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Price Floors for Emissions Trading

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Table of Contents

Abstract

Price floors in greenhouse gas emissions trading schemes can guarantee minimum abatement efforts if prices are lower than expected, for example due to technology shocks or economic slowdown. They can be argued for on grounds that they help manage cost uncertainty, reduce price volatility, and improve investment certainty for low-emission technologies. Implementation however has potential pitfalls. Possible mechanisms are government commitments to buy back permits, a reserve price at auction, or an extra fee or tax on acquittal of emissions permits. Our analysis of these alternatives shows that the tax/fee approach has budgetary advantages and is more compatible with international permit trading than the alternatives. It can also be used to implement more general hybrid approaches to emissions pricing.

Keywords:

Price floor; hybrid emissions pricing; carbon tax; emissions trading; technology shocks; business cycle; US, EU and Australian climate policy.

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1. Introduction

Price ceilings are a widely recognised option to limit the risk that carbon prices exceed acceptable levels if constraining emissions turns out to be more expensive than expected, providing greater cost certainty to emitters, and limiting the overall potential short-term economic cost of mitigation. The mirror instrument is a price *floor*, which would ensure a minimum price on carbon. It would provide more certainty for investors in low emission technologies, and allow emissions to go lower than a target set by the administrator, thus providing more abatement if costs are lower than expected. The basic concept of a combined system of price ceilings and floors in allowance trading goes back to Roberts and Spence (1976).

Both price ceilings and price floors can reduce risk and price volatility in carbon markets, which has been of concern in the EU emissions trading system or ETS (Grubb and Neuhoff, 2006), and can thus make the introduction of ETS systems more acceptable. However, such 'hybrid' instruments also present specific challenges for scheme design and for trading of permits between countries, and in terms of their budgetary impacts.

There has been considerable discussion of approaches that include a price ceiling, also known as a 'safety valve' (Aldy et al., 2001; Jacoby and Ellerman, 2004; Pizer, 2002; McKibbin and Wilcoxen, 2002; McKibbin *et. al.*, 2009). Price ceilings have been proposed for various carbon trading schemes, for example in Australia (Commonwealth of Australia, 2008), and in less direct ways for the US Regional Greenhouse Gas Initiative (RGGI, 2008), and the Waxman-Markey Bill as passed by the United States House of Representatives in June 2009 (H.R. 2454, 2009)[1].

The academic debate on price floors is much less developed, though the concept of price floors has begun to find its way into policy and legislative proposals. One of the novel aspects of the Waxman-Markey Bill is that it stipulates a reserve price of US$10/t$CO_2$-e when permits are auctioned, which would increase by 5% above the consumer price index each year. This reserve price could function as a price floor.

The US Regional Greenhouse Gas Initiative (RGGI) scheme has a reserve auction price in place. In March 2010, approximately 40 million tons of CO_2 allowances for the present compliance period (2009-2011) were auctioned US$2.07 per permit, but approximately 2 million tons of CO_2 allowances for the next compliance period were sold at the reserve price of US$1.86 per permit. Unsold allowances may be sold in future auctions according to each state's regulations (RGGI, 2010). These price levels are substantially lower than prevailing prices under the EU ETS.

Calls in early 2009 for a price floor to be introduced to the EU emissions trading scheme, via an auction reserve price, were rejected by the European Commission. The European Commission claimed that "a floor price may unduly interfere with the market" (Gardner, 2009). However, this argument is flawed as permit markets are entirely the product of government regulation in the first place. It also runs counter to stated EU interests to achieve

[1] At the time of writing, the fate of climate legislation in the US Senate was unknown.

ambitious climate mitigation outcomes. The proposed Australian ETS also does not include price floor provisions.

The next section reviews the reasons why incorporating a floor price in an emissions trading scheme would be attractive. In Section 3, we compare the different approaches for implementing a price floor and propose that a suitable approach is to have firms pay a tax or extra fee as well as buy permits. Compared to the alternatives, it has budgetary advantages and is compatible with international permit trading. In Section 4, we examine how this mechanism can also be used to implement more general hybrid approaches for putting a price on emissions. One of these approaches is the use of an 'allowance reserve', which is similar to a price ceiling, but where the total number of permits remains limited. Section 5 concludes.

2. A rationale for price floors

A range of arguments can be made in favour of price floors, relating to price volatility, innovation, and management of cost uncertainty.

Price floors (and ceilings) truncate the possible range of permit prices in the market and hence can reduce price volatility. Price volatility can also be reduced by banking and borrowing of permits; with short-term market fluctuations tempered through longer term price expectations. But recent experience with the EU ETS suggests that volatility still remains. The EU permit price ranged between €15 to €25/tCO_2-eq from mid-2007 to early 2008, spiked at €30 in mid-2008, declined to a low of €9 in early 2009, and has ranged around €13 in late 2009 and early 2010.[1]

The steep reductions in permit prices have in large measure been related to the global financial crisis, which contributed to lower emissions and also constrained financial resources for investment. The price falls occurred despite provisions for banking of permits being in place, which limits short-term downward fluctuation if markets operate properly. It can be argued that falling permit prices in times of economic downturn are desirable as an economic stabiliser.

However, there are two important counter-arguments. Firstly, policy should be designed in a way that keeps incentives for long-term investments stable through temporary business cycle effects. A short-term emissions price below the long-term optimum would exacerbate presumed problems of underinvestment in technologies whose costs come down with increased deployment (Sterner and Turnheim 2009).

Second, an unanticipated economic slowdown allows to cut emissions further than originally targeted at the same cost as originally expected. Under a specific mechanism design (variable extra fee, see Section 3.3) it would also be readily possible to use extra government revenue from implementation of a price floor to finance economic stimulus measures.

Investment certainty is another important argument for price floors. Investments such as power plants, buildings, and infrastructure involve long-term time horizons. A price floor gives investors in low-emission assets greater certainty about the minimum return to their

[1] Data from European Climate Exchange, http://www.ecx.eu/EUA-Futures.

investments – it effectively provides insurance against low carbon prices, analogous to the insurance function of a price ceiling against cost blow-outs to owners of existing high-emissions assets.

The argument also applies in the case of unanticipated technological breakthroughs that reduce abatement costs: if it turns out that a given short to medium term target can be more easily reached than initially thought, the efficient response is to increase the abatement effort. Successful technological innovations lower the carbon price for a particular emissions target, or increase the amount of emission reductions achievable at a particular carbon price. The economically efficient response is to increase the amount of abatement, to keep the abatement cost in line with the social cost of emissions. Under a pure cap-and-trade approach, innovation will only increase abatement if the regulator adjusts emissions targets in response to a lower, or lower than expected, carbon price. A price floor by contrast provides a mechanism for additional emission reductions to be achieved automatically.

Uncertainty about abatement costs affects the relative performance of abatement mechanisms in terms of their expected welfare impacts, as shown by Weitzman (1974) for the comparison between price and quantity instruments. Hybrid approaches under uncertainty were studied by Roberts and Spence (1976), who examined pollution reduction when the costs of pollution reduction are uncertain, but the benefits are known. It was found that the expected net benefits of using a hybrid approach with both a price floor and a price ceiling are significantly higher than for a purely price or quantity based approach. Quantitative modeling for climate change mitigation (Pizer, 2002; Burtraw et al., 2009; Fell & Morgenstern, 2009) is consistent with this conclusion. Modeling by Philibert (2008, 2009) shows that price ceilings and floors could help design a policy with similar climate results at lower expected costs.

3. Mechanisms for a price floor

We compare three mechanisms for implementing a price floor in an emissions trading scheme:

1. The administrator commits to buy back licenses at the floor price, thereby reducing the amount of permits in the market (Hepburn, 2006). A similar approach is for the administrator to commit to pay a subsidy to firms that possess more permits than required to cover their emissions, the subsidy being proportional to the number of excess permits (Roberts and Spence, 1976).

2. A reserve price applies when permits are auctioned, again limiting the amount of permits available to emitters (Grubb and Neuhoff, 2006; Hepburn *et al.*, 2006). This approach features in some current US policy proposals, and in an existing US scheme (RGGI).

3. Emitters have to pay an extra fee (or tax) for each ton of carbon emitted, in addition to having to surrender a permit. The effective carbon price then becomes equal to the sum of the permit price and the extra fee. This approach appears to have been largely overlooked in the current debate, though variants of it can be found in earlier academic contributions.

3.1. *A commitment to buy back permits*

A commitment to buy back permits may be theoretically the ‘neatest’ way to implement a price floor, because it allows for the price floor to be implemented exactly with just one instrument. The market price will never go below the threshold price, and the administration of the floor price remains within the cap-and-trade scheme. However, the option would likely be unworkable in practice because of budgetary aspects and because it would stand in the way of international permit trading.

A buy-back commitment would create potentially large contingent liabilities to governments, through budgetary costs of buying back permits in the market. This would be especially problematic where large shares of the total permits available are given out freely to start with, or where revenue from the initial sale of permits is earmarked for other purposes – one or both being the case for most existing and proposed emissions trading schemes. If the contingent budgetary liabilities are large, this might even undermine the credibility of the policy.

International trading in permits would exacerbate the budgetary problems faced by any one country, as it would potentially create an unlimited liability for the administrator (Garnaut, 2008, p. 310). Even if the buy-back commitment is limited to domestic permits, international permits could be used by domestic emitters to substitute for domestic permits, effectively extending any one government’s liability overseas.

These are serious obstacles. They are related to the problems inherent in linking emissions trading schemes with price ceilings (Jotzo and Betz, 2009). With price ceilings implemented by governments selling permits at a fixed price, it becomes untenable for other countries to link their schemes to a country that has a (lower) price ceiling in place; while a country wanting to uphold a floor price through permit purchases would find it untenable to link its scheme to overseas systems that do not have floor prices, or have lower floor prices.

For a commitment to buy back permits to be compatible with international trading, it would be required that all of the schemes involved have the same price floor (PricewaterhouseCoopers, 2009). This would be difficult to achieve in practice because of movements in exchange rates. Another way to address these issues is to not have international permit trading, which has also been advocated for other reasons (McKibbin *et. al.*, 2009). However, this would fly in the face of a general trend and widespread desire by policymakers to link schemes internationally (Tuerk *et. al.*, 2009), and would make it harder to achieve an internationally harmonized carbon price and the associated efficiency gains.

3.2. *A reserve price at auction*

The reserve price approach is the one proposed for the United States under the Waxman-Markey Bill, implemented under RGGI, and considered but rejected by the European Union (see Introduction). It would imply that there is no strict price floor, because although there would be a minimum price that firms would pay at auctions, the market price could fall below the reserve price. An advantage of having a reserve price is that independently of its function as a price floor, it is an auction design feature that can protect sellers and in some cases buyers from unexpected outcomes in the auction (Hepburn *et al.*, 2006).

To what extent a reserve price translates into a floor price in part depends on the share of permits auctioned. If a large proportion of permits is given out freely, then a situation could occur where few or no permits are in fact auctioned, given the reserve price. In this case, the market price would be above what it would be in a 'pure' cap-and-trade scheme with the full amount of permits available to emitters, but below the reserve price.

International trade of permits could also result in the reserve auction price no longer being a floor price. If permits from another country's scheme, or offset credits such as from the Clean Development Mechanism, can be imported at a price lower than the reserve price, then this will become the source of purchased permits in the domestic scheme rather than permits bought at auction from the government.

Under this scenario, there is an important negative budgetary impact for the country attempting (but failing) to uphold a price floor, because rather than contributing to domestic government revenue through purchases at auction, emitters transfer money for permit purchases overseas.

3.3. *An extra fee or tax*

Under this option, emitters have to pay an extra fee (or tax) for each unit of emissions, independently of or in addition to their permit obligations.

We can write this as

$$MC = p + t$$

where MC is the marginal cost of abatement (the effective carbon price), p is the permit price, and t is the extra fee or tax. Firms would be expected to engage in emission reductions if those reductions cost less than the sum of the permit price and the extra fee.

There are fundamentally two ways that the price of the extra fee could be set:

a) A fixed fee on emissions. The fixed fee is equal to the floor price:

$$t_{fix} = p_{min}.$$

b) A variable fee on emissions. When the permit price in the market is less than the price floor, the extra fee is equal to the difference of the permit price and the floor price; when the permit price is above the floor, the fee is zero. We can write this as

$$t_{variable} = \begin{cases} p_{min} - p & \text{if } p < p_{min}, \\ 0 & \text{otherwise;} \end{cases}$$

where $t_{variable}$ is the extra fee, p_{min} is the floor price, and p is the permit price.

Fixed fee

Under the fixed fee approach, the effective carbon price is prevented from falling below the level of the fee, but it is always higher than it would be if there was only the permit trading scheme. The approach is similar to what transpires when both a carbon tax and an emissions trading scheme are in place simultaneously. The fixed fee approach is conceptually similar to 'emission permit rental charge' proposed by Grafton and Devlin (1996), where holders of a permit are required to also pay a fee. Grafton and Devlin noted that this approach has advantages for rent capture in the case that permits are given out for free.

The fixed fee approach is similar to having a call option to buy a permit at a fixed price, as described by Unold and Requate (2001). The difference is that what we describe as a 'permit' is described as an 'option' by Unold and Requate; and the fixed fee here is on emissions, while the fixed fee described by Unold and Requate is the price of what they call a 'permit'. Under their approach, the carbon price would be equal to the 'option' price plus the 'permit' price, so the two approaches are equivalent when the fixed fee is an integral feature of the permit being surrendered.

In the fixed fee context, it is worth noting that permit trading in any case already interacts with various taxes and subsidies that discourage or encourage activities that incur carbon emissions, for example energy taxes or subsidies. In that sense, the effective carbon price, relative to a hypothetical situation of no taxes and subsidies, can differ from the permit trading price, and it can differ between countries even if they have the same nominal carbon price in place (Babiker *et. al.*, 2004).

Several countries that take part in EU emission trading scheme also have a carbon tax, including Sweden, Finland, and the Netherlands (Baranzini *et al.*, 2000; Stavins, 2003). In September 2009, France announced that it would introduce a carbon tax in 2010 (Portail du Gouvernment, 2009), but this was postponed indefinitely in March 2010.

Variable fee

The variable fee approach by contrast more closely achieves the effects of a 'classic' price floor, as a predetermined minimum price with no effect if market prices are above the threshold. It would be in operation only if and to the extent that the market price falls below the threshold level.

A complicating factor is that permit prices fluctuate over time, and consequently the variable fee may have to change over time or be determined at a chosen point in time. There are several options for deciding what permit price is used when determining the extra fee. One option would be to use the permit price in the market on the date of permit surrender. But under this option, firms with market power could have an incentive to influence the market price near the compliance period to minimize fee payments. Another option would be to use the permit price that was paid by the firm when acquiring the permit – this would require that information about permit purchases is stored, possibly affecting transaction costs. An alternative is to use the average permit price over the time period in which emissions are being accounted for (usually a year).

Further analysis of the tax/fee options

It is important to note that an additional fee/tax implemented in a purely domestic scheme (with no international permit trading), and without banking or borrowing, would leave the effective domestic carbon price (the marginal cost of abatement) unaffected (Figure 1a). With a fixed emissions cap to be met within the system, the required marginal abatement cost remains the same irrespective of the pricing mechanisms applied. Hence the introduction of a fee/tax simply lowers the permit trading price by an amount exactly the same as the fee/tax.

By contrast, in the case of a fee/tax system in a country that takes part in international permit trading, the tax/fee directly influences the effective domestic carbon price. The fee gets added to the international permit price which only partly changes in response, and thereby increases the effective domestic carbon price or marginal cost of abatement. In the case of a ‘small country’ participating in a large international permit market, the domestic fee/tax is simply added to an unchanged international permit price (Figure 1b), so the effective domestic price is increased by the amount of the fee/tax.

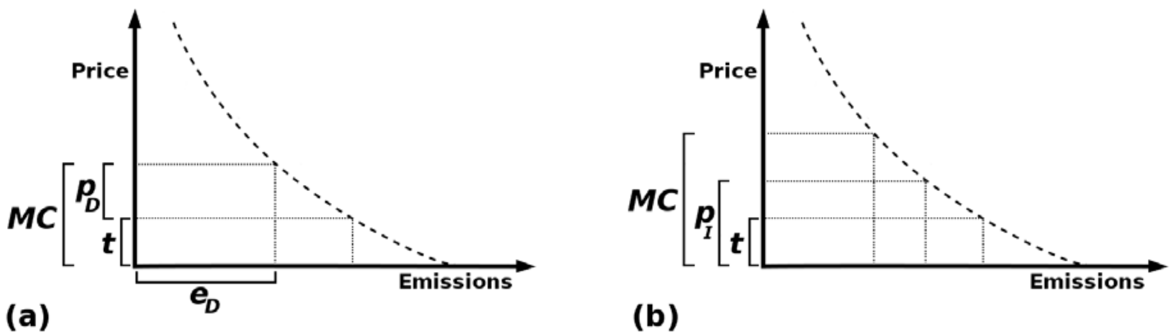

Figure 1. We compare a purely domestic permit market with a large scale international permit market. The curved dashed line denotes the marginal cost of abatement. With a purely domestic permit market (a), the government sets a quantity of emissions e_D, and an extra fee (tax) t. These quantities determine the carbon price, MC, and the permit price is given by $p_D = MC - t$. Thus, the effective domestic carbon price (marginal cost of abatement) is unaffected. By contrast, with unrestricted international trading of permits (b), the international permit price p_I is determined in international markets. The domestic carbon price is given by $MC = p_I + t$.

It could be argued that combining fees/taxes with permit trading would increase transaction costs by an unacceptable amount. However, given that general taxation systems for emitters already exist, and that permit trading systems are (or are likely to be) in existence also, the extra cost impost is likely to be small. The main transaction costs are associated with measurement, reporting and verification, which are incurred only once for both aspects of carbon pricing.

The budgetary impacts of the fee models are positive or neutral, and there are no risks of budgetary outlays. A fixed fee (or tax) will yield a highly predictable revenue stream, while a variable fee will yield revenue in the event of low permit prices. Highly variable and unpredictable government revenue from a variable fee poses challenges to fiscal management, however it could be a highly attractive feature in times of economic slowdown. If the emissions price falls because of a recession, as has recently been the case in the EU, then a variable tax/fee provides additional revenue that could be immediately spent on fiscal stimulus measures. In other words, the extra money levied on emitters could be returned to consumers and industry, but without affecting the incentive effect of higher emissions prices.

More generally, in the aftermath of large fiscal stimulus spending in all countries that have or are considering emissions trading schemes, implementing emissions charges in addition to permit trading could become an attractive option to help replenish public finances, though it would no doubt also be subject to hard political bargaining by concentrated lobby groups, as for example Australia's recent experience in preparing an ETS has shown (Pezzey *et al.*, 2009; Menenzes *et al.*, 2009).

Perhaps the greatest advantage of the fee/tax approach is that it can be fully compatible with international trading of permits. A domestic fee or tax on domestic emissions can be implemented in any one country without affecting the international tradability of permits. It affects the price of permits in the international market only indirectly. What the fee will do is lower emissions independently of the trading scheme, and so reduce the demand for permits relative to the situation without a fee or tax. In the case of a country that imports permits from overseas, imposing an emissions fee will result in lower emissions and therefore fewer permit imports (Figure 1). This will tend to lower the (international) permit price, but only to the extent of that country's share in international permit markets. Also, an extra fee or tax also does not affect arrangements for banking and borrowing of permits.

The situation regarding international tradability would be different if the requirement to pay a fee was made an integral feature of the emissions permits issued by any one country. This is the case with the approach of Unold and Requate (2008). If different countries attach different fee conditions to their permits, then emission permits from different countries are no longer the same commodity. International trading could still occur, either with different prices for permits from different countries, or with equal prices achieved through cross-border arrangements between countries on the charging, exempting and remitting of fees. Insofar as economic distortions are sizeable or administrative arrangements too complex, it may be preferable to separate fees or taxes from permits.

4. Floors, ceilings, and allowance reserves

Some proposals for putting a price on emissions combine both a price floor and a price ceiling, in what has been termed a 'price collar' (McKibbin *et al.*, 2009). An alternative to a price ceiling is an 'allowance reserve' (Murray *et al.*, 2009) in which there are extra 'ceiling' or 'reserve' permits, but the amount of extra permits is limited.

Under the allowance reserve approach, the ceiling is no longer strict; if all of the extra permits are used, the carbon price could exceed the 'ceiling price'. The mechanisms described in the preceding section for implementing a price floor can also be used for implementing an allowance reserve. The extra permits could be auctioned with a reserve price that is higher than the price floor; alternatively, firms could be required to pay a higher 'extra fee' if they use the extra permits to account for their emissions. Under the latter approach, the requirement to pay a fee would be an integral feature of the permit issued.

The Waxman-Markey Bill includes an allowance reserve, known as the strategic reserve. Each year a small amount (1-3%) of permits is added to the 'Strategic Reserve Fund'[1]. Each quarter, there is a strategic reserve auction, which auctions these permits at a higher reserve price than the reserve price of the rest of the permits. The effect of a strategic reserve in reducing mitigation cost uncertainty may however be significantly weaker than under pure price ceilings, as indicated by Philibert's (2009) modeling.

In their appendix, Roberts and Spence (1976) show that by issuing an arbitrary number of different kinds of permit, it is possible to approximate any convex damage function arbitrarily closely (Figure 2). This could further increase the expected net benefits, by providing a better match between marginal costs and marginal benefits. It would also further reduce price volatility, and could reduce problems with market power (Krysiak, 2008). This could be implemented by auctioning different types of permit at different reserve prices, or having firms pay different fees when they surrender different types of permit. The second approach is equivalent to the options approach of Unold and Requate (2001). Under the second approach, extra administrative arrangements would be required for international permit trading, similar to those mentioned above.

As an example of how such a hybrid approach could be used, it would be possible to simultaneously have an allowance reserve of a fixed number of permits with higher extra fee than the 'normal' permits, and an unlimited number (or a very large number) of 'safety valve' permits with a higher extra fee than the allowance reserve permits.

An allowance reserve could facilitate international cooperation to reduce greenhouse gas emissions. International environmental agreements on issues such as acid rain and pollution of the North Sea have had weak binding commitments, but also have had ministerial level non-binding commitments that are significantly stronger (Victor, 2007). An allowance reserve could have the total number of permits based on a binding commitment, and the number of extra permits based on the difference between the binding and the non-binding commitment.

[1] We are referring here to the version of the Bill that was passed by the U.S. House of Representatives on June 26, 2009 (H.R. 2454, 2009). The strategic reserve can also be replenished with unsold permits from auctions, and proceeds from strategic reserve auctions can be used to purchase offsets in order to replenish the strategic reserve.

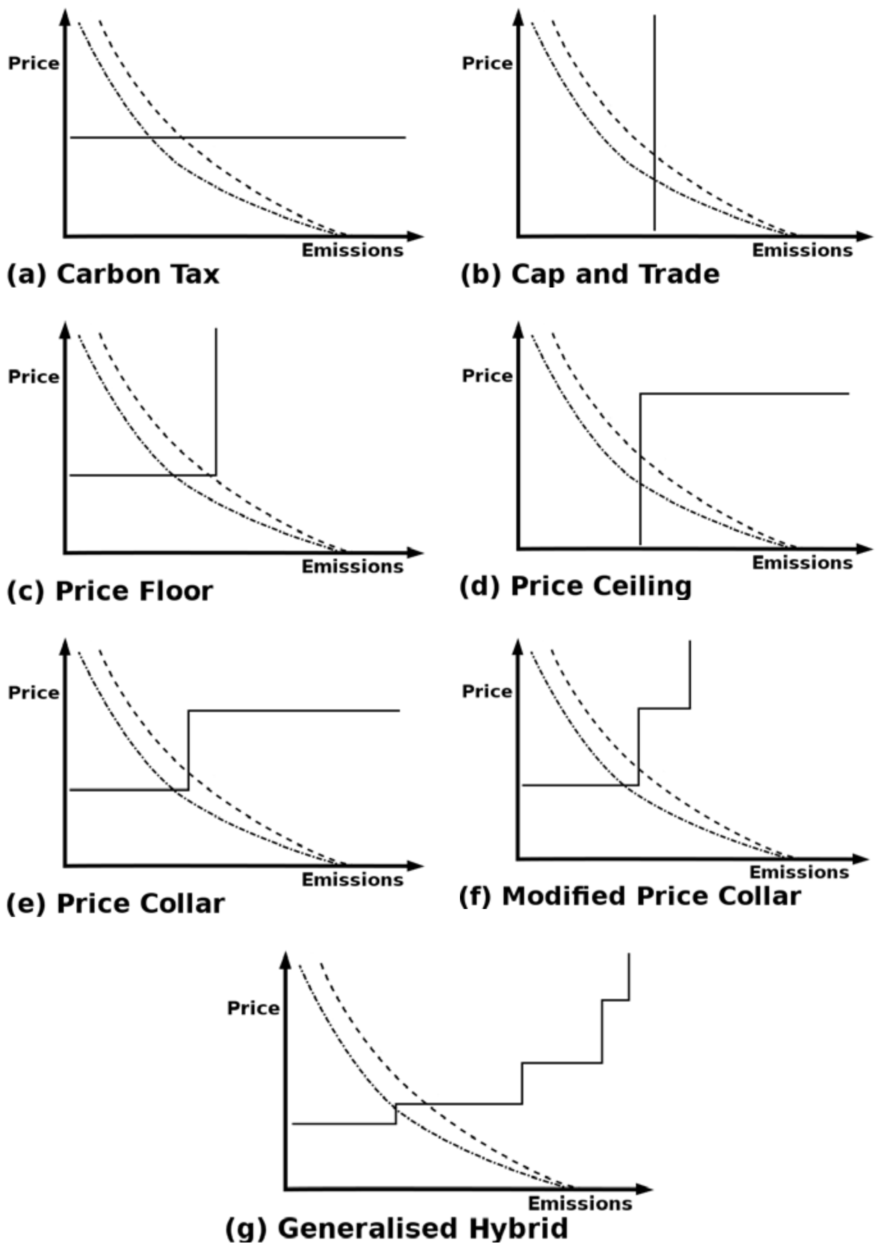

Figure 2. The curved dashed lines represent alternative marginal abatement cost functions. The marginal abatement cost schedules will be unknown in advance, so two possible curves are shown. The lower curve corresponds to abatement being cheaper. The solid line illustrates the carbon price for different policy options. The carbon price and emissions level are determined by the point where the curves intersect. We illustrate a carbon tax in (a), the carbon price does not change for different marginal benefit curves but the amount of emissions changes; for cap-and-trade (b), the carbon price varies but the amount of emissions does not change; for cap-and-trade with a price floor (c), if the cost of abatement is sufficiently low, the amount of emissions will be lower than without the price floor; for a price ceiling (d), the upside risk for the carbon price is reduced but the quantity of emissions may be greater than without a price ceiling; a price collar (e) combines a price ceiling with a price floor; the price collar can be modified (f) so that the price ceiling is replaced with an allowance reserve; more general price curves (g), as described in the appendix to Roberts and Spence (1976), can also be implemented.

5. Conclusions

There are sound arguments for including price floors in emissions trading. Advantages include lower potential price volatility, automatic climate benefits from innovation, and better management of cost uncertainty in the event of lower than expected abatement costs, which in turn improves predictability of returns for low-emissions investments. Price floors are natural complements to price ceilings, which limit price variability at the opposite end of the scale.

Price floors need to be carefully designed to avoid budgetary liabilities, and to avoid barriers to international trade in permits. The most direct approach of a government commitment to buy back permits at a threshold price is unlikely to be viable, especially in the context of international permit trading, because it implies large contingent budgetary liabilities. An alternative approach of a minimum reserve price for auctioned permits, as pursued in the Waxman-Markey Bill, RGGI, and as was earlier considered by the European Union, could yield the desired effect, but could be ineffective if the share of auctioning is small.

A superior option is to require the separate payment of a fee or tax on domestic emissions, in addition to cap-and-trade. This approach carries desirable budgetary implications for national governments, and is fully compatible with international permit trading. In fact, this is precisely what governments do where they have a levy or carbon tax in addition to emissions trading. The fee or tax could be fixed or variable, giving different results in permit markets and for government revenue, and posing different questions for implementation. The impact of an additional fee or levy on the effective domestic carbon price depends on whether permits are traded internationally or not. The extra fee approach can also be used to implement allowance reserves, as well as more complex hybrid mechanisms.

In summary, price floors could fulfil an important supporting role in ensuring effective and efficient climate change mitigation, they can be implemented without compromising vital aspects of emissions trading, and their budgetary properties may turn out to be highly attractive to governments. Current US legislative proposals have important design innovations that could support a lower bound for carbon prices, but the extra fee approach could perform better. The reform of the EU ETS for the post-2012 period offers an opportunity to do better, as does the ongoing process of designing emissions trading schemes in Japan, Australia, and other countries.

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