI has proposed to cancel 800 million allowances stored in the market stability reserve in 2021. This directly reduces the long-run cap by the same amount. The nature of the impact of cancellations of allowances that are in the reserve depends on the number cancelled. If both before and after the cancellation the market stability reserve imposes additional short-term scarcity, i.e. it is not redundant, then the number of allowances in the reserve and the total cap are irrelevant for prices initially. In the medium run, prices increase as the reserve stops injecting allowances earlier. There is a period where prices are strictly higher than without the cancellation (see Figure 3, 400 million). If the reserve does not affect prices before the cancellation or becomes irrelevant due to the cancellation, then initial price levels increase (see Figure 3, 1.4 billion). In the simulation, the cancellation of 800 million allowances is just sufficient to render the market stability reserve irrelevant.

Insert Figure 3 about here

Intake rate of reserve

The intake rate of the stability reserve defines by how much the number of auctioned allowances is reduced by placing them into the reserve while there are more than 833 million unused allowances in the market. In 2015 a rate of 12 percent of the number of unused allowances has been agreed (EU, 2015). ENVI proposes to raise this to 24 percent for the first four years. Simulations reveal that the intake rate has no substantial effect on price levels (Column 6 in Table 1). The upper threshold of 833 million that stops the intake of further allowances into the reserve is reached earlier. The degree of scarcity imposed by the reserve, however, is driven by the point in time when the cap is binding for the first time. Column 4 in Table 1 reveals that it is essentially unaffected by the intake rate of the market stability reserve. The reason is simple. Although allowances are removed faster, it neither implies that more allowances are removed in total nor that they are coming back later. Doubling the intake rate of the reserve increases the maximum number of allowances held by it by only 0.14

percent (Column 5 in Table 1) and increases the price level in 2019 by only 0.02 percent (Column 6 in Table 1). Graphs of price paths perfectly overlap and are not shown. Increasing the intake rate of the market stability reserve is not an effective means to increase allowances prices.

Table 1: Effect of reserve intake rate.

Intake rate	**Years until bank at**			**Max. number of allowances in reserve (in million)**	**Price level in 2019**
	833 million	**400 million**	**zero**		
0.12	3.23	8.874	18.115	1,880.9	4.323
0.24	1.56	8.856	18.111	1,883.5	4.324
0.48	0.69	8.856	18.111	1,883.5	4.324

Re-injection rate of reserve

In contrast to an increase in the intake rate of the market stability reserve, a reduction in the re-injection rate changes the price path. Releasing allowances from the reserve at a lower rate extends its activity period substantially. Short-term scarcity increases which is reflected in higher prices in the first decades. Later on prices are lower than otherwise since the extended injection phase increases the supply of allowances in the second half of the century, based on the assumption that the rules of the market stability reserve and the EU ETS remain unchanged.

Insert Figure 4 about here

Conclusion and Policy Implications

ENVI has proposed the following key amendments to the EC's proposal for Phase IV of the EU ETS and the market stability reserve agreed on in 2015 (European Parliament, 2016): an increase of the linear reduction factor to 2.4 percent (compared to 1.74 in Phase III and the 2.2 percent proposed by the EC), the cancellation of 800 million allowances from the reserve in 2021 and an increase in its intake rate to 24 percent during the first four years (instead of 12 percent). The continuous grey price path in Figure 1 illustrates how the ENVI proposal compares to two points of reference each with a linear reduction factor of 2.2 percent: the EU ETS without a market stability reserve (grey dashed) and the EU ETS with the 2015 version of the reserve (black). In contrast to the reform agreed on in 2015, the ENVI proposal generates a price increase over the entire time horizon. However, this is exclusively driven by reductions in the long-run cap, i.e. by increasing the linear reduction factor and the cancellation of allowances from the reserve. As illustrated above, the adjustment of the intake rate has no impact on prices. In this simulation, the ENVI proposal renders the market stability reserve almost irrelevant. The relevant price path features only a small dent around 2037. Without the reserve but with the same reductions in the long-run cap, the price path would smooth that dent by being slightly lower before and somewhat higher after.

Interventions into intertemporal allowance markets require careful analysis. This contribution identifies which design parameters for Phase IV are effective in increasing allowances prices over the coming years and which are not. Sustained increase in the allowance price require allowances to be permanently removed. Reserving them for future use can increase short-term scarcity but only at the cost of lower prices in the future. The literature contains several proposals how rule-based cap adjustments can be implemented avoiding ad-hoc regulatory interventions that might undermine market participants' trust in the regulatory environment.[3]

If in the real world and in contrast to our assumption firms do not perfectly optimise intertemporally, then our model underestimates the extent of short-term impacts to the same extent as it underestimates the medium-term counter-effects. If, for example, an increase in the intake rate of the reserve increases prices due to imperfect intertemporal arbitrage, then there is a corresponding reduction in allowance prices later on.

References

Böhringer, C. Two decades of European climate policy: A critical appraisal. *Review of Environmental Economics and Policy* **8(1),** 1-17 (2014).

European Parliament and Council. Decision (EU) 2015/1814 of the European Parliament and of the Council of 6 October 2015 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/ec. *Official Journal of the European Union* **58**, L264/1-L264/5 (2015).

European Parliament. Committee on the Environment, Public Health and Food Safety. COMPROMISE AMENDMENTS 1 – 17 Draft report by Ian Duncan (PE582.397v02-00) on the proposal for a directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, 2015/0148(COD), 14.12.2016 (2016).

[3] See e.g. Fell et al. (2012), Grosjean et al. (2016), Kollenberg/Taschini (2016), Pizer (2002), Roberts/Spence (1976) and Unold/Requate (2001).

Fell, H., Burtraw, D., Morgenstern, R. D., Palmer, K. L. Soft and hard price collars in a cap-and-trade system: A comparative analysis. *Journal of Environmental Economics and Management* **64(2)**, 183-198 (2012).

Grosjean, G., Acworth, W., Flachsland, C., Marschinski, R. After monetary policy, climate policy: is delegation the key to EU ETS reform?. *Climate Policy* **16(1)**, 1-25 (2016).

Kollenberg, S., Taschini, L. Emissions trading systems with cap adjustments. *Journal of Environmental Economics and Management* **80**, 20-36 (2016).

Landis, F. Final report on marginal abatement cost curves for the evaluation of the market stability reserve (No. 15-01). ZEW-Zentrum für Europäische Wirtschaftsforschung/Center for European Economic Research. EconPapers. http://EconPapers.repec.org/RePEc:zbw:zewdok:1501 (2015).

Perino, G., Willner, M. Procrastinating reform: The impact of the market stability reserve on the EU ETS. *Journal of Environmental Economics and Management* **80**, 37-52 (2016).

Pizer, W. A. Combining price and quantity controls to mitigate global climate change. *Journal of Public Economics* **85(3),** 409-434 (2002).

Richstein, J. C., Chappin, É. J., de Vries, L. J. The market (in-) stability reserve for EU carbon emission trading: Why it might fail and how to improve it. *Utilities Policy* **35,** 1-18 (2015).

Roberts, M. J., Spence, M. Effluent charges and licenses under uncertainty. *Journal of Public Economics* **5(3)**, 193-208 (1976).

Rubin, J. D. A model of intertemporal emission trading, banking, and borrowing. *Journal of Environmental Economics and Management* **31(3),** 269-286 (1996).

Salant, S. W. What ails the European Union′ s emissions trading system?. *Journal of Environmental Economics and Management* **80**, 6-19 (2016).

Unold, W., Requate, T. Pollution control by options trading. *Economics Letters* **73(3)**, 353-358 (2001).

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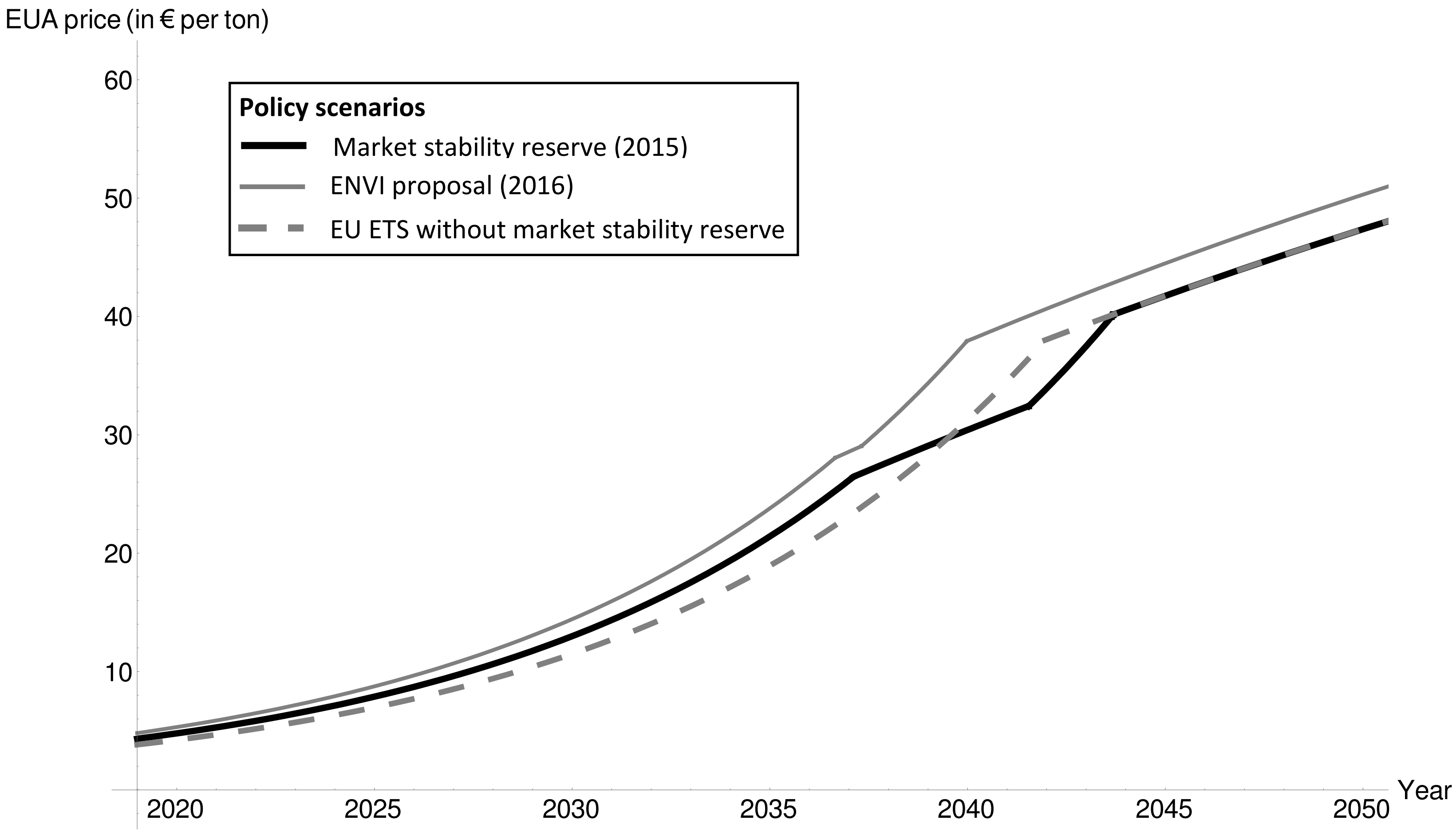

Figure 1: Stylised allowance price scenarios for Phase IV and beyond. Price paths without the market stability reserve (grey dashed), with the 2015 version of the market stability reserve (black bold) and the market stability reserve incorporating the 2016 ENVI proposal (grey continuous). The first two are based on a linear reduction factor of 2.2 percent and differ only by the presence of the market stability reserve. The ENVI proposal increases the linear reduction factor to 2.4 percent, cancels 800 million allowances from the market stability reserve in 2021 and assumes an intake rate of 24 percent of the reserve for the first four years.

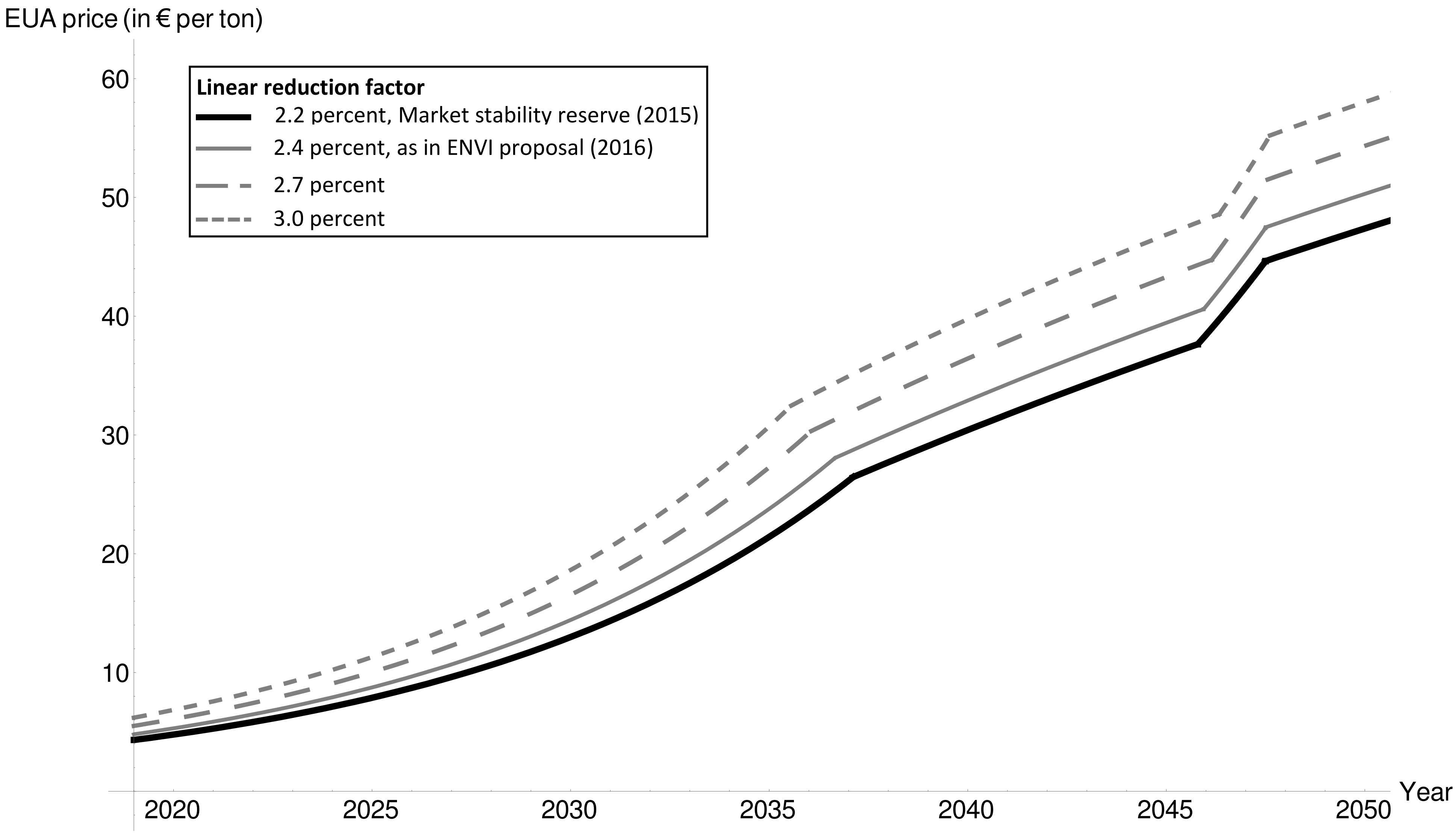

Figure 2: Price paths for different linear reduction factors.

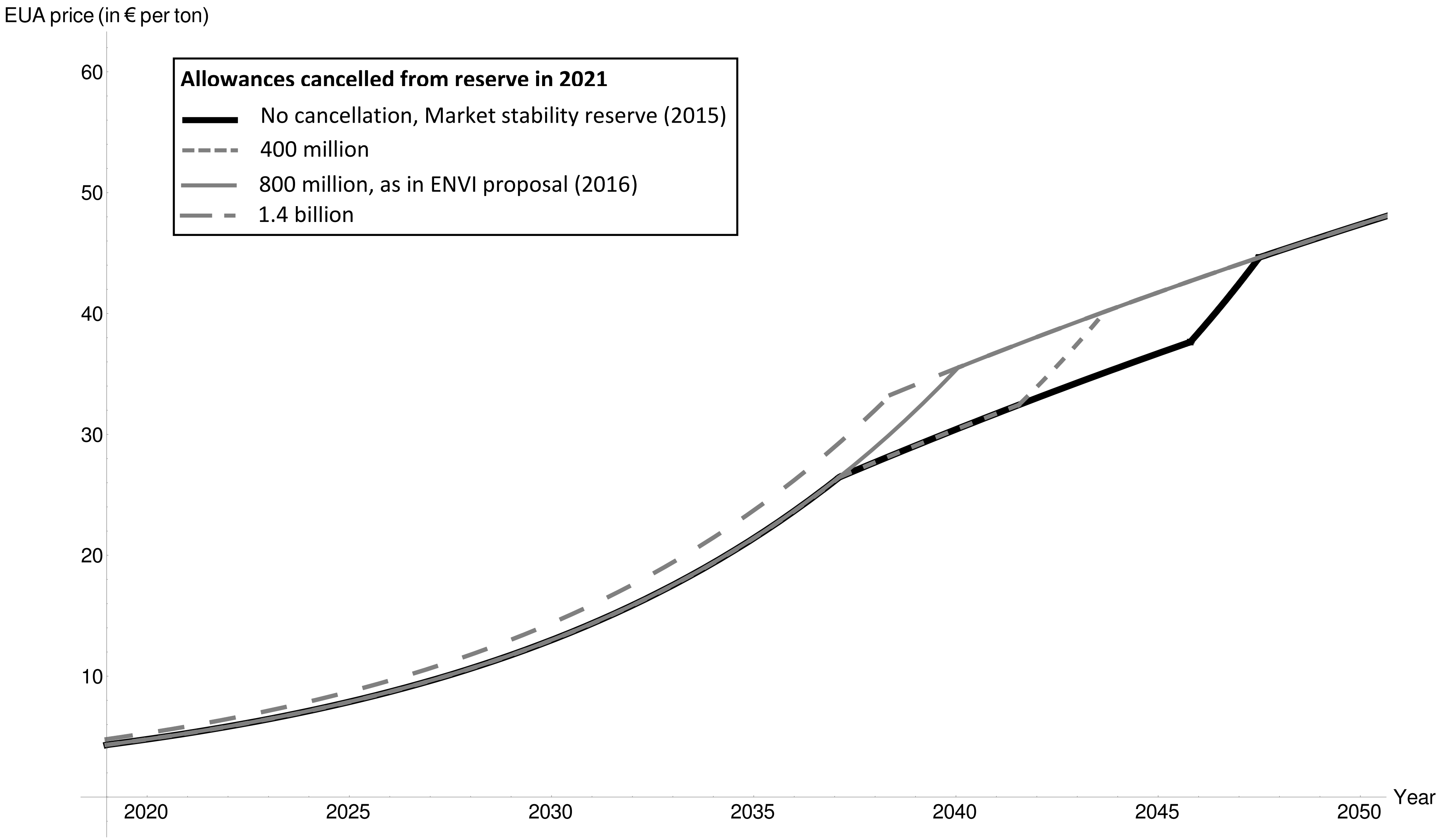

Figure 3: Cancellation of allowances from the market stability reserve.

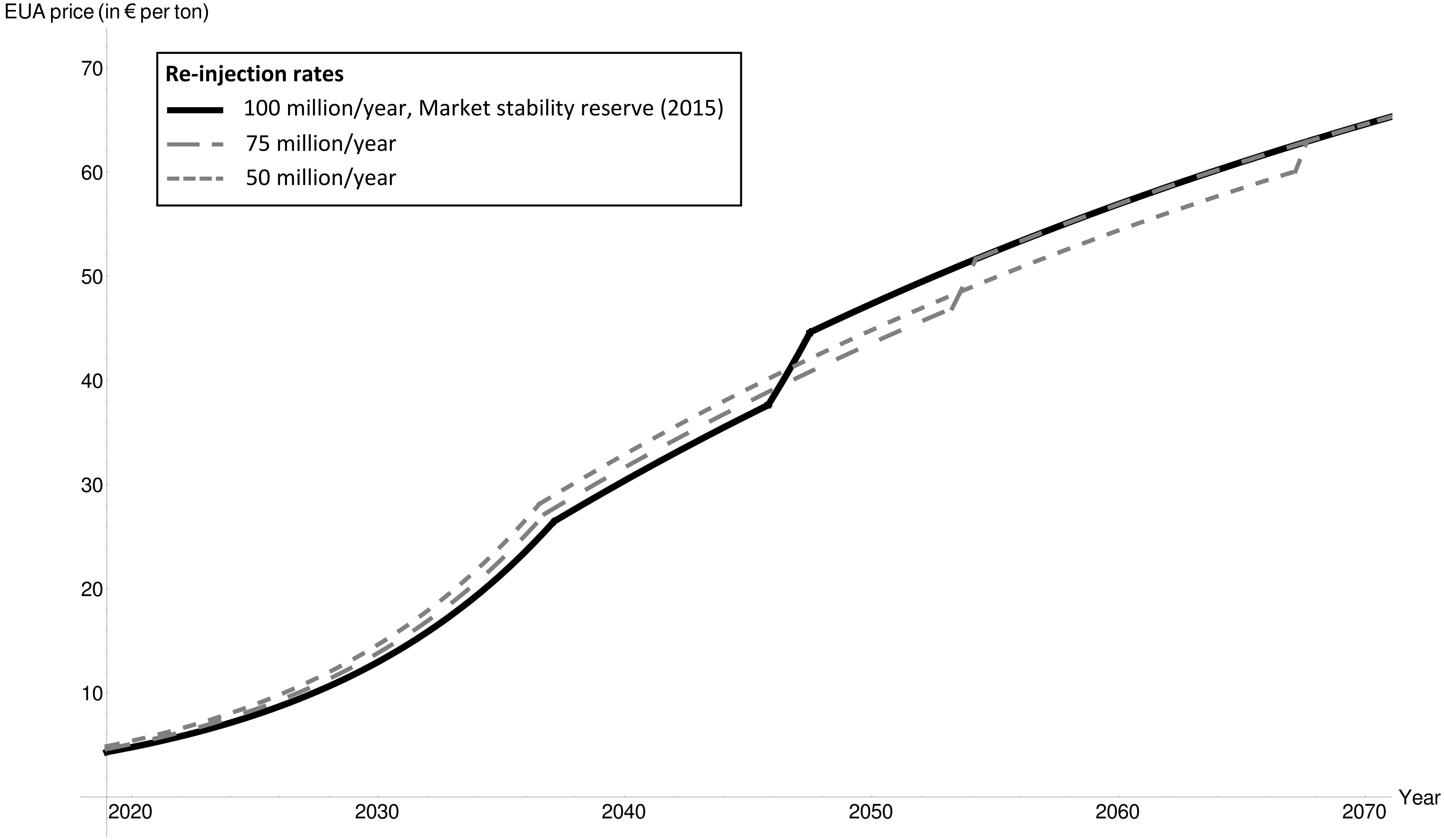

Figure 4: Reduction of the re-injection rate.