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Is a Market Stability Reserve likely to improve the functioning of the EU ETS?

Evidence from a model comparison exercise

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Authors

Karsten Neuhoff
William Acworth
Regina Betz
Dallas Burtraw
Johanna Cludius
Harrison Fell
Cameron Hepburn
Charles Holt
Frank Jotzo
Sascha Kollenberg
Florian Landis
Stephen Salant
Anne Schopp
William Shobe
Luca Taschini
Raphael Trotignon

DIW BERLIN

RESOURCES FOR THE FUTURE
THE AUSTRALIAN NATIONAL UNIVERSITY
UNIVERSITY OF OXFORD
ZEW Zentrum für Europäische Wirtschaftsforschung GmbH
Climate Economics Chair
Colorado School of Mines
Grantham Research Institute on Climate Change and the Environment
UNIVERSITÄT DUISBURG ESSEN
The University of Michigan
University of Virginia
zhaw

About the Authors

Karsten Neuhoff
German Institute for Economic Research, (DIW Berlin)
William Acworth
German Institute for Economic Research, (DIW Berlin)
Regina Betz
Zurich University of Applied Sciences
Dallas Burtraw
Resources For the Future
Johanna Cludius
Zurich University of Applied Sciences
Harrison Fell
Colorado School of Mines
Cameron Hepburn
University of Oxford
Charles Holt
University of Virginia
Frank Jotzo
Australian National University
Sascha Kollenberg
University of Duisburg Essen
Florian Landis
Centre for European Economic Research
Stephen Salant
University of Michigan
Anne Schopp
German Institute for Economic Research, (DIW Berlin)
William Shobe
University of Virginia
Luca Taschini
Grantham Research Institute on Climate Change and the Environment
Raphael Trotignon
Climate Economics Chair, Paris Dauphine University.

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Table of Content

EXECUTIVE SUMMARY
1. Our approach 1
2. The efficient carbon abatement pathway 2
2.1. Inter-temporal optimisation 2
2.2. Flexibility 2
2.3. Securing investment (price credibility and consistency) 2
2.4. Guiding transformation 3
3. Why the EU ETS may not deliver the efficient carbon abatement pathway 4
3.1. Problem I: Limited banking at social discount rate 4
3.2. Problem II: Regulatory credibility and myopia 6
3.3. Problem III: Imperfect response to uncertainty and complexity 6
3.4. The role of regulatory uncertainty 7
3.5. Modelling market and regulatory failures 7
4. Can an MSR move the EU ETS closer to the optimal abatement pathway? 10
4.1. Performance indicator 1: Efficiency 11
4.2. Performance indicators 2 & 3: Securing investment (price credibility and consistency) 12
4.3. Performance indicator 4: Transformation 15
4.4. Performance indicator 5: Robustness to shocks 16
4.5. Sensitivity to different assumptions on input parametrisations 18
5. Design considerations for an MSR 21
5.1. Setting the price corridor in a price based MSR 21
5.2. Setting the quantity trigger levels in a quantity based MSR 21
5.3. Adjusting the injection rates 22
5.4. The French Proposal 23
5.5. Price levels observed in modelling results 24
6. Conclusions 26
REFERENCES 28

EXECUTIVE SUMMARY

In January 2014 the European Commission proposed the introduction of a Market Stability Reserve (MSR) to improve the functioning of the European Union Emissions Trading System (EU ETS). According to the European Commission, the MSR is designed to adjust the EU ETS to supply-demand imbalances and protect the system from unexpected and sudden demand shocks and by doing so, ensure an efficient abatement pathway for the long-term decarbonisation of the European economy (European Commission, 2014).

We explore what market and regulatory failures could inhibit the functioning of the EU ETS and result in deviations from the efficient abatement pathway. Different research teams explore the implications of potential market and regulatory failures and/or inefficient responses to incomplete or complex information. Simulation models show that each of these factors can result in deviations from the efficient abatement pathway, and that an MSR can restore some of the lost efficiency. In considering MSR designs, an Early Start MSR (2017) with the back-loaded allowances placed directly into the reserve is shown to improve the performance compared to an MSR implemented in 2021. Laboratory experiments with human subjects show the importance of the quantity trigger levels and point to the necessity of review provisions for adjustments in the early 2020s to ensure private banking requirements can be met.

While the European debate is focused on a quantity based MSR, other emission trading mechanisms have implemented MSRs with price triggers. Our analysis in simulations and laboratory experiments confirms that a price based MSR can improve the functioning of the EU ETS, if the price collar can be set in line with the price trajectory of an efficient abatement pathway.

Additional aspects need to be considered in the choice of price or quantity based triggers for an MSR. The trigger definition requires information in the case of a price based MSR on the marginal abatement cost curve and in the case of a quantity based MSR on the allowance volume desired by market participants for hedging purposes. Information about prices and quantities remain uncertain, which is the explicit motivation for an MSR to align economic expectations, behaviour and investments with policy objectives. However, modelling can provide information about both expected prices and quantities.

Given the current surplus, the precise trigger levels for the MSR proposal of the European Commission and the United Kingdom/German proposal will only be of relevance in the early 2020s. This allows for a review process of the trigger levels informed by data gathered under the European Union Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) Directive. The Directive requires reporting of all energy contracts, and provides a robust evidence base for updating of the trigger levels.

The results in this report have been distilled from an international model comparison exercise combining empirical analysis, numerical simulations and experimental studies. The project brought together a research consortium involving researchers from twelve institutions from Australia, Europe and the United States. Each modelling team brings a unique perspective on the EU ETS, allowing for new insights to emerge from both within and across the institutions involved. Combining the insights emerging from several models we explore: (i) which criteria can be applied to assess the functioning of the EU ETS and the efficient abatement pathway; (ii) potential market and regulatory failures that could limit the

performance of the EU ETS against these criteria; and (iii) provide a quantitative evaluation of the EU ETS as well as the impact of different MSR design options under a variety of possible market conditions.

Is an MSR necessary?

In the absence of market failures, classical theory of emission trading mechanisms states that the temporary removal of allowances with an MSR would either have no effect or a potentially negative effect on the EU ETS. Allowances stored in the MSR will result in an equivalent reduction of banking by market participants and thus not impact prices and abatement efforts. However three potential market or regulatory failures can reduce the efficiency of inter-temporal smoothing by market participants, including: a limited capacity for market participants to bank emission permits at social discount rates (Neuhoff et al., 2012), problems with regulatory credibility, modelled as myopia and an excessive focus on the short term by market participants (Taschini et al., 2014) as well as an imperfect response to uncertainty and complexity (Trotignon et al., 2015). Market simulations with human subjects furthermore allow us to assess key features of the EU ETS without specific assumptions about market failures to provide additional insights on potentially unexpected market responses.

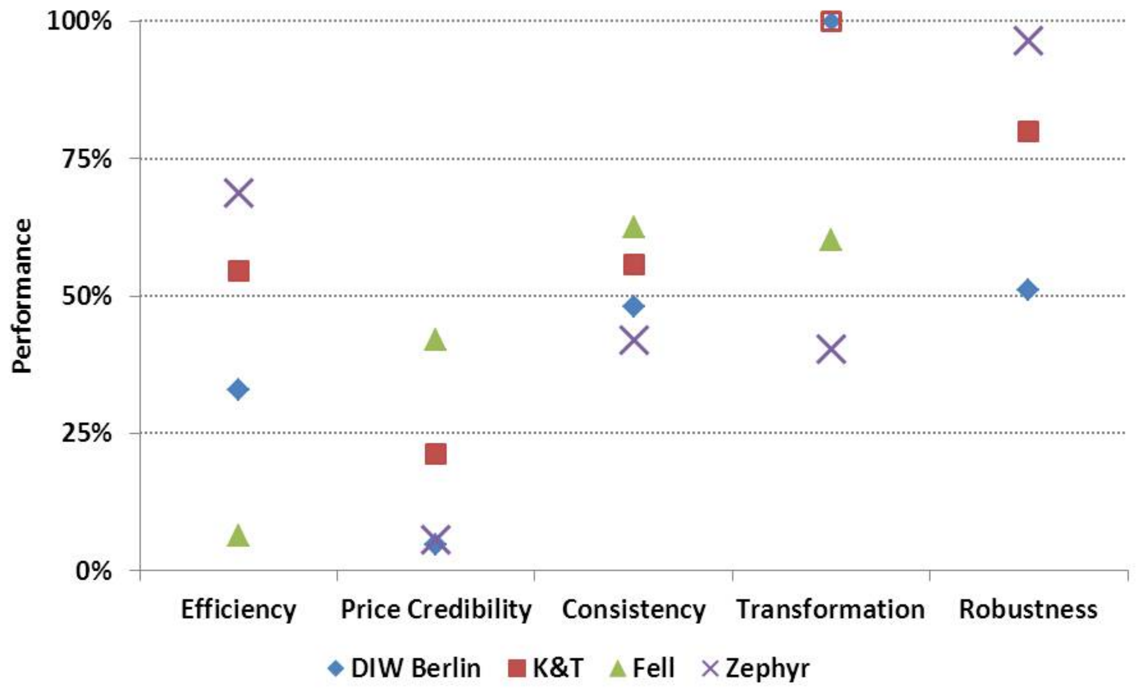
Economic policy should aim to reduce regulatory uncertainty as regulatory uncertainty increases the impacts of each of the market failures. An early commitment to 2030 emission reduction targets that are consistent with long-term mitigation objectives is therefore valuable. However, regulatory uncertainty is inherent and impossible to eliminate, not least because an essential component of democracies is the freedom of new governments to make new decisions. Hence it is warranted to also explore whether it would be necessary and possible to compensate for market or regulatory failures with a MSR. To investigate the significance of market or regulatory failures and the effectiveness of different MSR designs in compensating for these failures, we use the indicators detailed below.

- **Efficient abatement pathway (Efficiency)** - the degree to which emissions are reduced in a cost effective manner, measured as the degree to which a market exhibits inter-temporal optimisation by the net present value of the aggregated abatement costs adjusted for the value of the allowances held in the reserve at the end of the modelling period (2050).
- **Price Credibility** - the degree to which the EU ETS fosters mid to long term investment is affected by the stability of the carbon price, which is measured as the closeness of the carbon price growth rate to the social discount rate averaged across the modelling period.
- **Consistency** - price trajectory consistent with market participants' and policy makers' expectations, measured as deviations of realised price or mitigation effort from expected price and expectations ten years earlier.
- **Transformation** - whether the EU ETS is on track towards the long-term trajectory, measured as the ratio of emissions to the permit cap in the final years of the modelling horizon.

- **Robustness** - ability to respond to external shocks and uncertainty, measured again as the degree to which the model exhibits efficient inter-temporal optimisation (net present value) in the face of an external shock (for example an economic crisis).

We calibrate the indicators so that 0 per cent performance corresponds to no inter-temporal optimisation with carbon prices and abatement effort in each year set to match annual supply of allowances. 100 per cent performance corresponds to an optimal abatement pathway with carbon prices increasing at the social rate of discount assumed to be 3 per cent.

Figure 1: Quantitative impact of potential EU ETS market failures across key performance indicators.



Note: Being stochastic in nature, robustness is treated separately in the Fell model.

While the results differ across models, Figure 1 indicates that market and regulatory failures do indeed impede the efficient functioning of the EU ETS across key performance criteria. Therefore, policy intervention may be warranted to enhance inter-temporal price smoothing and in doing so, improve the functioning of the EU ETS.

How should the MSR be best designed?

The model comparison study was focused on three basic design choices including: the European Commission proposed MSR (EC MSR), an Early Start MSR (including direct transfer of back-loaded allowances) and a Price Based MSR. Results for the three main indicators are presented below. The main body of the report also depicts the remaining indicators, assessment of further design options and a sensitivity analysis.

European Commission proposed MSR (EC MSR)

The European Commission's proposal envisages an implementation in 2021 with an upper threshold of 833 million Allowances in Circulation (AiC) and a lower threshold of 400 million AiC. Withdrawal set at 12 per cent of AiC and injection set at 100 million allowances.[1]

Efficiency

With the EC MSR, all model runs get closer to an efficient abatement pathway. Thus on average across the models almost two thirds of the efficiency losses from market failures can be avoided.

Price Credibility

The EC MSR proposal encourages market participants to bank more efficiently and thus reduces the slope of the carbon price trajectory. Thus today's carbon price is more credible for investors.

Robustness

We test robustness of the MSR against a negative non-persistent economic shock, where emissions are reduced by 20 per cent between 2030 and 2034. The MSR increases the inter-temporal flexibility of the EU ETS making it more responsive and robust to exogenous shocks.

Additional insights

The laboratory experiments illustrated that if the upper trigger level of a quantity based MSR is set below the level of desired banking volume of market participants, then they change their bids and their production decisions to help maintain their private bank of allowances. This behaviour increases the surplus while at the same time the MSR attempts to reduce the available allowances resulting in carbon prices above the efficient abatement pathway.

Interviews with market participants support the experimental findings, suggesting that they aim to bank allowances (or equivalently hold derivatives) to hedge emission costs linked to production sold on contract. Simulation model results suggest that if the upper trigger level of

[1] The proposed price trigger, set in line with Article 29a (If, for more than six consecutive months, the allowance price is more than three times the average price of allowances during the two preceding years on the European carbon market) was considered ex post.

the MSR is set above the hedging needs, then the effectiveness of the MSR in delivering an efficient abatement pathway is significantly reduced.

Considering the results together, the trigger levels for an MSR are an essential design feature. If trigger levels are set too high the MSR will be in-effective, if they are set too low they can create some volatility. Given the current surplus, the precise trigger levels will only be of importance in the early 2020s. As such, policy makers have some space to learn from the market and update the trigger levels through the envisaged review process. The REMIT Directive will ensure the reporting of hedging contracts, and should therefore be used as basis for the future updating of trigger levels.

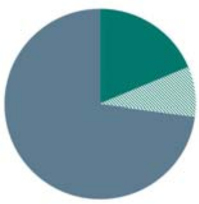
Early Start MSR

In reaction to the European Commission proposed MSR, the United Kingdom and Germany have argued in favour of a mechanism which starts earlier (2017) and places the back-loaded allowances into the reserve (Early Start MSR).

Efficiency

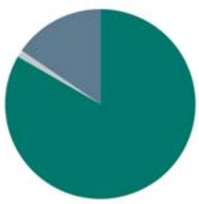
When compared to the EC MSR, the Early Start MSR further reduces deviations from the efficient abatement pathway. The additional improvement of the reported indicator seems modest as the indicator assesses the entire period 2014 to 2050 while the benefits of an Early Start MSR are focused on the years prior to 2030. In addition carbon prices and thus abatement effort and total savings are lower than in the later years. Over the next decade, the Early Start MSR delivers significant improvement when compare to the EC MSR.

Price Credibility



The Early Start MSR significantly improves the carbon price credibility of the EU ETS particularly over the next decade compared to the EC MSR across all models. The results remain significantly below the theoretical benchmark of full alignment of expectations and realised price.

Robustness



The robustness of the Early Start MSR is also tested against a negative non-persistent economic shock, where emissions are reduced by 20 per cent between 2030 and 2034. Compared to the EC MSR, the earlier start of the MSR has only limited impact on these later years. Hence the robustness indicator is on average only marginally affected.

Additional insights

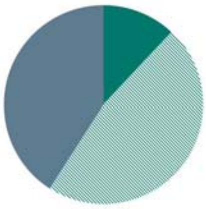
The earlier start of the MSR primarily impacts the next decade and during this period not only enhances efficiency of the abatement pathway and price credibility, but also the consistency of the carbon price with the expected price. Thus, it can enhance the European investment framework.

Price based MSR

The European policy debate is currently largely focused on the options within a quantity based MSR, linked to early political choices (e.g. proposal by European Commission and decision of European Council) that were guided by compatibility with European Union environmental legislation and political acceptability. Such constraints are not present in other regions and might not be permanent in the European context. Hence the model comparison exercise also explored possible design options of a price based MSR.

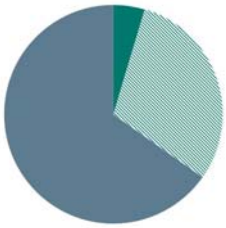
We initially tested a price based MSR implemented in 2021 with a trigger price of €10/CO_2 per tonne increasing at 5 per cent a year. As this had little effect on market outcomes, some models also assessed a trigger price starting at €20/CO_2 in 2021. The soft price cap, set in line with Article 29a of the EU ETS Directive was not triggered in any of the runs.

Efficiency



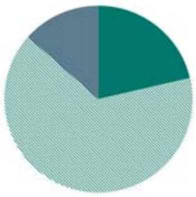
A price based MSR with a low price trigger was only triggered briefly in early 2020s and thus could recover only little of the efficiency losses caused by market failures. If the optimal abatement pathway is known and a trigger price can be set closer to this pathway, then the price based MSR would shows higher efficiency gains.

Price Credibility



The price based MSR with a low price floor had little effect on the market outcome and thus also on price credibility of the EU ETS. In contrast – a price based MSR with a trigger closer to the efficient abatement pathway can move the price path closer to the efficient and credible trajectory. It is often argued that a price based MSR avoids a repetition of the previously observed price volatility and thus enhances the credibility of the emission trading system for investors. This broader aspect of price credibility is not modelled in our analysis.

Robustness



The impact on the robustness of a price based MSR crucially depends on the right parametrisation. Too low a trigger price has – according to the simulations – limited impact on outcomes and robustness, while a trigger price closer to the price level of an efficient abatement pathway can also enhance robustness.

Additional insights

In the experimental study the price based MSR maintained prices (as to be expected) in the designated range. Within the experiments, given that prices usually did not move close to the price floor, concerns that a price based MSR would deliver carbon prices close to the reserve price and thus would equal a carbon tax were not confirmed. Alterations in auction quantities, which occur due to withdrawals of unsold allowances at the reserve price and injections from the MSR at the price cap, were infrequent. This suggests that the credible announcement of a price collar can guide price expectations of market participants. It can encourage additional banking at prices in the lower range of the price collar and contribute to less banking at prices in the higher ranges of the price collar, thus in both instances guiding the price toward the central range of the price collar.

Maintaining a price collar that is not routinely binding may require periodic adjustment of the price band in response to new information on costs of mitigation technologies or a strengthening of abatement effort as part of a global push to reach climate objectives. It needs to be assessed to what extent adjustments of the price collar, even if pursued with a rule based mechanisms, will increase hedging needs as well as regulatory risk associated with holding surplus allowances.

Limitations

The work is constrained by a number of limitations. Firstly, to ensure a common ground across modelling teams, policy options to correct the assumed market failures were limited to stability reserves. In this way, other options such as delegation to a carbon authority or changes to the cap trajectory have been ignored. Secondly, the earlier abatement takes place, the cheaper it is likely to be in the long run given the effect of endogenous technological learning (ETL). In DIW Berlin model runs, the ranking of the results is robust to ETL, however, the potential benefits warrant further investigation. Finally, while captured to a limited extent by the experimental work, we have not formally assessed potential strategic responses to the MSR such as speculative attacks witnessed in monetary policy.

Conclusions

Combining the insights emerging from several models, we find that there are a set of different market failures which can impede the performance of the EU ETS. An MSR does help – in all model runs – to correct for some of the market and regulatory failures. The introduction of a stability reserve with an early start (2017) and the back-loaded allowances placed directly into the reserve improves the performance in all models, when compared to the MSR proposed by the European Commission.

While the European debate is clearly focused on the implementation of a quantity based MSR, we also assessed internationally more common price based MSR designs. Evidence from the analysis suggests that price based MSRs can also improve the functioning of the EU ETS. Strong performance of a price based MSR requires accurate information on marginal abatement costs and a transparent political process for setting the price triggers. In contrast, the performance of a quantity based MSR requires an understanding of the hedging demand and can be severely reduced with too high or too low quantity trigger levels. The quantity based triggers will need to be informed and updated based on market monitoring data on hedging volumes gathered under the REMIT Directive.

1. Our approach

In January 2014 the European Commission proposed the introduction of a Market Stability Reserve (MSR). In October of the same year the European Council expressed support for a policy intervention "in line with" the Commission's proposal. Against this background European Union institutions are now discussing whether and how the MSR should be implemented.

To provide quantitative evidence to the debate we explore: (i) which criteria can be applied to assess the functioning of the EU ETS; (ii) potential market and regulatory failures that could limit the performance of the EU ETS against these criteria; and (iii) provide a quantitative evaluation of the current functioning of the EU ETS as well as the impact of different MSR design options.

The analysis is based on the results of an international model comparison exercise convened by Climate Strategies, funded through the Stiftung Mercator and coordinated by DIW Berlin, with contributing support from Mistra's Indigo Program, Resources for the Future's Center for Energy and Climate Economics, a grant from the United States Environmental Protection Agency and the German Federal Ministry for Economic Affairs and Energy (EUREEM project). The project brought together a research consortium involving researchers from twelve institutions across Europe, the United States and Australia, including: Australian National University, Centre for European Economic Research, Climate Economics Chair of Paris-Dauphine University, Colorado School of Mines, DIW Berlin, London School of Economics and Political Sciences, Oxford University, Resources for the Future, University of Duisburg Essen, University of Michigan, University of Virginia and Zurich University of Applied Sciences. Each team brings a unique perspective on the EU ETS, allowing for new insights to emerge from both within and across the institutions involved.

2. The efficient carbon abatement pathway

The EU ETS was implemented to facilitate trading across installations and through time so as to reduce the cost of climate policy by first adopting lower cost abatement options. By setting targets and allowing the market to drive abatement decisions, the EU ETS promised to overcome concerns surrounding the time inconsistency of short-term policy commitments and provide a credible framework for private sector investors. We identified five criteria to assess whether these objectives have been (or will be) addressed (See Figure 2 below).

2.1. Inter-temporal optimisation

Key to the proper functioning of an emissions permit market is the ability to bank permits such that market participants can make choices whether to abate now or at some point into the future. This is because firms can take advantage of expected future innovations or abate earlier when future abatement costs are expected to increase. Hence, banking allows entities to abate when it is cheapest for them, minimising the cost of emission reductions over the duration of the policy[2]. Under such conditions, an optimal abatement pathway emerges where carbon prices and abatement effort increase at a rate equivalent to the social planner's time preference providing a clear investment framework and ensuring that cumulative emission targets are achieved at least cost (Hasegawa and Salant, 2015; Fankhauser and Hepburn, 2010; Leiby and Rubin, 2001; Rubin, 1996)[3].

2.2. Flexibility

Price volatility in pure quantity based carbon markets may be excessive as the supply for carbon permits is fixed and therefore unable to respond to changes in price. As such, external shocks such as economic recession or technological development can have strong price effects. Allowing flexibility with respect to when emission reductions occur improves the robustness of a permit market as the impacts of the shock are spread through time, reducing price volatility and improving welfare. Consequently, we should expect that a policy that limits banking may increase price volatility (Shobe, Holt and Huetteman, 2014). In addition to banking, policies that allow the supply of allowances to adjust to large unexpected changes in prices can reduce the volatility of price shocks.

2.3. Securing investment (price credibility and consistency)

As well as driving efficient operational decisions, permit markets must steer capital towards low-carbon investments and innovations. This requires that permit markets reveal a clear, credible and consistent carbon price signal over a period relevant to investment decisions. Increased price volatility increases the riskiness of investment and, hence, may tend to

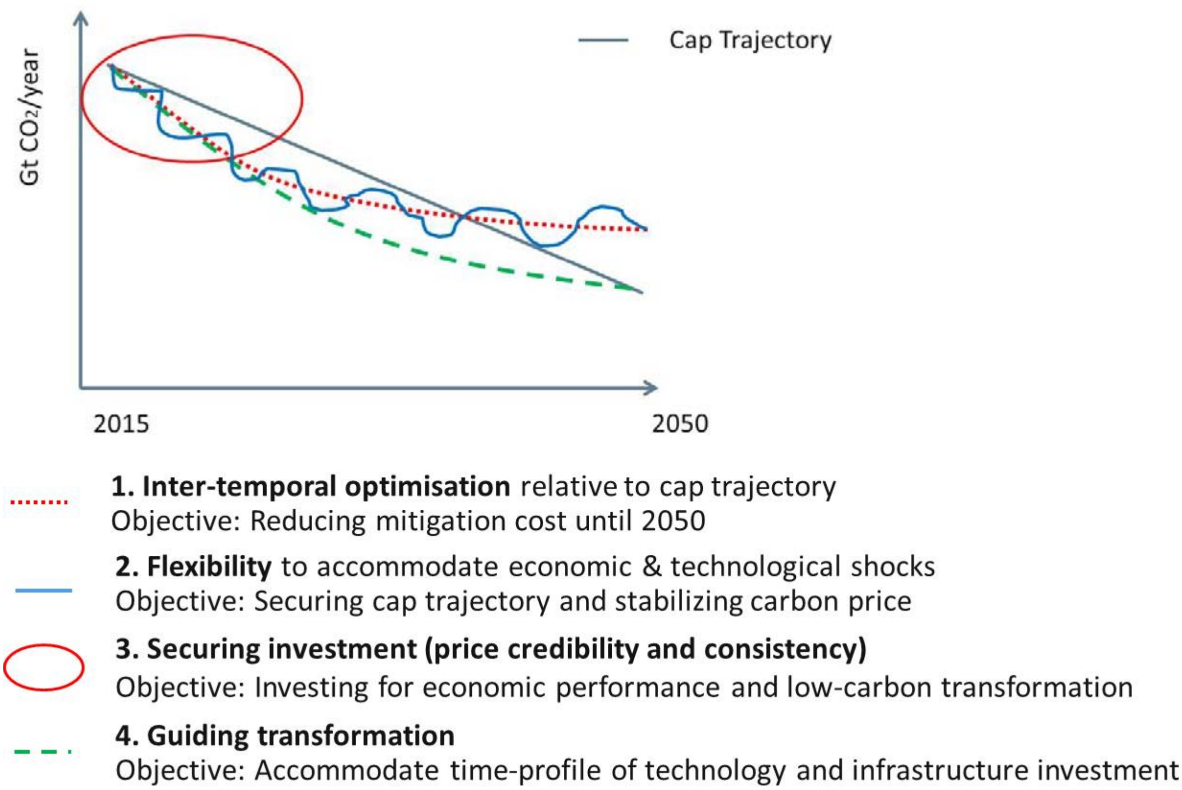
[2] In principle borrowing could further enhance efficiency – in practice with all our parametrizations the no borrowing constraint has not been binding, and extensive borrowing opportunities are seen to increase regulatory risk and undermine environmental integrity.
[3] While carbon prices and abatement costs will increase at the social planner's time preference, abatement effort need not.

reduce investment in low-carbon technologies. Moreover, if the short-term price signal differs significantly from long-term objectives, the investment signal is blurred creating a number of problems. First, in an economy where economic agents have limited foresight, if initially depressed carbon prices later increase steeply, early cost effective abatement opportunities may be ignored. Second, delayed abatement also slows technology learning reducing the scope of abatement options over the medium term. Third, most firms put more weight on the current carbon price for strategy and investment choices than on longer-term price expectations for which liquid forward markets do not exists and prices are subject to inherent uncertainty (Martin et al., 2011). As such, current carbon prices below the efficient abatement pathway may misguide strategic investment choices and potentially lock Europe into carbon intensive capital. We measure the ability of an emissions trading scheme to secure investment with two indicators: price credibility and consistency (described in Section 3).

2.4. Guiding transformation

Banking can reduce the cost of abatement during the long-term transition to a low-carbon economy. Model assessments thus need to avoid boundary effects like the return of large volumes of allowances from a stability reserve in the last modelling years prior to 2050. This would correspond to a carbon intensive economy, which could hardly shift to a low-carbon economy in 2051.

Figure 2: Four criteria to assess the efficient abatement pathway



3. Why the EU ETS may not deliver the efficient carbon abatement pathway

If there were no failures in the EU ETS, or in related markets, the EU ETS could be expected to deliver an efficient abatement pathway without needing an MSR. In the presence of existing market and regulatory failures, however, the EU ETS is unlikely to deliver an effective abatement trajectory. It could conceivably be improved upon by an MSR. In this section, we first explore three potential market and regulatory failures to assess their impact on the performance of the EU ETS. A key element enhancing the effect of the failures is regulatory uncertainty. As we discuss at the end of this section, it is the nature of government choices to remain discretionary and hence regulatory uncertainty can be reduced but not eliminated (Brunner et al., 2012). The subsequent sections explore whether interventions to compensate directly for the market failures through an MSR are effective.

The problems that could inhibit inter-temporal price smoothing include: a limited capacity for market participants to bank emission permits at social discount rates (Neuhoff et al., 2012), myopia and an excessive focus on the short term, for instance because of longer term credibility problems (Taschini et al., 2014) and incomplete information and foresight (Trotignon et al., 2015). The views of the various authors are not mutually exclusive and multiple effects can be present.[4]

3.1. Problem I: Limited banking at social discount rate

In many models of emission markets, actors are able to bank an unlimited number of permits at constant discount rates (Bosetti et al., 2009; Leiby and Rubin, 2001). Assessments of the EU ETS often assume that surplus allowances are banked at real discount rates in the order of 3 – 5 per cent irrespective of the scale of surplus (Bosetti et al., 2009; DECC, 2009; European Union, 2008; Ellerman and Montero, 2007). This assumption is contrast with evidence from other commodity markets (Bessembinder, 1992; Wang, 2001) and comprehensive interviews among companies involved in the EU ETS (Neuhoff et al., 2012). Two different types of actors are identified with differing banking strategies. First, actors that bank permits at low discount rates as hedge for future compliance such as power firms and large industrial emitters. Second, actors that bank permits for speculative investments like private banks or hedge funds that buy or sell permits or forward contracts as an investment if they meet their risk-return requirements.

At low levels of permit surplus, power firms and industry hold permits as part of specific hedging strategies to meet their compliance needs. Anecdotal evidence suggests that compliance entities discount future permit prices at a rate of about 5 per cent per annum (nominal), equivalent to the opportunity cost of capital, for example the cost of carry. However, due to internally established risk management protocols, compliance entities can only adjust their hedging volume to a limited extent in response to profitable opportunities, and thus the capacity to bank at social discount rates is limited (Neuhoff et al., 2012).

[4] We do not explore what might happen if more than one of these market failures were present. In theory, each one could alter the effect of the others.

As such, any additional permit surpluses end up being acquired by speculative investors. Experience from other commodity markets suggests speculators expect returns in the range of 10-15 per cent per annum (Bessembinder, 1992; Wang, 2001). They would thus only acquire allowances if spot prices are sufficiently low compared to their expectations about the price in later years so as to allow for an expected annual price increase exceeding 10-15 percent. If these speculators are at the margin the carbon price trajectory will deviate significantly from previously assumed price trajectories based on discount rates of a social planner and will not result in a (socially) efficient abatement path. Regulatory risk in carbon markets contributes to the high return requirements by speculative investors. High return requirements in other commodity markets suggests that regulatory risk is however not the only driver. Increasing familiarity and confidence with an established emission trading system should over the longer-term reduce return requirements.

The perspective that high discount rates are applied to carbon prices expected for future years seems initially inconsistent with the relative modest price increase at which future contracts are traded. As part of this project Betz et al. (2015) pursued semi-structured interviews and analysed data from the European Union Transaction Log (EUTL)[5,6]. The authors find that banks (they constitute the biggest buyer)[7] and other financial actors buy allowances from industry and European Emission Allowance (EUA) auctions and sell forwards or futures to electricity generators. Electricity generators use allowance derivatives to hedge power forward sales. They acquire futures rather than EUAs in auctions or on the spot market due to higher capital costs and financial liquidity restrictions. Most of these transactions are carried out by dedicated trading accounts, rather than the accounts of individual installations. Banks and financial actors pursue cost of carry arbitrage and thus do not face carbon price risk.

These observations could explain the low discount rates at which future contracts are offered and provide a direct link to the spot price. As long as financial actors' offer of future contracts backed by allowance holding sets the price of future contracts on CO_2 allowances, this price might be below the price expected by market participants. In theory such a difference between forward price and price expectations is eliminated by arbitrage. However, such arbitrage involves an open position on the carbon price and will thus only be pursued as long as expected benefits (remaining expected price difference) exceed the risk incurred with the open position. This would therefore be consistent with an increase of spot carbon prices over time significantly exceeding the price at which allowances are traded in forward and future contracts.

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[5] Formerly Community Independent Transaction Log (CITL).

[6] The EUTL is an electronic database managed by the European Commission that records all transactions of European Union Allowances (EUAs), Certified Emissions Reductions (CERs) and Emissions Reduction Units (ERUs) carried out under the EU ETS, including the allocation and surrendering of allowances, but also all trades taking place between market participants. The data is published with a delay of five years, which is why in this analysis we focussed on data covering the whole first trading period (January 2005 – April 2008, as companies have to submit by the April of the following year).

[7] Following new requirements from the Markets in Financial Instruments Directive (MiFID), many banks have closed down their commodity trading desks (not just for carbon) and other companies take over “trading” from banks as they do not face the same level of financial regulation.

3.2. Problem II: Regulatory credibility and myopia

Taschini et al. (2014) also question the assumption of constant and low discounting in the EU ETS, albeit for a different reason. While they assume constant and low discounting may take place over the short term (five years), they argue that subsequently discount rates increase due to an insufficient regard of market participants for long-term strategy. This could also reflect the fact that market participants do not believe that the EU ETS will continue to function in the same form into the 2020s. The longer the time horizon considered the greater are particularly regulatory uncertainties, for example surrounding international climate agreements, but also uncertainties about technological developments. As organizations will struggle to fully account for such uncertainties, they focus on the immediate planning horizon and discount future years heavily.

Under such conditions, the price will not be determined by the long term demand supply balance, but will rather be dictated by the short term balance. Hence a large short term surplus could disproportionately depress current carbon prices as private market participants might not consider the value of allowances in the longer-term and thus not bank sufficient allowances and as a result not deliver an efficient abatement pathway. In this setting, policies such as the proposed MSR, could complement insufficient private banking and thus, in principle, improve long-run outcomes. Thus the MSR could provide additional inter-temporal flexibility moderating the impact of economic shocks by distributing the response over longer periods than the myopic horizon of market participants.

3.3. Problem III: Imperfect response to uncertainty and complexity

Market participants must base their decisions on detailed knowledge of the operations of the EU ETS, the economic sector being regulated and to some extent the expected behaviours of other scheme participants. Such knowledge must be gained from experience with the scheme and is unlikely to be evenly distributed across firms or sectors. Regulatory uncertainty is often stated to be of particular complexity for carbon market participants, not least because of the multiple actors involved in regulatory decisions. This includes actions by policy makers in member states as well as at a higher level in the EU ETS. These factors contribute to the difficulty in gaining experience with regulatory uncertainty.

Given all the complexity and uncertainty, it is likely that market participants will "imperfectly" respond. For the implementation of computational models such imperfect response needs to be specified. One specific imperfect response is a myopic behaviour that has captured sufficient attention to warrant a separate discussion (Problem II). Trotignon (2014) implements a further example of imperfect response in his model – namely that firms do not estimate future emissions but proxy future emissions with today's emissions.

Holt and Shobe (2015) pursue laboratory experiments to explore further options of imperfect response to uncertainty and complexity. Laboratory experiments offer the advantage that no assumptions need to be made about particular imperfections in agent decision-making, rather, participants must make their best decisions in an environment with considerable uncertainty about the future scarcity of allowances and about the behaviour of other market participants. Experimental subjects were informed about a declining cap, and the need to acquire allowances for production. Similar to power production to the extent that some portion of it is already contracted forward, subjects were informed that the price at which they can sell production will not change in response to carbon prices. However, participants did face an overall output price uncertainty in the order of 20 per cent.

3.4. The role of regulatory uncertainty

Regulatory uncertainty is a key driver for all three types of market failures, as both the impact of future regulatory choices and their likelihood is difficult to assess and predict for market participants. Regulatory uncertainty is being reduced with the definition of energy and climate policy targets for 2030 (European Council October 2014), but some uncertainty remains as future governments have the democratic legitimate right to make new decisions. However, regulatory uncertainty and credibility of the system are closely related to any discussions on reforms and interventions (Zetterberg et al., 2014). Lessons from the monetary policy and regulated commodity markets (for example gold or wheat) suggest that policy debates that have the potential to cause market turmoil need not necessarily be held in public. Furthermore, given the political setting, avoiding situations that will make policy makers dissatisfied with the performance of the EU ETS can also reduce the risk of future unexpected policy interventions and regulatory uncertainty.

Experience with the EU ETS has shown the need for adjustments to the mechanisms to respond to learning about design features and policy developments for example on allocation rules or use of off-set credits, but also on targets. Such adjustments have been portrayed by analysts as an example of regulatory risk of government interventions while others interpret it as sign of government commitment to an effective scheme. To the extent that the MSR reduces the need for future interventions, it may reduce regulatory uncertainty. However, this aspect of political credibility has not been assessed further in this report.

3.5. Modelling market and regulatory failures

Four numerical models were applied in the model comparison exercise. In addition, a theoretical model was developed to guide the analysis as well as an experimental investigation involving human subjects. Each model has a unique design allowing many different aspects of the EU ETS to be assessed (see Table 1 and Box 1 for a brief overview)[8].

[8] To ensure model uncertainty is represented, each model has a unique parameterisation. However, to better understand the differences across models and what may be driving some results, a “Model Test” was conducted in which a uniform base run was conducted across all models. The results showed that the models were well calibrated.

Table 1: Overview of models used in the analysis

Institute/model	Limited capacity to bank at social discount rates	Myopia	Incomplete or complex information
DIW Berlin (DIW Berlin Model)	X		
The Grantham Research Institute and University of Duisburg-Essen (K&T Model)		X	
Climate Economics Chair (Zephyr Model)			X
University of Virginia[1]	*Experimental*	*Experimental*	*Experimental*
Colorado school of Mines and the University of Michigan (Fell Model)	X		
University of Michigan (Theoretical) [2]	X		X

Notes: [1] The University of Virginia experiments do not assume any particular market imperfections. [2]The teams from the Colorado School of Mines and the University of Michigan worked collaboratively on a theoretical model which was then implemented numerically. The Fell Model runs presented in this chapter were run in line with "a limited capacity to bank at social discount rates". However, results presented in Section 5 present results produced with a uniform discount rate.

Box 1: Overview of models used in the analysis

DIW Berlin Model

A dynamic, deterministic partial equilibrium model of the demand for emission permits in the EU ETS over the time horizon 2008-2050. The model yields a Nash equilibrium in the demand for permits between emitters, hedgers and speculators: emitters can choose to abate and mitigate emissions if it is economically viable given the permit price; hedgers limit their exposure to future permit prices from forward sales of electricity; speculators are looking for inter-temporal arbitrage opportunities. The model can include several different implementations of a market stability reserve as currently discussed with regard to the EU ETS reform. It allows assessing impacts of price and quantity controls on banking volumes and carbon prices as well as responses to economic or policy shocks. For a detailed description of the model, see Schopp et al. (2015).

K&T Model

The Kollenberg and Taschini (KT) model is a stochastic partial equilibrium model in continuous time, solved in closed-form. Companies on the allowance market choose Markovian abatement- and trading strategies to minimize their expected costs under the constraint of compliance at a finite time-horizon. The resulting Nash equilibrium of Cournot type consists of abatement- and trading strategies for all companies and a market-clearing price process. The sources of uncertainty are abatement costs, emissions (before abatement) and allocations, all of which are modelled as stochastic processes. In particular, the model incorporates the impact of an MSR on allocation uncertainty. By means of continuous compounding of future payment flows, the companies' inter-temporal optimization is affected by a market-specific interest rate. Due to the closed-form of the solution, selected scenarios can be considered in terms of realizations of the resulting equilibrium stochastic processes. Furthermore, the model yields distributions for all results along with their expected outcomes. For a detailed description of the model, see Kollenberg and Taschini (2015).

Zephyr Model

The Zephyr model is an EU ETS simulation model based on iterative annual EUA supply-demand equilibriums. It differs from optimization models that would minimize inter-temporal compliance cost over 2014-2050 by representing non-optimal/imperfect compliance behaviour and how they interact with the market design features such as the MSR.

The Zephyr model represents the behaviour of participants through an 'anticipation framework', where market actors look each year at the expected future supply-demand balance over a certain anticipation time-horizon, and react by adjusting their current emission level and banking behaviour accordingly in a dynamic manner. Parameters are included to control the degree of myopia and biases in market actors' expectations and compliance behaviour. Several market imperfections are represented in the model: the knowledge of future costs (inter-temporal costs are not considered in the abatement/banking decisions); participants' limited foresight/myopia (controlled by, the length of the anticipation time-horizon); the potential over/under estimation of future emissions (controlled by, the expected percentage growth of emissions over the anticipation period); and the uncertainty regarding the expected effect of MSR on the cap (built in the anticipation framework representation). For a detailed description of the model, see Trotignon (2015).

For this project, the Zephyr model is run using one representative EU ETS economic sector, with the same MACCs, baseline emissions, and allocation data as the other modelling teams.

Fell Model

The basic framework is a finite-horizon dynamic model in discrete time, where identical firms take the current price and the probability distribution of future prices as given and choose their emissions levels to minimize the expected discounted sum of their abatement costs. Account is taken of various emissions trading rules such as allowance banking and borrowing, allowance price floors and ceilings and offset mechanisms through the effect these policies would have on the endogenous equilibrium price distributions.

As uncertainty is embedded in the model, expected behaviour generated from this model will be inherently different to scenario exploration models that solve emission choices under complete certainty. On top of this general framework, various emissions trading rules such as allowance banking and borrowing, allowance price floors and ceilings, and offset mechanisms can be layered. For a detailed description of the model, see Fell (2015).

Salant Model (Theoretical)

Salant's model shows that, even under certainty, the cap will not be achieved at least discounted cost if permits are sufficiently back-loaded. In the absence of such back-loading, his model shows that the least cost solution will still not emerge if there is an ongoing risk that, at an unknown time, regulations will change and the price will jump. If this jump is on average downward, the model predicts a depressed but rapidly rising spot price as well as a futures price that rises over time as any given contract's delivery date approaches. Changes in the beliefs of market participants about the spot price that will occur after the regulatory uncertainty is resolved are predicted to cause sharp jumps in either direction in the spot price. For a detailed description of the model, see Salant (2015).

The University of Virginia (Experimental)

The University of Virginia approach uses the behaviour of human subjects in a laboratory setting that is designed to reflect important features of the EU-ETS. The laboratory setting includes multiple periods with a declining cap where participants, who are assigned roles of high or low emission intensity, choose production (and hence emission) levels each period. Subjects purchase allowances in a sealed-bid, uniform price auction and my use the allowances or bank them indefinitely into the future. Future production costs and output prices are subject to random shocks, which generate uncertainty over the future value of production and of allowances. The experiments are used to compare performance of parallel series of market conditions run with the EU MSR, an MSR with a price floor and soft cap, and with a baseline of no MSR policy at all. For a detailed description of the analysis, see Holt and Shobe (2015).

4. Can an MSR move the EU ETS closer to the optimal abatement pathway?

According to the European Commission MSR Impact Assessment, the MSR is designed to adjust the EU ETS to supply-demand imbalances to protect the system from “future unexpected and sudden demand shocks”. Furthermore, by maintaining a supply-demand balance, a well-designed MSR is expected to push the carbon price signal in line with the trend necessary to achieve the long-term decarbonisation target in a cost-effective manner (European Commission, 2014).

To achieve these objectives, the MSR is designed to withhold surplus allowances from auction in a reserve and possibly release these allowances in auctions at a later date. Both withholding permits from and returning permits to the market is based on automatic triggers. The European Commission’s proposal envisages a quantity based trigger. If the volume of banked allowances (Allowances in Circulation - AiC) exceeds a threshold, then some allowances are moved into the stability reserve and gradually released if the surplus falls below a second threshold level. In addition to the quantity based trigger, a price trigger also envisages that the MSR releases allowances in case of rapid price increases. The European Commission MSR design in addition to two other design choices as well as a no MSR case is modelled in the comparison exercise – resulting in four policy designs implemented by the computational models, being:

- **The Existing EU ETS without an MSR (No MSR);**
- **The European Commission proposed MSR (EC MSR) –** Implemented in 2021 with an upper threshold of 833 million (AiC[9]) and lower threshold of 400 million AiC. Withdrawal set at 12 per cent of AiC and injection set at 100 million allowances[10];
- **Early Start MSR –** an MSR parameterised as proposed by the European Commission however implemented in 2017 with the back-loaded allowances placed directly in the reserve; and
- **Price Based MSR –** implemented in 2021 with a price floor set at €10/tCO_2 and increasing at 5 per cent per annum. A price cap was set in line with the measures outlined in Article 29a of the EU ETS directive.

In addition to these scenarios, which were agreed to ex ante and implemented by all modelling teams, the modellers also assessed alternative MSR design options and tested the robustness of the results against a variety of parametrisations. These proposals include the French Proposal (DGEC, 2014) and a price based MSR with a higher price floor and a range of different injection and withdrawal rates for the European Commission proposed MSR. These results are discussed in Section 5.

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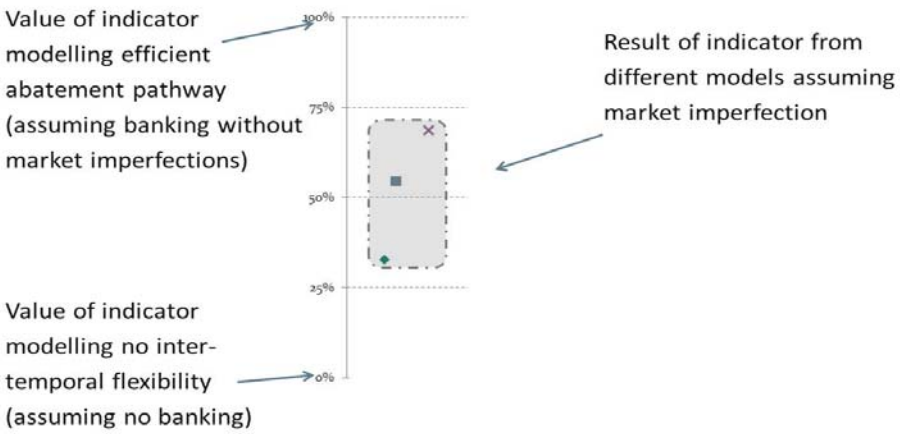
[9] Allowances in circulation are the cumulative number of allowances issued in the period since 1 January 2008 and entitlements to use international credits exercised by installations under the EU emission trading system in respect of emissions up to 31 December of year x, minus the cumulative tonnes of verified emissions from installations under the EU emission trading system between 1 January 2008 and 31 December of year x, any allowances cancelled in accordance with Article 12(4) of Directive 2003/87/EC and the number of allowances in the reserve (Commission 2014).

[10] The price trigger was not triggered in the model runs (Article 29a: If, for more than six consecutive months, the allowance price is more than three times the average price of allowances during the two preceding years on the European carbon market).

The analysis complements an extensive literature on price versus quantity based instruments that aimed to achieve efficient policy design in the presence of uncertainty (Stavins, 1996; Weitzman, 1974). Later this literature was extended to understand strategic choices of emission reduction trajectories, the impact on investment decisions of reserve prices (Wood and Jotzo, 2011), as well the benefits of price quantity hybrid schemes in a dynamic setting (Fell and Morgenstern, 2010; Fell et al., 2012; Burtraw et al. 2010). The novel part of the analysis presented here is the assessment of different policy instruments designed to reduce the effective supply of allowances in the short to medium term while not changing the aggregate supply of allowances below the cap now in place.

The MSR design options where compared and contrasted across EU ETS performance indicators within a scale set by two extremes: (i) no market failures such that the price path follows Hoteling's rule [11] (representing a score of 100) and (ii) zero inter-temporal optimisation such that prices are dictated by annual demand supply balances (representing a score of zero) (see Figure 4 below). The results of the analysis are discussed in the sections that follow.

Figure 4: Scaling of the MSR comparison indicators

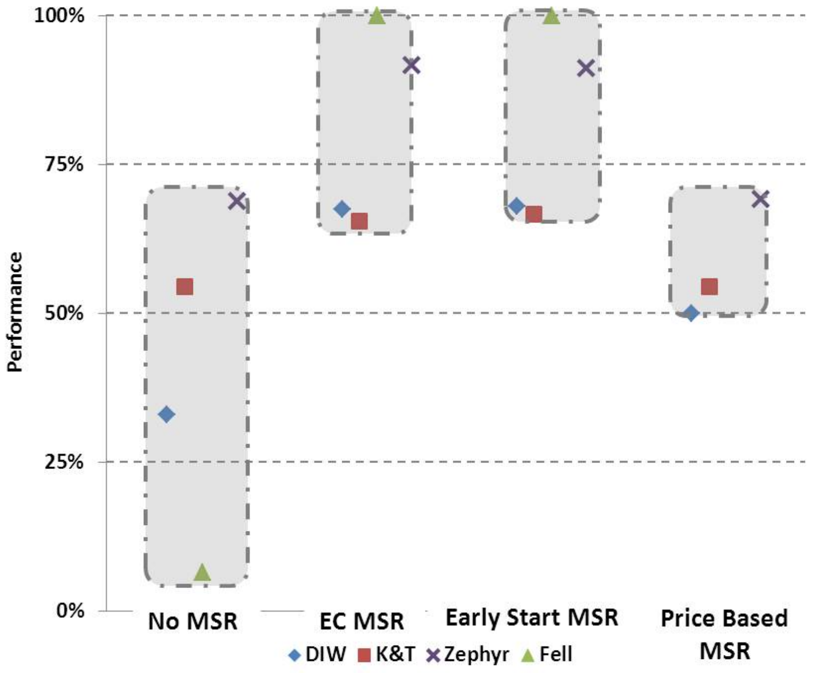


4.1. Performance indicator 1: Efficiency

Inter-temporal optimisation allows participants to distribute their abatement efforts through time to minimise abatement costs. Hence we measure the degree to which a market exhibits inter-temporal optimisation by the net present value of the aggregated abatement costs. To avoid end-of period effects we subtract from the abatement costs the value of the allowances held in the reserve at the end of the modelling period (2050). We value the allowances based on the average discounted carbon price between 2030 and 2050. The ranking of the different MSR options across the models was largely robust to valuing the allowances at 2050 prices only.

[11] A three per cent real interest rate was assumed.

Figure 5: Efficiency criterion



Note: The criteria is bound by 0 and 100 per cent, however, in some model runs by Fell performance above 100 per cent results from the treatment of accumulated allowances in the reserve in 2050 and the price based MSR was not implemented.

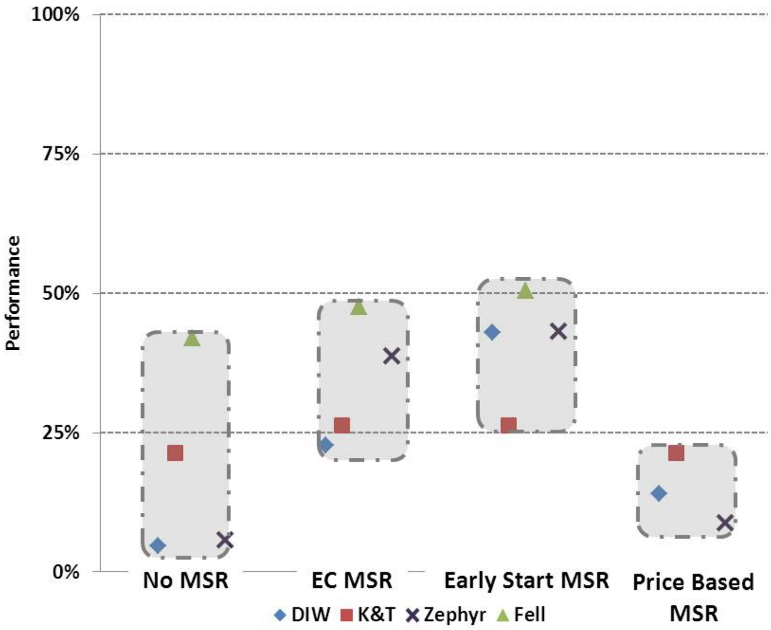
All market failures modelled in the exercise reduce the efficiency of the EU ETS below the performance that would be achieved with banking at social discount rates (100% mark) but still above the performance of a EU ETS without the possibility for any banking or inter-temporal arbitrage (0% mark) (Figure 5).

In all of the simulation models of market failures, the EC MSR and Early Start MSR can improve outcomes and move the system closer to an efficient abatement path. The relatively low price floor starting at 10 Euro in 2021 only had a very limited impact on supply-demand balance and abatement trajectory and thus resulted in less of an improvement compared to the quantity based adjustment mechanisms in the simulation runs. We pursued additional simulation runs described in Section 5 that showed that the price base trigger needs to be set close to the optimal abatement pathway to achieve a performance improvement that exceeds that of the quantity based MSRs tested here, although this does not appear to be as true in the experimental sessions.

4.2. Performance indicators 2 & 3: Securing investment (price credibility and consistency)

The impact of the EU ETS on investments will depend on perceived price credibility and consistency. We measure price credibility as the alignment of today's spot price with the carbon price that is relevant during the years over which investors will recover their investment costs. If instead carbon prices are projected to increase at a steep rate, then investors tend to question the price credibility of a projection that assumes a significantly stronger commitment to carbon prices by future policy makers than by today's policy makers.

Figure 6: Price Credibility criterion



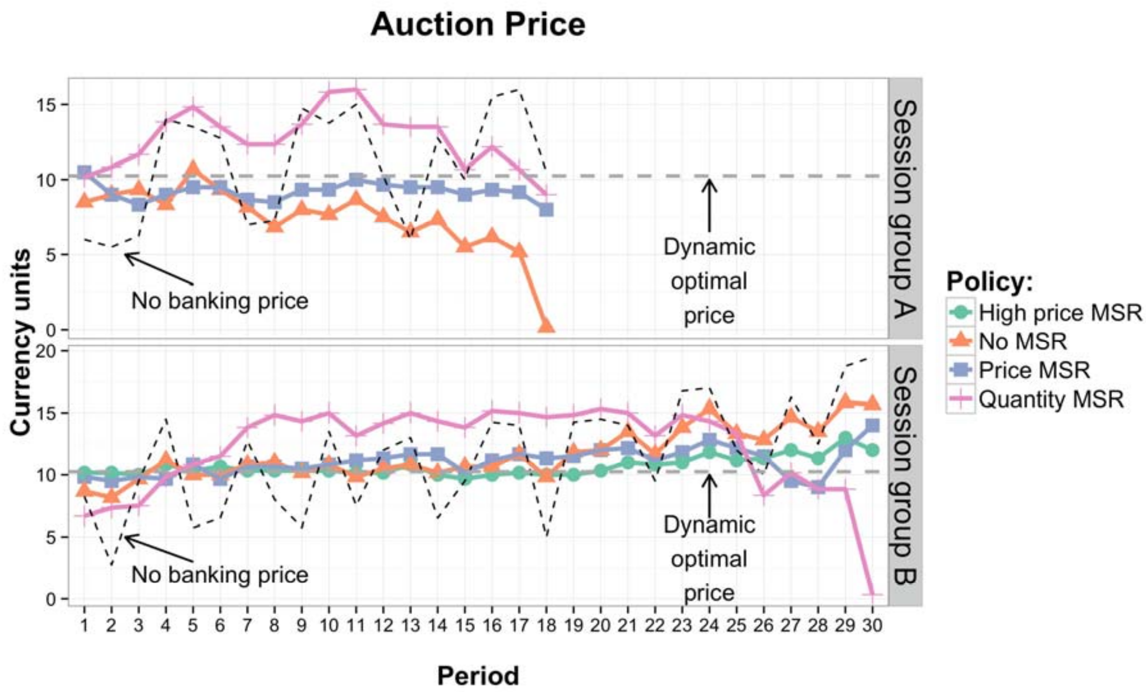
Note: An average carbon price growth rate of 3 per cent would score 100 and a growth rate of 11 would score 0.

As detailed in Figure 6, the EU ETS scores poorly against the price credibility criterion when market failures are considered. This reflects steeply increasing prices in later periods in order to achieve legislated policy goals. The MSR proposed by the European Commission partially corrects for these market failures, ensuring a flatter carbon price growth trajectory between now and 2050. In the European Commission proposal it is however envisaged that allowances that are currently temporarily withheld through back-loading are returned prior to 2021. This contributes to price volatility and can be avoided in the Early Start MSR that directly transfers back-loaded allowances into the MSR.

In the experimental study (Holt and Shobe, 2015), the price based MSR maintained prices (as to be expected) in a designated range (Figure 7). As prices were not frequently constrained by the price floor, concerns that a price based MSR would deliver carbon prices close to the reserve price and thus would equal a carbon tax, were not confirmed. Alterations in auction quantities, which occur due to withdrawals of unsold allowances at the reserve price and injections from the MSR at the price cap, were infrequent. This suggests that the credible announcement of a price collar can guide price expectations of market participants. It can encourage additional banking at prices in the lower range of the price collar and contribute to less banking at prices in the higher ranges of the price collar thus in both instances guides the price toward the central range.

As with all MSRs, maintaining a price collar that is not routinely binding may require periodic adjustment of the price band in response to new information on costs of mitigation technologies or a strengthening of abatement effort as part of a global effort to reach climate objectives.

Figure 7: Carbon price each period averaged across trials (Experimental results)

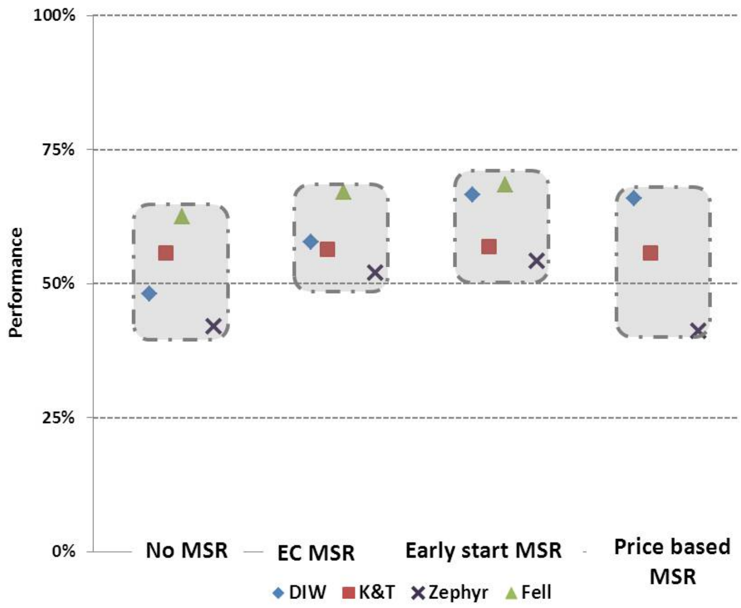


Note: The dynamic optimum price is 10.25 in all treatments.

Consistency is a further criterion that will determine the effectiveness of the EU ETS in supporting low-carbon investments. Several of the market failures modelled in the simulation exercises can result in discrepancies between the price of allowances in forward markets, the expected price by market participants and the average realized price. While some discrepancies are inherent – for example the realised market price will differ from the expected price – to measure consistency we ask whether the forward price or the price expected by market participants is a biased estimator for the later realized price.

On average across the model simulations, there is a degree of inconsistency between future prices and prices expected by market participants based on projections of today's price. An MSR can align realised and expected prices and hence improves price consistency across all of the simulation models, with an Early Start MSR performing the best.

Figure 8: Consistency criterion

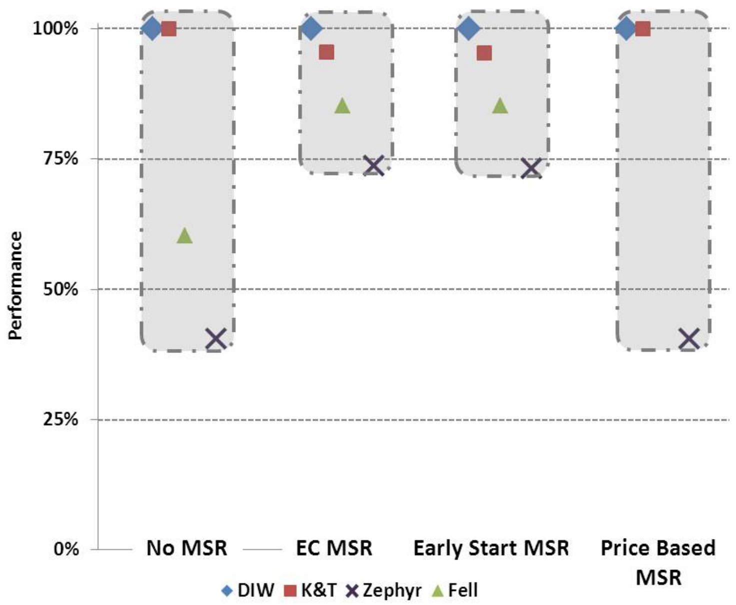


Note: In Zephyr the consistency criterion is calculated as the expected abatement versus realised abatement.

4.3. Performance indicator 4: Transformation

To measure whether the EU ETS is on track to achieve its decarbonisation goals, we compare emissions to the permit cap in the final years of the modelling horizon (2045 to 2050). Thus we assess whether the system is on track towards delivery of the emission targets beyond the modelling horizon. It will be early decisions on the structure of the energy sector, industry and infrastructure that will determine whether the emission reductions beyond 2050 can be implemented cost effectively. Both the K&T and DIW models result in emission levels in the final years in line with the cap. The Zephyr and Fell models use some banked allowances in the later years but show an improvement in transformation goals through the introduction of an MSR (See Figure 9). In the experimental sessions, the private bank is always close to zero in the final period because the allowances have no residual value. In most sessions using the EC MSR design, while the stability reserve was being released due to the small private bank, generally some allowances remained in the reserve in the last period.

Figure 9: Transformation criterion



Note: The K&T Model achieves greater than 100 per cent for No MSR and Price Based MSR due to borrowing.

4.4. Performance indicator 5: Robustness to shocks

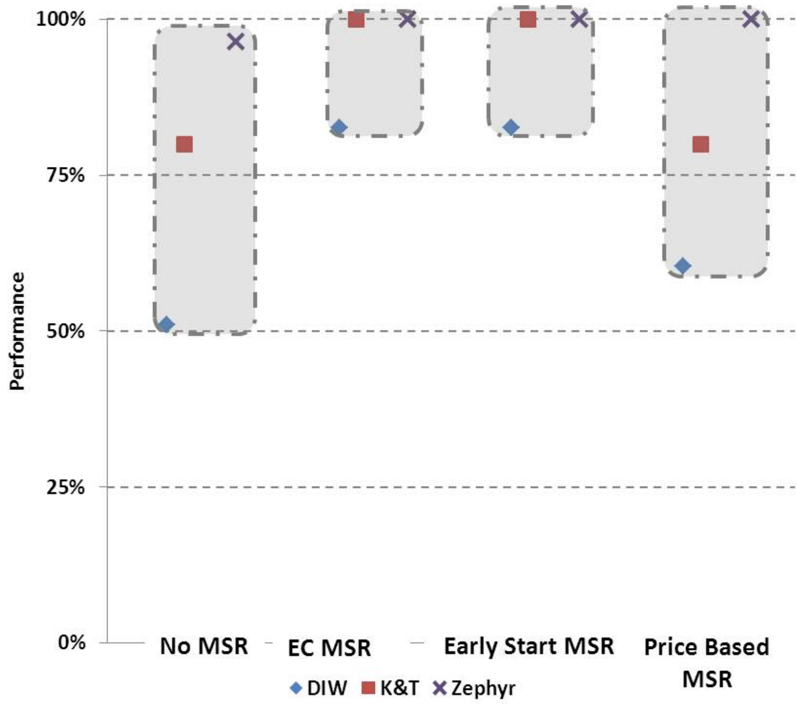
A repeated concern voiced about carbon markets is vulnerability to shocks. Hence we model different shocks to assess the robustness towards such events. We measure the robustness by assessing how the net present value of aggregated abatement cost changes in response to the shock. The first robustness indicator measures the response to an unanticipated reduction of output and emissions by 20 per cent in the period 2030 to 2034[12].

The EU ETS allows for banking of allowances over years – and thus has an inbuilt mechanism to enhance the flexibility by distributing any response to surplus allowances across years. However, this mechanism is less effective in the presence of market failures. Both limited capacity to bank at social discount rates and myopia limit the capacity of the market to smooth shocks over multiple years and thus the EU ETS with market failures is less robust.

The introduction of an MSR improves the robustness of the EU ETS in all computational modelling approaches (see Figure 10). The Early Start MSR proposal performs slightly better (across most models) compared to the EC MSR designs. While the price based MSR with a trigger level starting at €10/tCO_2 Euro had the least impact on the robustness criterion, subsequent runs of a price based MSR with a higher trigger level performed very well against the robustness criterion.

[12] In addition to the temporary economic shock, two unanticipated persistent shocks , implemented in 2030, were modelled including: an increase of targets to 80 per cent below 1990 levels by 2050; and a 30 per cent decrease in abatement costs. Both shocks shifted the optimal abatement pathway for all years following the shocks, and hence prices and abatement was adjusted in all subsequent years. In our linear parametrisation of the marginal abatement cost curve this did not involve a shift of abatement and banking between years, and hence the MSR designs did not differ in their response.

Figure 10: Robustness criterion

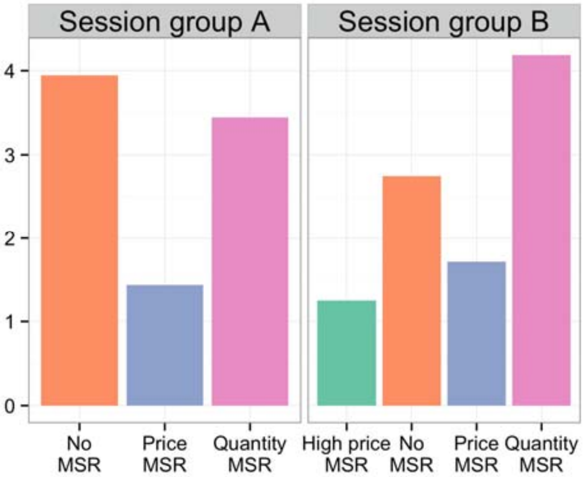


Note: The indicator measures the change in NPV as a result of the shock across the scenarios. In some cases, consideration of the value of permits stored in the reserve in 2050 actually improves the NPV of abatement costs beyond the case of no market failures where there is no reserve. As such, the K&T Model (Early Start MSR) and Zephyr Model (EC MSR, Early Start MSR and Price Based MSR) scored above 100 per cent

As a Stochastic model, the Fell Model does not include one-off economic shocks and is therefore not considered here.

As can be seen in Figure 11, in the laboratory experiments, the quantity based MSR did perform somewhat better than no policy, although this difference is not statistically significant. However, the price based MSR demonstrated significantly lower price variability than either the quantity based MSR or no MSR (see Section 5.2).

Figure 11: Experimental results - Price variability by MSR across Sessions A and B.



4.5. Sensitivity to different assumptions on input parametrisations

4.5.1. The Marginal Abatement Cost Curve

Of critical importance to the results is the choice of the underlying Marginal Abatement Cost Curve (MACC). Technological progress, institutional developments, the structure of complementing policies and the behavioural response of organizations and individuals can all impact the MACC, but each are difficult to predict in particular for the long time horizons up to 2050 (Grubb et al., 2014; IEA, 2012). Hence we run the results with different MACCs to test whether the choice of the MACC impacts the ranking of the MSR design options.

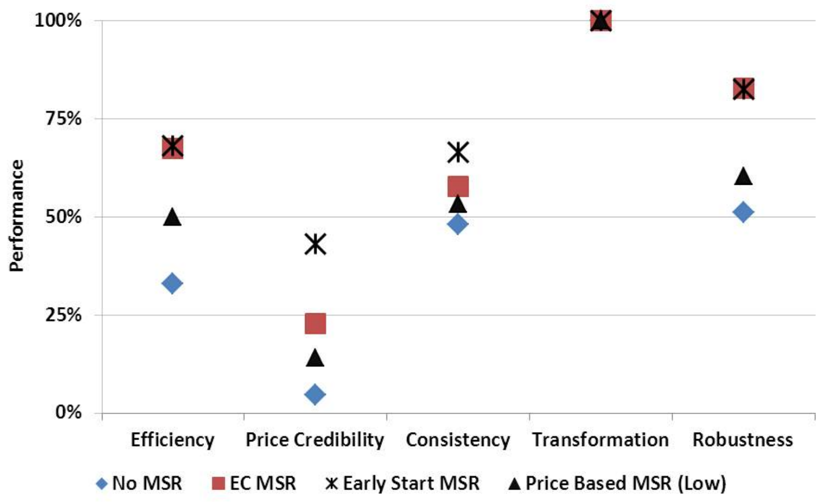
The MACCs used for all studies were derived from the PACE model, a well-established General Equilibrium Model which has repeatedly been applied for the European Commission to assess the impacts of climate (and other) policies. The base case MACC approximates the PACE MACC around abatement levels consistent with the European Commission Reference Case Scenario (European Commission, 2013). We tested all scenarios against a MACC which assumes higher costs for abatement efforts derived from a Computer General Equilibrium Model with relatively inelastic substitution assumptions (ZEW MACC) (Landis, 2015). A variation in the opposite direction (low cost MACC) was created and tested by reducing the base case MACC by 40 per cent[13].

Figure 12 illustrates that across most indicators, the ranking of the MSR designs remained similar. One difference is the price based MSR performs better under the "low cost MACC" sensitivity analysis. This is because the pre-defined price corridor turns out to be more closely aligned with the price trajectory of an efficient abatement pathway, under assumptions of lower abatement costs.

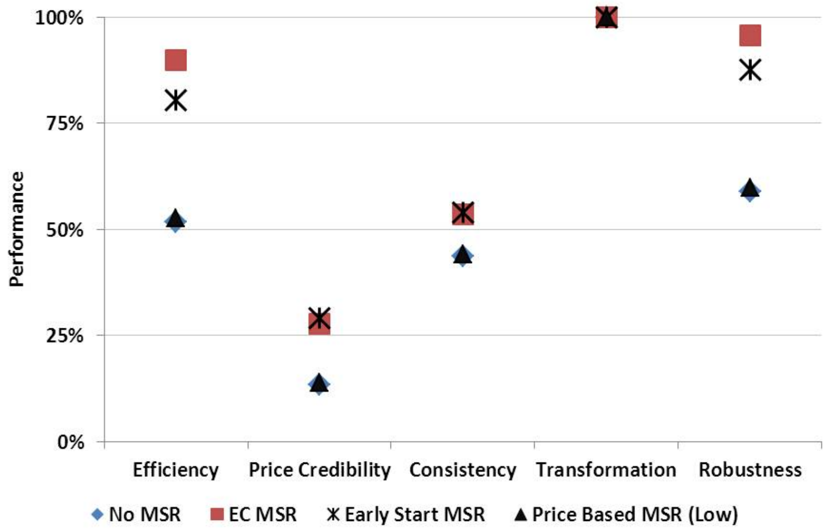
[13] Sensitivity analysis was conducted using the DIW Model.

Figure 12: Sensitivity of the DIW Model results to changes in the MACC assumptions.

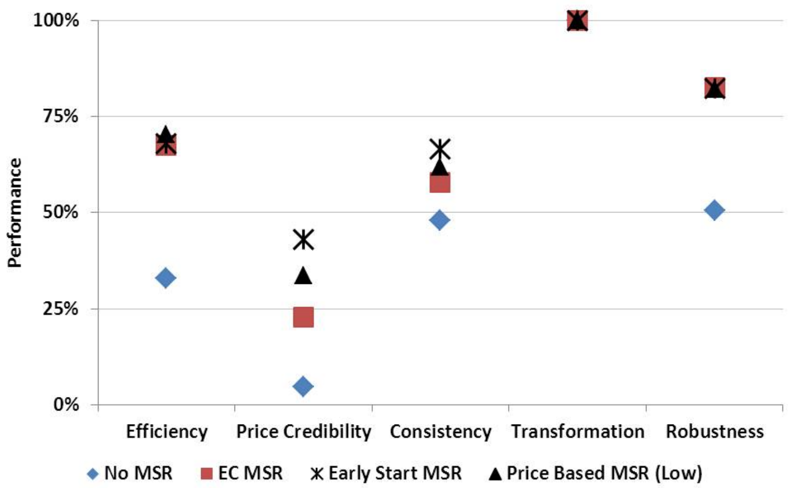
Base case MACC



High cost technology MACC



Low cost technology MACC



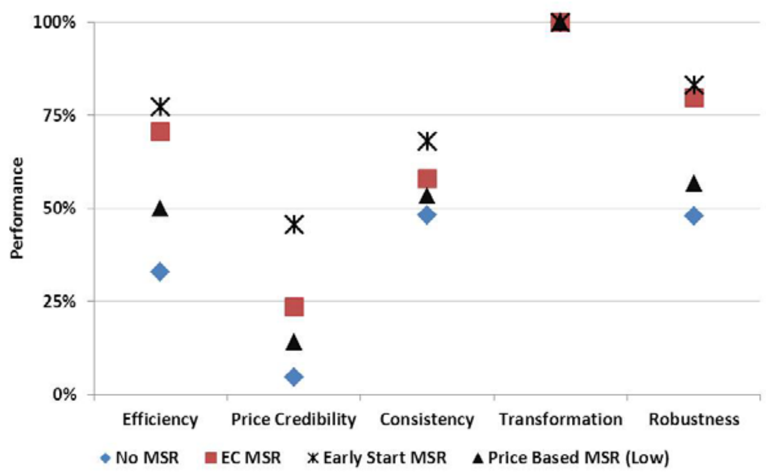
4.5.2. Sensitivity to Endogenous Technological Learning

As all models used in the comparison exercise focused on a representation of the permit market, they ignored dynamic aspects of technology and infrastructure development and the resulting implications. To test what further effects might need to be considered, a simplified version of Endogenous Technological Learning (ETL) was implemented[14]. It was assumed that an increasing volume of abatement effort in the years prior to 2030 will result in additional technology learning and development of suitable infrastructure. Therefore abatement costs in the years post 2030 are assumed to decline in proportion to the abatement pursued pre 2030. The efficiency indicator shows that the ranking of the different MSR designs is robust to the introduction of ETL (Figure 13).

Figure 13: Sensitivity of the DIW Model results to Endogenous Technological Learning (ETL)

Performance across different MSR designs without ETL

Performance across different MSR designs with ETL



Note: The Market Failure and price based MSR (Low) did not result in increased levels of abatement in the 2014 to 2029 period when compared to the no-banking case. As such, these scenarios do not induce ETL. We did not model the influence of the high price MSR in the ETL case.

[14] Analysis conducted using the DIW Model.

5. Design considerations for an MSR

5.1. Setting the price corridor in a price based MSR

The initial parametrisation of a reserve price trigger assumed a price starting at 10/tCO_2 in 2021. The results showed that the MSR is in this case only triggered briefly in the early years which resulted in very limited impact on volumes, prices and the abatement pathway. Hence an alternative parameterisation was subsequently tested with a trigger price starting at €20/tCO_2 Euro in 2021 and increasing at 5 per cent per annum. This price based MSR scored well across key criteria (Figure 14). These results highlight the importance of understanding technology costs and the resulting efficient abatement pathway when setting the trigger levels of a price based MSR.

Figure 14: Assessment of a higher price collar MSR against other MSRs across key performance criteria, within the DIW Model.

5.2. Setting the quantity trigger levels in a quantity based MSR

The experience of the EU ETS has shown that power generators and some industrial producers hold CO_2 allowances or forward contracts on CO_2 allowances to hedge production costs. This creates a demand for surplus allowances (allowances in circulation). According to different studies the power sector requires 0.4 to 1.4 billion allowances in 2020 to meet emissions linked to electricity sold on fixed price forward contracts for up to four years ahead (European Commission, 2014; Point Carbon, 2014; Pöyry, 2013; Tschach Solutions, 2014). Very carbon intensive commodity producers (for example steel) sell products in global markets and thus also will need to hedge production costs against European carbon price developments. However, as carbon and trade intensive sectors receive allowances to meet large shares of their emissions for free, they do not need to hold allowances to hedge the corresponding emissions.

The laboratory experiments suggest that market participants have a desired level of banking. This might be partly linked to anticipated price increases due to future reductions in the cap and partly linked to a desire to cover compliance obligations on “must-serve” production. As the quantity based MSR modelled in the experiment seems to reduce the number of allowances available bellow this desired level of banking, the subjects bid up allowance prices and reduced production in order to achieve their desired level of holdings. This points to the importance of setting the trigger levels in quantity based MSRs sufficiently high to accommodate desired banking behaviour.

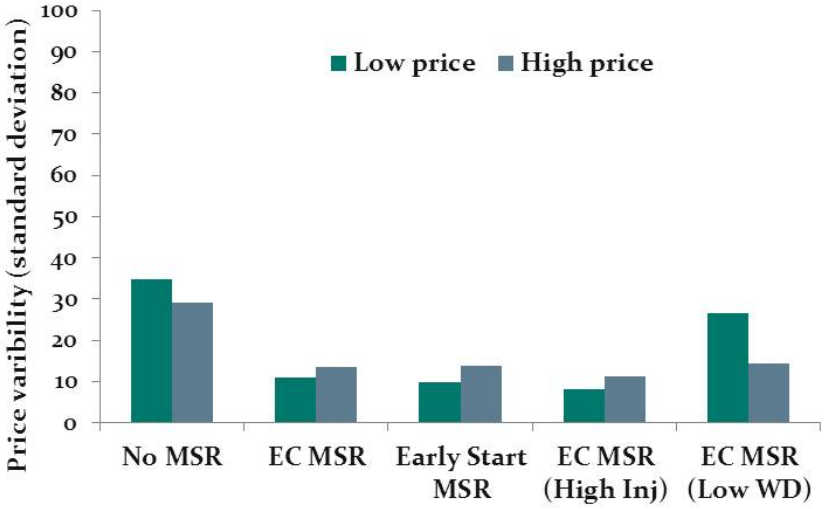
The hedging needs of the power sector will evolve with the total power demand, the carbon intensity of the power production and the volume of forward contracting. It is therefore important to update trigger levels in response to developments across these three factors. Power production and carbon intensity is easily verifiable. According to the REMIT Directive, contracting volumes of exchange based and over the counter trades must be reported from 2015 by all market participants and therefore will also be verifiable. Hence robust information will be available that can be used as the basis for the future refinement of trigger levels. The modelling results suggest that such refinements will only be necessary after 2020 as before then all MSR designs will be triggered given the large existing surplus of allowances.

Therefore much of the debate is focusing now on the current volume of banking by other market participants. The DIW modelling analysis suggests that most of the other actors will sell surplus allowances as the surplus is reduced with the introduction of an MSR. This is because their speculative holding of allowances is motivated by the return expectations in the market. Across the models we observe that with the introduction of the Early Start MSR the annual average price increase declines and speculative holding is less attractive.

5.3. Adjusting the withdrawal and injection rates

The injection and withdrawal parameters were also varied applying Fell’s stochastic modelling framework. As detailed in Figure 15 the MSR as proposed by the European Commission significantly increases the resilience of the EU ETS to stochastic shocks, reducing price variability. The model results show that a tripling of the injection rate at which permits are returned to the market if the lower trigger is reached can deliver a small additional reduction in price variance. The results are more sensitive to changes of the withdrawal rates – a reduction from 12 per cent to 2 per cent results in a large increase of variability both towards low and high prices (Fell, 2015).

Figure 15: Price variation over the period 2014 to 2030 in a stochastic modelling framework under different MSR designs



Notes: High Inj increased the injection rate from 0.1 billion to 0.3 billion allowances; Low WD reduced the withdrawal rate from 12 per cent to 2 per cent. The discount rate in the analysis conducted here was set at 3 per cent and did not vary with the size of the surplus.

5.4. The French Proposal

France has proposed an alternative parameterisation of the quantity based MSR comprising five elements as outlined below (See DGEC, 2014).

(1) The French Government proposed to increase the corridor to 0.8-1.3 GtCO_2 from 0.4-0.833 GtCO_2

(2) Different calculation of MSR response rate. If the upper trigger level is exceeded, 33 per cent of the difference to the lower trigger level will be taken into the MSR (instead of 12 per cent of total allowances in circulation as in European Commission proposal). If AiC fall below the lower trigger level, then 33 per cent of difference to the upper trigger level are returned to the market (instead of 100 million tonnes as in European Commission proposal).

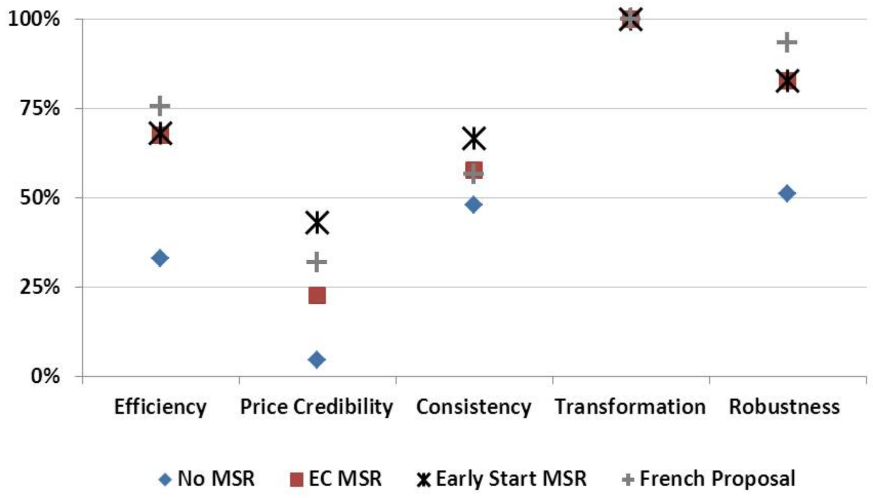
(3) Acceleration of response speed of MSR (from two years to one year). This would imply a potential adjustment of the auction schedule closely after publication of the verified emission data on April 1st. As emission forecasts based on economic performance data has improved in recent years, the final publication would unlikely comprise large surprises and thus the adjustment to auction schedule can already be anticipated early on.

(4) Early start and transfer of back-loaded allowances into MSR as in the Early Start MSR.

(5) Use of Comitology process to allow for more frequent adjustment of trigger levels for MSR than 5 years as envisaged in the European Commission proposal that requires legislative changes.

In the DIW Berlin simulations the French proposal scores higher on the efficiency and robustness indicator than the Early Start MSR while the Early Start MSR scores better on the price credibility and consistency indicator (See Figure 16 below).

Figure 16: Assessment of the French Proposed MSR against other MSRs across key performance criteria, within the DIW Model.

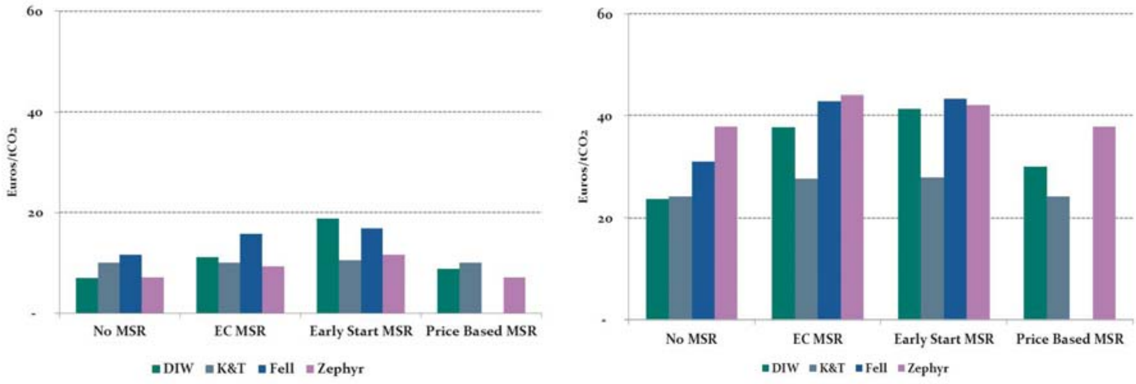


Note: Given the treatment of the permits in the reserve at 2050, the French Proposal scored above 100 per cent.

5.5. Price levels observed in modelling results

The report has focused on the presentation of performance indicators so as to illustrate the relative merits of different design options in approaching efficient abatement pathways. This has been a particular emphasis of the project design to ensure compatibility with the stated objective of policy makers to avoid price management. Obviously any model run does provide price trajectories, and Figure 17 illustrates that prices vary across the models and scenarios. The move of allowances to the MSR as part of the Early Start MSR has a noticeable but overall moderate upward impact on prices in 2020 towards levels that are generally perceived to be more relevant for investors while well within the region that is often argued to be political acceptable (European Commission, 2013). The precise price levels will however vary with the parameterisation of the marginal abatement cost curve and ultimately real abatement costs and longer-term mitigation objectives.

Figure 17: Carbon prices in 2020 and 2030 across the DIW, K&T, Fell and Zephyr Models.



Note: The Price Base MSR was not assessed in the Fell Model.

6. Conclusions

European Institutions are considering the implementation of a MSR to improve the functioning of the EU ETS. To provide quantitative evidence to the debate of whether an MSR is necessary and if so, how best should it be designed we explore:

(i) which criteria can be applied to assess the functioning of the EU ETS;
(ii) potential market and regulatory failures that could limit the performance of the EU ETS against these criteria; and
(iii) provide a quantitative evaluation of the current functioning of the EU ETS as well as the impact of different MSR design options.

An MSR will only improve the functioning of the market if there are significant market failures. In the absence of market failures, the temporary removal of allowances with an MSR would either have no effect or a potentially negative effect on the EU ETS. Allowances stored in the MSR will result in an equivalent reduction of banking by market participants and thus not impact prices and abatement efforts. However we explore three potential market and regulatory failures that can reduce the efficiency of inter-temporal smoothing by market participants, including: a limited capacity for market participants to bank emission permits at social discount rates (Neuhoff et al., 2012), myopia and an excessive focus on the short term (Taschini et al., 2014) and imperfect response to uncertainty and complexity (Trotignon et al., 2015).

Assessing the EU ETS across key performance indicators, we find the above market failures have a non-trivial impact that could be alleviated through a stability mechanism. At the same time, regulatory uncertainty is considered to intensify each of the market failures such that reduced regulatory uncertainty should be seen as a key priority for European policy makers. An early commitment to 2030 emission reduction targets that are consistent with long-term mitigation objectives is for example valuable. However, some level of regulatory uncertainty is inherent and impossible to eliminate, not least because of the high level of uncertainty surrounding climate policy with respect to science, economics as well as global politics, and the significant stakes involved in climate policy decisions.

Both quantity and price based MSRs could improve the functioning of the market but have associated challenges. The quantity based MSR proposed by the European Commission pushes the EU ETS closer the efficient abatement pathway and therefore improves the EU ETS across key performance criteria.

In reaction to the European Commission’s proposed MSR, the United Kingdom and Germany have argued in favour of a mechanism which starts earlier (2017) and places the back-loaded allowances into the reserve. The Early Start MSR further improves the functioning of the EU ETS against key performance indicators, when compared to the European Commission’s proposal. Specifically, not returning the back-loaded allowances to the market reduces price variance and improves price credibility and consistency. On average across the models almost two thirds of the efficiency losses from market failures can be avoided. In addition, the Early Start MSR results a more stable price trajectory upon which investment decisions can be based.

Both experiment and computational analysis points to the importance of setting the trigger levels correctly. In the computational analysis, trigger levels set too high largely reduced the efficiency of the achieved abatement pathway. In the laboratory experiments a trigger level of a quantitative MSR below the level of desired banking volume of market participants, encouraged adjustments of bids and production decisions to help maintain desired private banking volumes and emission reductions above the efficient abatement pathway. Hence, data gathered under the REMIT Directive should be used to follow the evolution of hedging needs and as basis for the future updates of trigger levels. The computational models suggests that as the surplus is significantly above trigger levels in the initial years, updating will only be necessary around the mid 2020s.

The European policy debate is currently largely focused on the options within a quantity based MSR. However, price based MSRs have been implemented in other regions and therefore, the model comparison exercise also assessed two price based MSRs: one with a price floor starting at €10/tCO_2 (low) and another at €20/tCO_2 (high), with both increasing at five per cent per annum. While the low price based MSR was rarely triggered and therefore only offered a marginal improvement across performance indicators, the higher price based MSR was closer to the efficient abetment pathway and more effective than the quantity based MSRs assessed in this report. In the experimental results a price collar effectively maintained the price within the desired range by encouraging additional banking at prices in the lower range of the price collar and contributed to less banking at prices in the higher ranges of the price collar thus in both instances guiding the price toward the central range.

Consequently the relative merits of price versus quantity based MSRs can be linked to the capacity of policy makers to set price or quantity based trigger levels that cannot be answered within the modelling framework. In the current European context, discussions typically involve mitigation targets in line with the long-term climate objectives. This is reflected in the quantity based MSR that responds to temporary allowances surpluses while reaffirming the quantity based nature of mid and long-term emission targets. Hence the European Commission proposed a quantity based MSR and the European Union heads of state (EU Council meeting October 2014) have decided to support an implementation “in line with” the proposal. This also reflects the difficulties anticipated to agree at a European level in a political process on price levels required for a price based MSR, in particular given the high level of uncertainty (and thus discrepancies) in assessments of marginal abatement cost. Also, the track record of the EU ETS does provide experience on the use of allowances for hedging purposes by European companies and can thus inform the setting of quantity based trigger levels. Thus the prioritization of a quantity based MSR can be well explained in the European context, but might not translate to emission trading mechanisms in other regions.

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