

Credible commitment in carbon policy

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Abstract

In this article the problem of credible commitment in carbon policy is discussed. Investors favour long-term predictability of the policy but without any external enforcement mechanisms a commitment made by a government can be withdrawn, leading to scepticism and lack of credibility. This results in increased market risks and investment hold-up. Regulatory uncertainty stems from (i) strategic interactions between government and firms, (ii) potential learning about climate damage and abatement cost, and (iii) political volatility. While commitment to future policy encourages private investment, it also imposes costs in the form of reduced flexibility to accommodate new information or preferences. The article reviews devices that may help policymakers to raise the level of commitment while also leaving some room for flexible adjustments. In particular, legislation of a long-term governance framework, delegation to an independent carbon agency, and securitization of investors' stakes in emission markets offer palliative approaches.

Keywords: carbon pricing, incentive mechanisms, regulatory uncertainty, climate policy frameworks

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1 Introduction

If a government unilaterally introduces a carbon price and commits itself to this policy for the foreseeable future, then firms will react to this by incorporating the expected price in their investment decisions. Yet, rational actors will discount the expected carbon price and will do so even more when it is felt that the government might not stick to its self-imposed commitment. Firms will either postpone investing until uncertainty regarding future carbon policy is resolved or require higher rates of return. In both cases, this will reduce the total level of emissions abatement (IEA, 2007). Thus, the issue of how to internally strengthen commitment in order to gain credibility is vital for the effectiveness of carbon policy. At the same time, however, commitment imposes costs if there is uncertainty over relevant parameters such as climate change damage or abatement costs. Commitment then reduces the flexibility to adjust the policy according to new information. Thus, carbon policy is faced with a trade-off between valuable commitment and valuable flexibility.

The commitment problem in carbon policy has been widely discussed and there are many different views as to both its source and its 'solution'. For example, Helm et al. (2003) highlight time inconsistency as a source of the problem and propose that responsibility be delegated to an independent carbon agency, while Ismer and Neuhoff (2009) suggest using financial options to secure government commitment. In Section 2, a discussion of 'credibility' is given, while in Section 3 three sources of regulatory uncertainty regarding carbon policy are distinguished and their implications for commitment are examined. In Section 4, the literature on commitment devices is reviewed and a conclusion is offered in Section 5. The main aim of this article is to present a synthesis of existing approaches for future research.

2 Sources of credibility

What is credibility? In our context, individuals, or a set thereof, have credibility if others believe that they will do what they commit to. A common scenario in carbon policy is for a government to announce that it will price carbon (e.g. by taxation or an emissions trading scheme) over a future period in order to encourage emissions abatement by firms. Firms will assess the credibility of the government's announcement and chose their level of investment accordingly. Credibility is hence a vital element of intertemporal transactions where actors move sequentially.¹ The assessment by firms does not entail a binary choice but rather extends along a continuum between perfectly credible and perfectly incredible. The level of perceived credibility by a firm depends on the government's observable incentives. Assuming that the government acts in its self-interest, the more the observable gains from compliance outweigh the observable gains from deviation, the more credible a policy is. Following Forder (2001), it is assumed that two main factors that determine the level of incentives and perceived credibility are: (1) reputation and (2) commitment devices.

2.1 Repetition and reputation

A government can build up the reputation of credibility through a history of compliance in political transactions. This reputation can be treated like a capital asset that both needs investment (refraining from opportunism) and also pays a yield (Dixit, 1996). Since credibility leads to lower risk, higher private investments and growth (North, 1993), this yield consists in the government's ability to secure better outcomes for the economy. If the incentives of repetition and reputation are strong enough, no additional measures are needed (Persson and Tabellini, 1994).

2.2 Making binding commitments

Where reputation is lacking or low, credibility can be deliberately engineered or improved through forming various ties and bonds known as 'commitment devices'. Kydland and Prescott (1977, p.487) describe them as 'institutional arrangements that make it a difficult and time-consuming process to change the policy rules in all but emergency situations'.² Before these institutional arrangements are discussed in detail below, three principle dimensions of commitment are first distinguished:

First, an institutional arrangement or commitment device (we use the terms interchangeably) can be either external or internal to the jurisdiction undertaking the commitment (Ismer and Neuhoff, 2009). An internal arrangement primarily binds a government vis-à-vis its regulated subjects (a vertical hierarchy), while an external arrangement primarily binds a government vis-à-vis other governments (a horizontal hierarchy). The analysis here focuses on internal commitment devices because external devices, such as multilateral environmental agreements (MEAs), depend on the feasibility of international cooperation. Hence, external devices are beyond any single government's control. Nevertheless it is important to understand that an external device could considerably improve the credibility of commitments vis-à-vis internal stakeholders (Conconi and Perroni, 2009). In the case of non-compliance, the MEA might introduce certain penalties, providing a government with an external incentive to honour its internal obligations. However, as the experience with the Kyoto Protocol demonstrates, devising a self-enforcing international climate treaty is a challenging task (Barrett, 2003).² Even if sustained global cooperation were eventually achieved, an international agreement on carbon constraints would still require their transcription into national policies. Hence, the issue of how to strengthen commitment internally, i.e. using devices that bind policymakers within their own jurisdiction, is of great importance.

Second, a commitment may be credible in a motivational or an imperative sense (Shepsle, 1991). A commitment is motivationally credible if the observable gain from deviation from it is below the observable gain from compliance. While motivational commitment devices do not rule out deviation *per se*, they introduce additional costs for potential defectors making deviation less profitable and hence less likely. By contrast, a commitment is imperatively credible if actors are not free to act otherwise because compliance is coerced. A popular example of an imperative commitment is Ulysses, who bound himself to a mast in order to resist the lure of the Sirens' song on his future self (Elster, 1977). Ulysses committed to resist their song, while the fetters around his wrists forced his compliance. However, unlike Ulysses, a sovereign state - one who owns the

monopoly for using ultimate force - cannot be coerced to honour its commitments (an exception is when actors are prepared to go beyond political deliberation by entering the realm of war). Hence, commitment in public policy can only be of the motivational kind.

The case of Ulysses and the Sirens also illustrates the third dimension of commitment: autonomous or heteronomous commitment. A commitment is autonomous (or self-binding) when the agent (or set thereof) who forms a commitment to act is the main intended recipient or beneficiary (or set thereof) of the action itself: Ulysses commits himself to a course of action intended to prevent his future self from breaking his prior commitment (Schelling, 1984). Commitment in public policy, however, also needs to bind others (Alesina and Tabellini, 1988). A commitment is heteronomous when the agent making the commitment to act is not the intended recipient of the act itself. For example, constitutions are deliberately structured so as to be difficult to change by successive majorities (Holmes, 1988). Carbon policy obviously needs to provide for heteronomous kinds of commitment because climate change is a long-term issue and both the agent (e.g. current government) and the recipient (e.g. future government) will be composed of different sets of individuals at the time of performance.⁴ Commitment devices hence provide successive majorities with an incentive to honour their predecessors' policies. While they foster trust in the regulatory regime, investment, and growth, commitment devices also carry costs. This trade-off is discussed in the next section, before turning to a discussion of individual commitment devices.

3 Sources of regulatory uncertainty

The benefits of commitment are not unequivocally positive but rather depend on the source of regulatory uncertainty considered. Rodrik and Zeckhauser (1988) argue that public policy in general suffers from a fundamental trade-off between valuable commitment and valuable flexibility (or 'responsiveness' as they call it). While Hovi et al. (2009) identify time inconsistency, international anarchy, and domestic politics as sources of uncertainty in climate change policy, they ignore the distinct trade-offs between flexibility and commitment. In our view, there are three main sources of carbon policy uncertainty and each of them implies different net-benefits of commitment. First, in a deterministic setting where government and firms interact strategically, government's ability to make binding commitments improves outcomes whenever firms' anticipation of government's reaction may have adverse incentive effects. Second, with potential learning about climate change damages, abatement technologies, and international politics, commitment can impose costs as it reduces valuable flexibility to respond to new circumstances. Third, political volatility may be used as an argument for commitment but it raises questions of democratic legitimacy. These issues are discussed in detail below.

3.1 Strategic interaction between government and firms

3.1.1 Time inconsistent optimality

Analyses of the problem of time inconsistency began with the seminal article by Kydland and Prescott (1977) in the arena of macroeconomic policy, who demonstrated the conditions under which policymakers have an *ex post* incentive to renege on a policy that may have been optimal *ex ante*. Time inconsistency now is a widely discussed issue in the literature on optimal pollution control, though there is still no unified opinion on its origin and direction. While some authors identify redistribution as the source of the problem (Marsiliani and Renström, 2000; Helm et al., 2003; Baldursson and von der Fehr, 2008), others emphasize changes in marginal abatement cost curves (Biglaiser et al., 1995; Gersbach and Glazer, 1999). Some even predict higher ex-post levels of the optimal carbon price (e.g. Marsiliani and Renström, 2000), while others the opposite (e.g. Abrego and Perroni, 2002).

Consider a benevolent and omniscient government whose sole objective is the maximization of social welfare. This government commits *ex ante* to tax carbon emissions on the basis of which firms invest in low-carbon technologies. These investments generate sunk costs on the private sector side since firms are committed in virtue of their investments in factories, power plants etc., while the government is only committed in virtue of existing laws (many of which it can change). In pursuit of other goals, the government is tempted to exploit this difference by adjusting the policy *ex post*, for example, by reducing the carbon tax to a level which permits low-carbon energy providers to only cover their variable costs (Blackmon and Zeckhauser, 1992). The appropriated quasi-rent of sunk investments is then redistributed to consumers in the form of lower energy prices. Utilities in general, and the energy sector in particular, are vulnerable to *ex post* appropriation because plant value is highly dependent on location and use (Spiller, 1996).⁹ It is assumed here that the reason for the impartial and benevolent government's policy change consists not in resolved uncertainty or shifts in political preferences (these issues are discussed below) but rather in the maximization of social welfare once investments are made. Either the government re-optimizes its policy *ex-post* (time inconsistent) or maintains the now sub-optimal *ex-ante* level (time consistent). Hence, in this context, policy can be either optimal or time consistent but not both.

3.1.2 Investment hold-up

In order to achieve an optimal outcome, the government might try to 'fool' firms by first promising the *ex ante* policy before opportunistically adjusting the policy *ex post*. Of course, this strategy will only work with naïve agents. Rational agents who anticipate the government's incentive to renege might respond in several ways (Spiller, 1996): they can either postpone investment or require a higher rate of return to compensate for higher risk, or they can invest in areas where the payback period is relatively short. Moreover, firms may reduce maintenance expenditures or choose technologies that have a lower degree of specificity in order to reduce their exposure to governmental opportunism. This, however, reduces social welfare because less specific technologies are less well suited for their task and hence less efficient.

The risk premium firms demand, in the presence of regulatory risk, reflects the loss of the option value of being able to decide whether the investment should at a later stage be undertaken when additional information is available (Dixit and Pindyck, 1994). The value of that option increases with risk. For example, Blyth et al. (2007) have found that uncertainty regarding policy increases the carbon price required to stimulate investment in Carbon Capture and Storage by 16-37% compared to a situation of perfect policy certainty.

3.1.3 Ratchet effects

While having a flexible policy allows governments to pursue time inconsistent strategies against firms, firms can also try to exploit regulatory discretion to their own advantage. So-called ‘ratchet effects’ can occur if firms’ current performance is used as a criterion for setting future policy targets (Weitzman, 1980). For example, consider the periodic update of emission caps in the EU Emissions Trading Scheme (EU ETS). Flexible caps provide firms with an incentive to distort investment decisions in order to signal high compliance costs and prepare the ground for a more lenient cap in subsequent trading periods (Harstad and Eskeland, 2010). A firm’s chance of winning with this strategy increases with its market power. Moreover, the use of grandfathering will further aggravate dynamic incentive problems if allowance allocation is based on historical emissions (Hepburn, 2006). Regulated entities can seek to delay abatement or even exacerbate carbon lock-in in order to maximize the number of allowances received.

Regardless of whether firms or governments pursue opportunistic strategies, flexible policy carries the risk of distorting the incentives for emissions abatement. The mere potential for strategic interactions between government and firms, with firms having incomplete knowledge about the direction and extent of policy change, generates risks and reduces investments below socially optimal levels.

3.2 Uncertain damage and abatement costs

Given the potential costs of strategic interactions, the ability to commit is clearly valuable in a deterministic setting. Carbon pricing, however, has to deal with many unknowns. The best available estimates of benefits and costs of emissions abatement are likely to change over time. There are three main areas of positive (rather than normative) uncertainty.

First, the benefits of emissions abatement (mainly, avoided climate change damages) depend on multiple variables and links in the Earth system, none of which are perfectly understood today (IPCC, 2007a, 2007b). Second, the costs of emissions abatement are determined by the development and deployment of low-carbon or carbon-free technologies (IPCC, 2007c). For example, consider the unexpected arrival of a backstop technology which provides low-carbon energy in abundance and at low costs. The *ex ante* carbon price would need to be lowered to reflect cheaper abatement costs. (In the case of emissions trading, the cap would have to be tightened to achieve the new socially higher level of abatement.) If the policymaker was completely committed, significant economic inefficiencies could arise.

Third, the scientific uncertainty over climate damage and abatement costs is further exacerbated by uncertainty over international climate policy. Emissions abatement is a global public good and the net benefits of national carbon policy depend on the contribution of other nations to this. For example, consider the EU which has unilaterally committed to reduce emissions by 20% below 1990 levels by 2020. The EU expects that other regions and countries will eventually take on comparable burdens. However, if they choose instead to free-ride on EU efforts, unilateral abatement is likely to become very costly: carbon-intensive industries might relocate from the EU to countries with less stringent policies (carbon leakage) with the result that EU reduction efforts would yield little or no impact on global emissions.⁶ The behaviour of other countries is therefore a key parameter in assessing the optimal level of national and regional carbon policy.

In sum, carbon policy deals with a so-called ‘super-wicked problem’ (Lazarus, 2009) that is characterized by deep uncertainties, many interdependencies, and complex social dynamics. Once more is learnt about these factors, carbon policy might have to change accordingly. Having the flexibility to update policy according to new discoveries is therefore valuable. However the existence of positive uncertainty rules out any easy way to distinguish opportunism from reasonable responses to changed circumstances. For example, it may not always be possible for a government to determine whether higher than expected abatement costs are a consequence of strategic moves on the private sector side or simply a bad state of nature (Rodrik and Zeckhauser, 1988). Similarly, the diversity of ways in which circumstances can change provides a government with plenty of excuses to opportunistically adjust its policy.

3.3 Political volatility

The above analyses assumed a benevolent and unitary policymaker whose sole objective is the maximization of a common social welfare function. Under a public choice perspective, however, the individuals that constitute the government change over time and hence so may the preferences that are thereby represented. Various stakeholders with conflicting views and interests seek to influence policies to their own advantage. Incumbents may be inclined to use carbon policy for maximizing votes, for example, by reducing the carbon price in order to spur economic growth before an upcoming election.⁷ Further, policy risk arises when shifting majorities in politics lead to alternating represented special interests (Strausz, 2009). Based on different ideologies and constituencies, carbon policy may look very different depending on which political party is in charge.

Another source of political volatility is changing public opinion. Although the equilibrium preference for climate protection may be relatively stable over time, the public’s temporary awareness of environmental problems may be subject to issue attention cycles (Downs, 1972). Peaks in problem awareness (e.g. after climate-related disasters) can lead to more stringent carbon policy (Brunner, 2008). By the same token, carbon policy may eventually be weakened when other issues such as unemployment move up the political agenda. Indeed, it seems likely that political volatility is skewed toward the downside (less stringent carbon constraints) rather than the upside because of the asymmetric temporal cost structure of carbon pricing. Whereas abatement costs

accrue immediately, benefits largely materialize in the distant future in form of avoided impacts from climate change. Although many people feel morally obliged to abate their adverse effect on posterity, the temporary willingness to sacrifice current income to protect future generations from serious harm may wane under difficult economic conditions.⁸

Carbon policy is hence at risk of being undermined by constant economic pressures that prefer to roll-over the costs of mitigation to posterity. A society interested in providing credible incentives for emissions abatement should want to reduce short-term political volatility. The cost of commitment, however, is that it also increases the obstacle to policy change when collective preferences in regard to climate protection move toward a new equilibrium. Commitment then raises questions of democratic legitimacy as it restrains policymakers' ability to respond efficiently to new preferences. The debate over constitutionalism versus democracy involves similar questions. In a review of the arguments, Holmes (1988) concludes that constitutional rules promote - rather than limit - democratic decision making. As he puts it, a constitution is a limit imposed by 'Peter when sober on Peter when drunk' (p. 196). Lazarus (2009) reviews arguments in the context of climate policy.

3.4 *Balancing commitment and flexibility*

3.4.1 Risk sharing

The dilemma of carbon policy is that society is forced to choose a balance between the different benefits and costs of commitment. Determining the appropriate degree of commitment is beyond the scope of our analysis (for an attempt in the context of utility regulation, see Blackmon and Zeckhauser, 1992). It should be emphasized, however, that regardless of the commitment level governments enshrine in their policies, the ultimate outcome of their decision is the allocation of risk between public and private actors. Under complete flexibility, the risk of policy change is fully borne by the private sector. Firms react by either postponing investment or increasing their required rate of return (which is not necessarily inefficient from a social perspective). Efficiency depends on who is best able to carry the risk in question. Optimal risk allocation requires that actors accept risk in proportion to their ability to bear it (Hepburn, 2006). IEA (2007) maintains that governments are better placed to underwrite some carbon policy risks for a number of reasons. First, the long-term and incalculable scope of climate change (and therefore carbon pricing policy) impede insurability, and private agents might not be able to relocate and diversify policy risk. Moreover, if government faces a political incentive to change policy (e.g. for pleasing voters by lowering carbon, and hence energy, prices), it can reap the benefits without bearing the costs. The costs of policy change will be more carefully taken into account if governments have a share in them.

3.4.2 The current commitment gap

Although risk sharing seems appropriate on efficiency grounds, carbon policy, as currently practiced in most countries lacks credible commitment to long-term objectives. Politicians are quick to sign up to ambitious aspirations in the form of 'reducing emissions of greenhouse gases in aggregate by 80% or more by 2050' (G8, 2009, p.19)

but remain reluctant to enshrine necessary incentives in credible policies. The first commitment period of the Kyoto Protocol expires in 2012, with some signatories (e.g. Canada) steering toward explicit non-compliance. What happens after 2012 is still the subject of strenuous climate negotiations. With regard to domestic policies, the US is contemplating the introduction of long-term emissions caps but prospects remain equally unclear. In Europe, the EU ETS extends until 2020 without specifying legal carbon constraints beyond this.⁹ In most countries, long-term reduction commitments only exist in the form of political declarations. Policymakers who are interested in triggering the profound economic transition, deemed necessary to limit global warming, might want to entrench their aspirational targets within more credible structures.

4 Commitment devices

What can policymakers do to increase investors' confidence in long-term carbon policy? What are appropriate institutions to implement a sensible balance of flexibility and commitment? A survey of the literature on commitment devices was undertaken and three distinct strategies distinguished: legislation, delegation, and securitization. By and large, legislative devices leave more flexibility than securitization. Securitization, on the other hand, offers a robust foundation for commitment but is less suited to respond to new realities. Delegation seems to be able to combine flexibility and commitment to a certain extent. This review, however, is only indicative and the question of how individual devices in the end could work depends on their exact design and the adopting country's institutional environment. Spiller (1996), for instance, examines political institutions in the US and Great Britain with respect to their ability to promote credible commitment in utility regulation. Lazarus (2009) reviews legal commitment strategies for US climate policy.

4.1 Legislation

4.1.1 Adjustment rule and governance structure

Given the large uncertainties prevalent in carbon policy, the vehicle for commitment should be an adjustment rule, i.e. a policy which is itself contingent on other factors. Ulph and Ulph (2009) point out that many authors somewhat artificially generate a commitment problem in their analyses by only allowing policymakers to commit to a fixed carbon price (tax rate) or quantity (emissions cap) that is supposed to remain constant. Instead, Jakob and Brunner (2011) demonstrate why policymakers should formulate a rule - rather than a rate - that sets the price or quantity of emissions as conditional on pre-defined parameters (e.g. new insights in climate science or new outcomes of international negotiations), thereby limiting the risk of opportunistic discretion and partly reconciling policy flexibility with commitment. Parameters should be chosen such that regulated entities have no influence over their development in order to avoid incentive distortions (Rodrik and Zeckhauser, 1988). For example, including abatement cost as one variable of the adjustment rule carries the risk of distortions if the private sector has influence over the cost itself.

There are two general limitations to built-in responsiveness: First, it is practically impossible to formulate rules that hold under all contingencies, a deficiency well known in contract law. One may therefore allow some freedom to respond to an unforeseen circumstance. Evidently, such *force majeure* provisions constitute loopholes for opportunistic policy adjustments (Dixit, 1996). Second, even if writing such contracts were possible, the relevant contingencies would need to be observed and assessed before they could be explicitly codified in a rule response. Legislation therefore needs to structure the processes under which adjustment rules are monitored, and (in the case of emergency) triggered. Providing for a governance framework that structures these processes in a transparent and accountable way is thus a key element of credible carbon policy.

Of course, the legal quality of a rule matters for its level of credibility. Commitment by means of constitutional law presents a very high hurdle to policy change as parliaments usually need a qualified majority for constitutional amendments. Statutory law typically requires simple majorities. While there is no case of constitutional carbon constraints, the UK was the first country worldwide to enact a fully comprehensive climate governance framework in statutory law. The UK Climate Change Act of 2008 stipulates ‘legally-binding’ interim (2020) and long-term (2050) targets for emission reductions (UK CCA, 2008). It also set up a governance structure by defining the duties and powers of government, parliament, and an independent advisory body in monitoring, implementing, and (last but not least) updating targets when learning about changes in the relevant parameters (e.g. international climate politics, scientific insights).

Clarity over long-term carbon constraints is essential. Equally important, however, is breaking up long-term commitments into near-term incentives whose impacts can be timely monitored and evaluated. To this end, the UK CCA introduced a carbon budgeting system in which every single budget covers a period of five years and at least three budgets must be set in advance.¹⁰ Setting budgets not only takes into account the overarching long-term target but also a wide range of near-term factors such as economic and technological development (Hill, 2009). In addition, the UK government intends to break down accountability into departmental levels where each minister is responsible for meeting the sub-budget for their own economic sector (DECC, 2010). The downside of short-term budgets, however, is that they may hinder the intertemporal equalization of marginal cost. Efficient budgets require that the government knows what the development of abatement cost is over the entire time horizon.

4.1.2 Enforceability and public scrutiny

It is not obvious what the consequences of self-imposed ‘legally-binding’ targets are at first sight. After all, every subsequent legislature will have the authority to change laws and subsequent governments will be able to change the degree of enforcement. Legislation, however, raises the discursive hurdle for policy change. Targets can no longer be silently dropped when they become inconvenient. Changing laws entails a visible (and perhaps politically costly) process if constituencies are not convinced of the action’s legitimacy.

Governments sometimes choose to ignore legislated commitments instead of changing their legal basis. The ability to internally enforce targets against a non-complying

government varies over jurisdictions. For example, consider unbalanced carbon budgets in the UK CCA. In theory, every stakeholder has the right to take the government to court if a carbon budget is not met. In practice, judicial review in this issue area is restricted to procedural misdemeanour, and case law demonstrates that such a challenge is likely to fail (Hill, 2009). While the potential for judicial review is limited in the UK, other legal systems allow a greater role for courts or citizens in ensuring effective enforcement. For example, the US legal system offers more opportunities to sue a non-compliant government. Sina et al. (2009) explore the potential of applying a CCA-like framework in Germany and highlight the power of the Federal Constitutional Court to enforce climate legislation. However judicial procedures may be too time-consuming to be practical and the deviating government may be long out of office before the courts sanction a judgment of non-compliance.

Plausibly, the main motivation for government to avoid non-compliance with the law is public scrutiny. If a governing majority anticipates that the political costs of pursuing a certain course of action will be a loss of public support, then taking this route is less attractive. Hence, carbon policy should be deliberately designed so as to encourage public scrutiny, for example, by earmarking revenues from emissions trading for redistribution purposes. A large share of the proceeds from auctioning emission permits could be recycled back to consumers via annual lump-sum payouts. A congressional draft for climate legislation in the US included provisions on earmarking revenues from auctioning (see Cantwell and Collins, 2010). By mitigating (for the poorest households potentially reversing) its regressive distributional impact (Burtraw et al., 2009), a ‘climate dividend’ could create long-term political support for carbon pricing. It would restructure the incentives for the ultimate enforcer, namely the electorate, to have the policy implemented over time.

4.2 Delegation

The general limitation of using legislation as a commitment strategy is that no rule is carved in stone. No government can enact laws or regulations that successors cannot revoke or dilute. A credible policy is therefore one that tries to insulate implementation from day-to-day politics. Delegating part of the authority to institutions with a time horizon beyond the current legislative period may be a means to this end. In principle, these institutions may be an advisory or an agency.

4.2.1 Advisory

An advisory, or watchdog, is a government-independent monitoring entity¹¹ that is delegated the authority to advise and monitor government’s performance on a regular basis. The UK CCA institutionalized a regular reporting and monitoring cycle through the government-independent Committee on Climate Change. The Committee advises the UK parliament on carbon budgets and policies and monitors the country’s progress along the transition path through annual progress reports. The merit of having an independent watchdog lies in forcing government to publically justify its own actions on a regular basis (Lazarus, 2009). Yet the very existence of an organization does not suffice to increase policy credibility: Germany, for example, has three different government-independent advisory bodies for environmental policy none of which can even closely

match the Committee on Climate Change's high public profile in the UK.¹² A legal obligation for government to regularly obtain and respond to the organization's advice, as laid down in the UK CCA, and the choice of figureheads with influence in politics and business is critical to give it an authoritative standing. Time will show whether the UK CCA's political clout suffices to effectively check political opportunism.

4.2.2 Agency

In contrast to an advisory where policy control remains with the government, an agency is an institution that is delegated the authority to implement the policy on government's behalf. Two issues play a key role in the rationale for delegation: reputation and objectives. First, Barro and Gordon (1983) investigate how government reputation could mitigate the problem of time-inconsistency in monetary policy. But the transience of leaders and ruling majorities in politics leads to heavy discounting of the future value of reputation. Independent agencies that are insulated from political cycles have stronger incentives to build up and retain their reputation over longer time horizons (Persson and Tabellini, 1994). Second, in the context of commitment, agents can be most valuable when their objectives are distinct from those of the delegating principal (Schelling, 1956). Political opportunism often stems from governments facing multiple and at times conflicting objectives (e.g. low energy prices and climate protection). With delegation, the number of objectives per agency can be reduced. 'Political unbundling' (Brunekreeft and McDaniel, 2005) then eases the pressure to renege on past commitments and may help to increase policy credibility in investors' view.

The literature on the benefits of central bank independence inspired Helm et al. (2003) to transfer this device to carbon policy.¹³ Similar to monetary policy where the central bank is assigned to meet an inflation target, a carbon agency or 'carbon central bank' could be delegated the duty and powers to meet a certain temperature or emission target by, for example, setting a carbon tax. If the initial staff has some conviction in the task, the evolving organizational culture and sense of mission will create a barrier to change (Wilson, 1989). The separation of politics and administration enables the government to commit to the original program while the rationale/legal constraints of Weberian bureaucracy insulates agents from efficiency-undermining political pressures (Moe, 1990). The agency retains the flexibility to react to changing circumstances but it does so within clearly defined boundaries as laid down in its mandate. As such, delegation might be able to combine the advantages of credible commitment and flexibility.

4.2.3 Limits to institutional independence

If one argues that independent agents can solve the commitment problem in carbon policy, one needs to show when and why independence is costly to reverse. The central bank model has demonstrated how institutional independence can create credibility for time frames relevant for inflation targeting (Cukierman et al., 1992). If a government wants to regain influence over monetary policy (e.g. by lowering interest rates, for an upcoming election, thereby boosting economic growth), the mere announcement of doing so may raise the level of expected inflation, undermining the political goal of price stability. Before government actually regains control over monetary policy to produce the benefits it seeks, it will pay the costs of its attempt, thereby acting as a deterrent to performing the action in the first place. Time frames in carbon policy, however, are

considerably longer than in monetary policy. The inertia in the built energy system might allow governments to abolish carbon agency independence without immediately suffering the costs in the form of significantly higher emission levels.¹⁴ Note that an actual reversal of institutional independence is not even necessary. The mere threat to abolish independence suffices to influence agency decisions (McCubbins and Schwartz, 1984). Moreover, as Helm et al. (2003) point out, the trade-off between economic growth and monetary stability exists only in the short run. Carbon policy, by contrast, must balance the objectives of low energy prices and climate protection over longer time spans. To a certain extent, carbon pricing implies an intergenerational redistribution of welfare where the present generation bears costs (higher energy prices) to the benefit of future generations (lower damage cost from climate change). Delegating carbon policy to an independent agency may therefore face substantial resistance from those groups who argue that the task of resolving intergenerational distributional conflicts should remain within democratic institutions.

4.3 Securitization

As mentioned above, constitutions offer a robust foundation for commitment because political hurdles to change constitutional provisions are high. An integral part of most constitutions is the protection of private property. Securitization as a commitment strategy acts as leverage on these provisions by entrenching commitments in private property rights and contracts.

4.3.1 Contracts and carbon pricing

From an economic perspective, the legal characterization of commitment matters insofar as it impacts incentives. The less reliable a commitment is, the lower are market participants' incentives to invest in its implications. In this context, it is worth considering feed-in tariffs for renewable energy sources. A major strength of feed-in tariffs is that they provide a legal guarantee of revenues. Lowering the tariff within the guaranteed period faces high legal hurdles because it undermines contractually agreed payments and directly devalues investors' property.¹⁵ Carbon taxes and emission caps, by contrast, can be adjusted freely without violating any contractual agreements. In fact, the power to introduce and abolish taxes at their own discretion is constitutive of parliamentary sovereignty, and political constitutions shield rather than confine this power. Moreover, taxes seem less suitable to establish credible commitment because, in contrast to tradable permits, they do not directly create a financial market constituency interested in the continuation of the policy.

The introduction of contracts in carbon pricing therefore rests on the use of quantity-based instruments. The conventional assumption among economists is that tradable emission permits represent property rights. Legal experts, however, maintain that permits only grant a limited authorization rather than a private property right *per se* (Cole, 1999; Woerdman, 2005). Allowance holders do not own disposal space in the atmosphere. Rather, regulators recognize property rights *in allowances* and market participants can receive, hold, and transfer allowances. The value of allowances of course depends on regulation and regulators can modify or terminate trading regulations without necessarily infringing property rights. Hence, the establishment of a tradable permit system where

participants hold emission ‘rights’ does not provide sufficient protection against opportunism.

4.3.2 Enhanced tradable permit systems

Enhanced tradable permit systems build on current allowance markets but add some additional features. One means to strengthen the commitment to trading systems is to prolong the validity of permits (McKibbin and Wilcoxon, 2007). Long-dated permits allow their owners to emit one unit of emissions each year over the lifespan of the permit (e.g. 30 years). Permit owners have an interest in keeping the system running and the cap tight because these increase the scarcity value of their asset. They form a countervailing constituency against political attempts by subsequent governments to dilute commitments. To allow for flexibility, a fixed supply of long-dated permits could be combined with a variable supply of annual permits that can be adjusted in response to new information and preferences. However, long-dated permits may be prone to strategic investment hold-up (Biglaiser et al., 1995) as permit owners with market power might be inclined to strategically under-invest in abatement, thereby driving up permit prices and increasing the market value of their assets.

With put-options on emission allowances, investors could hedge their low-carbon assets against the downside of a carbon price risk while also providing government with a contractual incentive to honour its commitment (Laffont and Tirole, 1996; Kemp and Swierzbinski, 2007; Ismer and Neuhoff, 2009). Put-options may be partly seen as an equivalent to feed-in tariffs in terms of incentive- and risk- structure since they too ensure that part of the costs of learning effects are borne by tax payers. The government, having sold the option, has financial incentive to adhere to set targets and keep permit prices above the committed minimum. If the volume of outstanding options is sufficiently large, a price floor for emission allowances will emerge in the carbon market. As financial contracts, put-options are protected by constitutional provisions and can be enforced against government through independent courts. While they represent a powerful commitment device, regulators can freely choose the overall level of aspired commitment via three parameters: (i) strike price, (ii) the number of options issued, and (iii) the duration of options (Ismer and Neuhoff, 2009). Increasing any of these strengthens the commitment.

4.3.3 Carbon bonds and contracts

Carbon bonds and carbon contracts are both devices that can be implemented as complements to existing cap-and-trade (C&T) systems. First, consider a government that issues a bond whose coupon payment negatively correlates with the market price of allowances in an emissions trading system (Mainelli et al., 2009). Project developers investing in low-carbon technologies could buy this bond in order to hedge against carbon price risk. The carbon bond would transfer part of the risk to government, which then faces a financial incentive to keep prices in the permit market high. The device leverages on the credibility that governments seek on international bond markets because breaking with this kind of commitment imposes high costs in the form of higher risk premiums for public finance. The degree of commitment can be chosen via pay-off structure, duration, or the aggregate volume of outstanding bonds.

Second, the possibility that governments auction off long-term procurement contracts over the supply of emission reductions is complementary to the institutional choice of C&T (Newbery, 2003; Helm and Hepburn, 2007). Firms bid their prices for a specified quantity of emission reductions, and the government closes a contract with the lowest bidder. Tenders can be made technology-blind. Carbon contracts provide firms with a forward revenue stream with long-term price certainty. The government, by contrast, could resell emission credits into C&T systems such as the EU ETS. However, carbon contracts generate emission reduction credits relative to an assumed baseline (an analogue to credits stemming from the Clean Development Mechanism of the Kyoto Protocol). As such, their use is confined to sectors and installations not covered by C&T systems.

4.4 *Creating countervailing constituencies*

What is the common theme of commitment devices? In our view, the key to understanding credible commitment lies in what Dixit (1996) termed a theory of ‘transaction-cost politics’ or Spiller (1996), less elegantly, dubbed a ‘transactions cost-cum-positive political theory’ approach. Commitment devices place political transaction costs in the path of policy change in order to mitigate the risks of opportunism. They create or support long-term countervailing constituencies interested in the continuation of the policy. Partly, this strategy relies on the introduction of additional formal or informal veto players in the political system (Tsebelis, 2000). Political transaction costs can accrue in various forms: bad press, the need to seek cross-partisan consensus, logrolling, losing votes, lower contributions from interest groups, admonition from courts, financial expenditures etc. Political transaction costs do not put an absolute limit on government flexibility. Rather, they provide future majorities with an incentive to adhere to the announced course of action by decreasing the gains from deviation.

However, there are many open questions both in theory and in practice. This review lacks an analytical framework within which the net-benefits and feasibility of individual proposals can be compared. Both factors depend on a country’s objectives and institutional endowment and can therefore only be assessed on a case-by-case basis. The development of a political transaction-cost framework for carbon policy and its application to a case-specific institutional context is a task that is left to subsequent work.

5 Conclusions

There is a fundamental trade-off between flexibility and commitment in carbon policy, and the benefit of commitment decisively depends on the source of regulatory uncertainty. Three sources of carbon policy uncertainty were identified: First, in a deterministic setting, the strategic interaction between government and firms may have adverse effects if policy is flexible. The mere anticipation of time-inconsistent decisions leads to investment-hold up. Ratchet effects occur when firms see a chance of influencing future policy choice by changing their own performance. Commitment to future policy is valuable in this setting. Second, under uncertainty, commitment may lead to socially

inefficient outcomes if it impedes government's flexibility to respond to unforeseen developments in science, technology, and international politics. The presence of uncertainty also makes it difficult to distinguish opportunism from reasonable responses to changed circumstances. Third, political volatility in the domestic arena amplifies investment risks but strong commitment (which binds successive majorities) raises questions of democratic legitimacy. In brief, the dilemma of carbon policy is that society is forced to balance the different benefits and costs of commitment. The degree of government commitment determines the allocation of risks between public and private actors. Weak commitment imposes most risks on the private sector. Current carbon policy around the world is largely characterized by relatively weak commitments. Governments interested in triggering the economic transition deemed necessary to mitigate climate change might want to entrench long-term carbon policy in more credible structures.

How can governments attain a higher degree of commitment and credibility? Commitment devices were reviewed that internally restructure the incentives for successive governments to adhere to set policies. The underlying rationale of legislation, delegation, and securitization is to create and support countervailing constituencies with a long-term interest in emissions abatement. First, legislation can provide a transparent governance structure for setting, implementing, and updating carbon policy. A legal duty to write carbon budgets ensures accountability and continued attention to the policy issue. While enforceability cannot be generally guaranteed, earmarking carbon revenues for redistribution to consumers is one way of ensuring public scrutiny over time. Second, delegation insulates interests dedicated to emissions abatement from day-to-day politics while preserving the capacity for flexible adjustments. The institutional mandate may define monitoring and advisory duties. It may also delegate the authority to set policy on government's behalf to an independent carbon agency. Clearly defined agency objectives together with stronger incentives to retain reputation can improve the credibility of delegated policy. Third, securitization protects investors' stakes in carbon markets by entrenching commitment in enforceable contracts. In particular, put-options on emission allowances fit well with the institutional setting of cap-and-trade systems. In sum, these strategies may help to anchor private sector expectations regarding the future profitability of emissions abatement.

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Endnotes

1. A government that could move first - for example by paying the firm a subsidy for emissions abatement upfront - would need to worry less about credibility

- (Abrego and Perroni, 2002; Ulph and Ulph, 2009; Golombek et al., 2010). As Schelling (1956, p.283) writes, ‘what is the best way to persuade someone of his/her intention? ‘Make it true’’.
2. Bryan et al. (2010) point out that these arrangements do not serve a strategic purpose with respect to others but rather help the agent to fulfil his own future plans. Schelling (1954, p.282), by contrast, discusses commitment in an explicit strategic context where ‘the power to constrain an adversary may depend on the power to bind oneself’. Strategic commitment devices are designed to help players win a bigger share of the relevant pot, while efficiency-enhancing commitment devices are designed to increase the size of the relevant pot.
 3. Note that the quality of enforcement mechanisms varies over issue areas. The Montreal Protocol on ozone depleting gases is widely considered as a successful MEA with good enforcement mechanisms. However, designing a self-enforcing global climate change treaty seems more challenging for a number of reasons (for a detailed analysis see Barrett, 2003). Note that linking regional emissions trading systems could provide an alternative source of external commitment because linking agreements can curtail the flexibility for unilateral adjustments to carbon pricing (Flachsland et al., 2009).
 4. If one views ‘government’ as referring to a unitary, eternal entity, commitment in public policy will appear autonomous as the institution ‘government’ binds its own hands. This is usually the perspective chosen by analyses of time-inconsistency problems. However, government is here regarded as a group of individuals whose composition and motives may change.
 5. The incentive to appropriate is greater when the interval between investments is longer because the penalty for appropriation (higher future capital cost) has a lower present value (Blackmon and Zeckhauser, 1992).
 6. If, however, a global cap can be agreed upon in the near future, Europe is likely to benefit from an early-mover advantage (Edenhofer et al., 2009). The benefit of the timely redirecting of investments to low-carbon technologies and infrastructure is projected to exceed the costs of a higher cumulative reduction commitment.
 7. See Drazen (2000) for a review of the empirical evidence of political business cycles in fiscal and monetary policy. It is unclear whether similar patterns can be expected to occur in carbon policy.
 8. If all societal groups had their interests represented, then all external effects would become internalized and the political equilibrium would be socially efficient (Aidt, 1998). However, pressure groups representing the interests of future generations tend to be relatively weak (see Tremmel (2006), who discusses some models of institutionalization). Even in a purely intragenerational context, collective action problems arise. As Olson (1971) argues, economic interest groups tend to voice their preferences more effectively than public interest groups because they usually are well organized, homogenous and able to provide benefits to their exclusive membership.

9. EU Directive 2009/29/EC specifies an annual linear reduction factor of 1.74% that applies to the emissions cap beyond 2020. Article 9, however, explicitly states that the reduction factor shall be reviewed without indicating for what reasons, in which direction, or to what extent it may change.
10. Budgets cover the entire UK economy, including those sectors covered by the EU Emissions Trading Scheme (EU ETS). Having a ceiling on trading-sector emissions may eventually generate conflicts with EU law where a sectoral limit within the EU ETS cap is not foreseen (Sina et al., 2009). This is one reason why commitment devices should strive to match the governance level of relevant carbon pricing instruments such as the EU ETS.
11. A related concept is that of guardians. Guardians attempt to counter-balance the myopic bias of parliaments by deliberately representing the interests of future generations. For example, Hungary installed a Parliamentary Commissioner for Future Generations who has formal participation and review rights during policy formation. See Tremmel (2006) for a review of different models of intergenerational representation.
12. The Sachverständigenrat für Umweltfragen (founded in 1971), the Wissenschaftlicher Beirat für Globale Umweltveränderungen (1992), and the Rat für Nachhaltige Entwicklung (2001).
13. At the international level, Barnes et al. (2008) propose to create an Earth Atmospheric Trust that administers the global carbon budget with the aim to maximize the long-term benefits on behalf, and in the long-term interest, of global society.
14. We thank Karsten Neuhoff for pointing this out.
15. Nevertheless, feed-in tariffs too may involve regulatory risks. In Spain, the government retroactively announced cuts to remuneration for existing wind power plants in order to manage mounting subsidy payments. However, the market participants believe that this cut is unlikely to affect investors' property because it will only come into force when a certain (relatively high) number of operating hours is exceeded (Platts, 2010).

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