

1. An Overview of the Economics of Voluntary Approaches in Climate Policies

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THE CLIMATE PROBLEM

Climate change is possibly the most important threat to our global environment and future, while at the same time it is intimately and in many ways linked to our lifestyles and to how we produce, use and eliminate our goods and services. There are many possible actions and measures that authorities, firms and individuals can take to address climate change issues. Those actions can broadly be categorized into mitigation and adaptation measures. Mitigation activities are those that reduce greenhouse gas (GHG) net emissions.¹ The most obvious measure in this domain is to decrease GHG emissions into the atmosphere by reducing fossil fuels use. Other mitigation activities include end-of-pipe removal of GHGs from emissions streams and sequestration of emitted carbon through, for example, forest management, afforestation and agricultural practices. Since mitigation will affect GHG concentrations in the atmosphere only in the long-term, it is also important to consider adaptation measures, that is, actions that reduce our vulnerability and climate change damages. A wide range of sectors and activities may be subject and would need to adapt to climate changes, such as agricultural practices, water distribution systems and human settlements. The possibility and the costs of adaptation will depend on whether climate change will be gradual or increasingly subject to abrupt changes, for example, catastrophic events. In general, we may expect that poor countries would be less able and possess a lower potential to adapt (Kolstad and Toman, 2001). Both mitigation and adaptation require profound modifications in our value systems and consumption patterns, which implies that changes in lifestyles are as important as technical innovation.

A fundamental feature of the climate change issue is that the atmosphere is a global public good. This means that a unit of GHG emitted anywhere in the

world has the same impact on climate change and everybody suffers from global warming and benefits from global warming control (though not equally). That implies that the efforts of one country can be offset by increased emissions in any other. However, GHG mitigation also yields local environmental gains, mainly better air quality but possibly also less noise and traffic, which benefit the health and safety of people and the built environment. Those gains have been estimated to be sufficient to justify some unilateral mitigation measures (see IPCC, 2001). Nevertheless, the global public nature of climate change promises efficiency gains resulting from international co-ordination of mitigation measures. Aware of that, the international community agreed on the United Nation's Framework Convention on Climate Change (UNFCCC), which came into effect in March 1994. We may interpret the UNFCCC as an effort to change the property regime of the atmosphere – from an open access to a common property resource – and to establish a framework for its global management.

In December 1997, 160 countries, parties to the UNFCCC, reached an agreement in Kyoto on a Protocol to the Convention that translates the UNFCCC's general objectives into precise policy commitments. It prescribes legally binding emissions targets and timetables for nearly all developed countries and countries that are undergoing the process of transition to a market economy (Annex B countries). Altogether, those countries committed that their net emissions of a basket of six greenhouse gases² do not exceed, on average over the five years of 2008–12, 94.8 per cent of their emissions in 1990. Developed countries agreed to differentiated ceilings, for example, 92 per cent for the European Union and Switzerland, 93 per cent for the United States, and 100 per cent for the Russian Federation. There are no quantitative emissions targets for the developing countries.

The Kyoto Protocol becomes effective only if no less than 55 countries that are parties to the UNFCCC, representing at least 55 per cent of the Annex B countries' total 1990 CO₂ emissions, ratify it. After the Bush administration's announcement in March 2001 that it would not ratify the Protocol (the United States accounted for 36 per cent of Annex B CO₂ emissions in 1990), its future is uncertain. Even if it enters into force, the Kyoto Protocol will most likely not prevent the net emissions of all Annex B countries exceeding 94.8 per cent of the 1990 level, because the USA will not participate, but also because of the difficulties in measuring sequestration (Legge and Egenhofer, 2001). However, the real importance and effective impact of the Kyoto Protocol will be judged by looking at its capacity to implement an international architecture that will lead to further and much stronger emissions reductions in the future. That will be obtained only if all relevant stakeholders, including the developing countries, are willing to implement climate change policies.

Reducing GHG emissions relative to business-as-usual emissions paths implies sacrifices. The magnitude and distribution of those sacrifices depends very much on the instruments used to attain a given target. In general, no single instrument can be simultaneously the least costly and the fairest for everyone and in each circumstance, and thus countries have started experimenting with an array of initiatives and programmes. The current consensus is that a mix of instruments is best able to address the conflicting goals of efficiency and equity, with voluntary approaches (VAs) playing a key role in that mix. In some cases, like the USA, VAs are, however, practically the only instruments to foster GHG reductions.

GHG abatement can be achieved by reducing the volume of emissions for the same production level of goods and services. This involves mainly increasing energy efficiency, that is, reducing the quantity of energy needed to produce and operate a given product. Many technologies are already available and used by some but not all firms. Accelerating the adoption of those technologies is certainly an effective and relatively inexpensive way of reducing GHG emissions. For example, this approach is the only one considered by current USA climate policy. Further abatement can be obtained through input substitutions, in particular the replacement of fossil fuels by renewable energy sources. Finally, reductions in the volume of goods and services produced and in our standards of living might be inevitable.

These possible ways to abate GHG emissions can be illustrated by a simple decomposition analysis. Write E for total emissions, e for emissions per unit of output or 'emissions intensity', and Q for total output. Then, we have $E = e \times Q$ or, for small changes, $dE/E = de/e + dQ/Q$, where dx/x denotes percentage changes. Thus, the percentage increase (or decrease) in GHG emissions can be decomposed into the sum of the percentage increase in emissions intensity and the percentage increase in output. Reduced emissions intensity, obtained through greater energy efficiency or energy substitution, may be partly or fully offset by increased production. World CO₂ emissions grew at an average 1.67 per cent per year between 1973 and 1990 in spite of the reduction in CO₂ emissions per unit of GDP at the rate of 1.23 per cent per year, because world GDP grew at an average 2.90 per cent over that period (adapted from Darmstadter, 2001). Over the 1990–7 period, slower growth of GDP of 2.38 per cent per year still offset faster reductions in emissions intensity at the rate of 1.83 per cent per year to result in a net increase in CO₂ emissions at the rate of 0.55 per cent per year. We have to note that, since it is the concentration of GHGs in the atmosphere that matters for global warming, and since the rate of decay of the various GHGs is relatively slow, any increase in emissions will add to the total stock of GHGs in the atmosphere for several decades or even centuries.

WHAT DO WE MEAN BY VOLUNTARY APPROACHES IN THIS BOOK?

The general context of voluntary approaches is that of economic agents who have a negative impact on the natural environment and who reduce it without being legally obliged to do so. We might therefore speak of voluntary reduction of negative environmental impacts or ‘voluntary abatement’ efforts. More precisely, we consider as voluntary abatement only the reduction efforts that exceed what is required by existing regulation (over-compliance), or efforts made in the absence of regulation.³ Voluntary approaches are part of environmental policy, next to regulation and economic instruments such as taxes and tradable permits, because some public body is nearly always encouraging voluntary abatement.

There exist many forms of VAs and several taxonomies are proposed in the literature. In this book, we will mainly refer to the taxonomy proposed by the OECD (1999), which is probably the most widely used, although we will introduce some minor deviations from it. There are two main dimensions along which VAs differ most significantly:

1. The *degree of regulator control* over the VA. At one extreme, regulator control is very small: the regulator only offers encouragement, and registers and communicates the firms’ achievements. At the other extreme, the regulator creates a framework to which individual firms or industry associations may adhere, thus accepting the rules, constraints and deadlines decided by the regulator. In between those extremes, the regulator may negotiate with firms with a view to setting up tailor-made agreements involving reciprocal commitments.
2. The *extent to which an announcement is binding*. At one extreme, polluters may just communicate abatement efforts without any commitment to a target. At the other extreme, they may sign binding contracts with the regulator setting targets and deadlines, with sanctions enforced in case of non-achievement. Enforcement can be through the judiciary for breach of contract, or it can be through imposing regulation or taxes from which firms were initially exempted against their commitment to abate ‘voluntarily’.

The categories of VAs can be defined and represented along those two dimensions (Table 1.1).

Table 1.1 A taxonomy of voluntary approaches

	Regulator control	Binding commitment
Self-regulation	weak	rather weak
Negotiated agreements	intermediate	rather strong
Public voluntary programmes	strong	intermediate

Self-regulation refers to abatement efforts initiated by firms without substantial counterpart by the regulator.⁴ The regulator may nevertheless announce targets, communicate objectives, encourage, facilitate, disseminate technical information, offer technical assistance, monitor, register and communicate achievements, and so forth. Efforts obtained under the threat of regulation or taxation could be classified as self-regulation if the threat is hypothetical. Firms are generally not bound to attain environmental targets. Sometimes, however, they grant monitoring and enforcement powers to third parties. In that case, one can clearly speak of *unilateral commitments*. Adopting environmental management systems, implementing ISO 14001, and the USA programme Climate Leaders are typical examples of self-regulation.

Negotiated agreements (NAs) are tailor-made contracts between the regulator and individual firms or groups of firms, which define targets and timetables for pollution reduction, rewards and penalties. Typically, the rewards for participation are exemptions from taxes or regulation. Project XL and Climate Challenge in the USA and the Dutch long-term agreements are representative examples of negotiated agreements or frameworks for negotiated agreements.⁵

Public voluntary programmes (PVPs) are packages of required efforts and compensations that firms can choose to accept or not.⁶ When firms choose to participate, they are more or less bound to the programme's targets and timetable. Generally, the more substantial the compensation offered by the regulator, the greater is enforcement of programme objectives. Many but not all the US Environmental Protection Agency's 'voluntary partnership programmes' or 'voluntary programmes' have those characteristics. Its Green Lights and 33/50 programmes are typical examples of public voluntary programmes.

VAs can be further qualified within those three broad categories with reference to the following features:

- Whether firms undertake voluntary abatement alone or jointly, typically with a whole industry sector. Self-regulation that takes the form of agreements within an industry is sometimes called unilateral agreement.
- The type of compensation or incentive offered by the regulator, from the least substantial such as information, technical assistance, and labels, to the most substantial such as tax breaks, exemptions from costly regulation and subsidies.
- The motives for participation (see below).
- Whether abatement is costly in the net or not ('no regret actions'). However, one must make it clear whether only direct internal benefits from abatement are included (such as saved resources) or whether the compensations offered by the regulator or even the costs avoided by fending off stiffer regulation and taxes are also included.

In this book we will *not* use some terms sometimes mentioned in the literature. However, they are discussed hereafter, since this might spell out some useful concepts and the differences between VAs and other policy instruments.

- *Private agreements*: defined by the OECD (1999) as 'contracts between a firm and those who are harmed by its emissions'. We do not deal with those situations under VAs, but would rather refer to them as Coasian solutions. Indeed, they do not involve the public sector other than in defining property rights and enforcing contracts. Those agreements could fall under self-regulation, as the polluter commits towards the polluted. When the regulator represents the polluted, the agreements will be classified as negotiated agreements (see Figure 1.1).

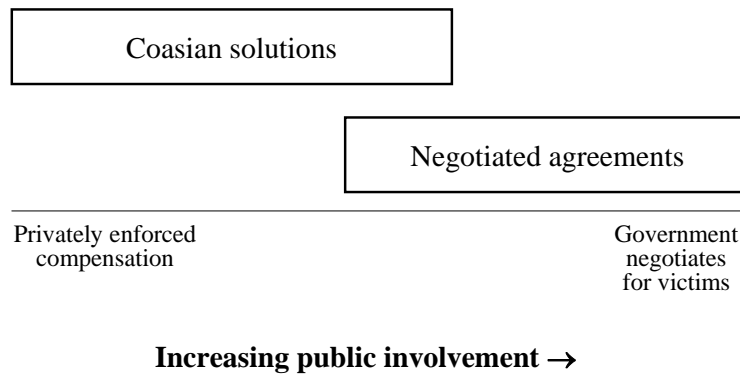
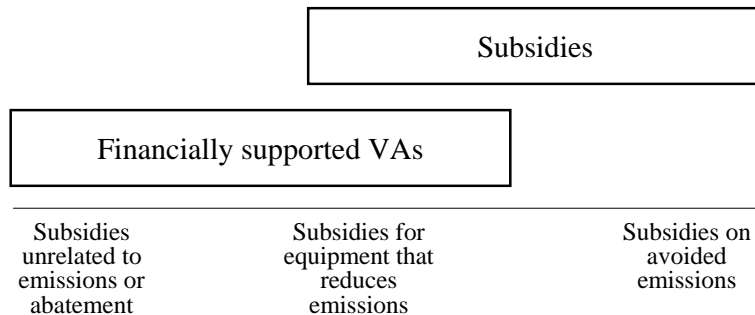


Figure 1.1 VAs vs. Coasian solutions

- *Standards* elaborated by a business organization and imposed on all firms with enforcement by a legal authority do not belong to voluntary abatement.
- *Participatory regulation*. Of course, it is not enough that the polluters are consulted on regulation to make it a voluntary approach.
- Some programmes offer *subsidies* to participants who reduce their environmental impact (for example, in agriculture). Those should be considered simply as subsidies rather than voluntary approaches (see Figure 1.2). On the contrary, we consider as voluntary approaches the agreements between regulator and firm that provide for a subsidy or tax break on emissions if the firm agrees on some particular effort different from simply answering to the subsidy or tax.



Increasing link between subsidies and emissions →

Figure 1.2 VAs vs. subsidies

WHAT IS SPECIAL ABOUT VAs?

What distinguishes VAs from other policy instruments in the field of environmental protection? There are many features of VAs that make this type of policy instrument quite peculiar. Those main distinguishing features are:

- Co-operation with the regulator is a central distinguishing feature of VAs. Voluntary approaches belong explicitly to co-operative policy design. However, we should note that, although not an explicit part of the instrument as such, regulation and even economic instruments are always negotiated too. The concerned agents are at least consulted and given a chance to influence policy making (see Figure 1.3). Only in economic

textbooks does an omniscient and benevolent regulator impose regulation and policy instruments. In some VAs, there is an explicit contract concluded between polluter and regulator. Again, co-operation can be weak or strong, when the regulator participates in abatement costs (subsidies for equipment, for example). It can be between regulator and individual polluters or with industry representatives.

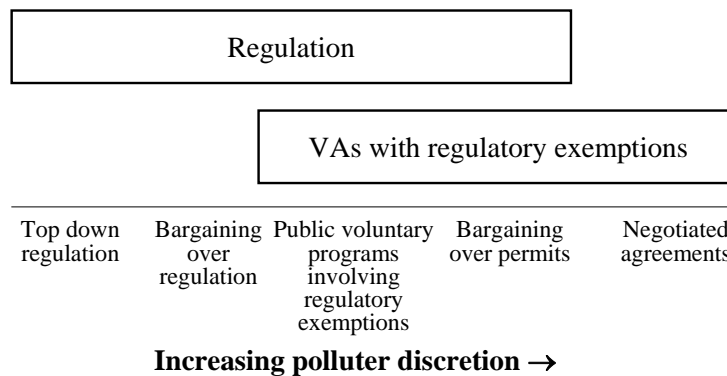
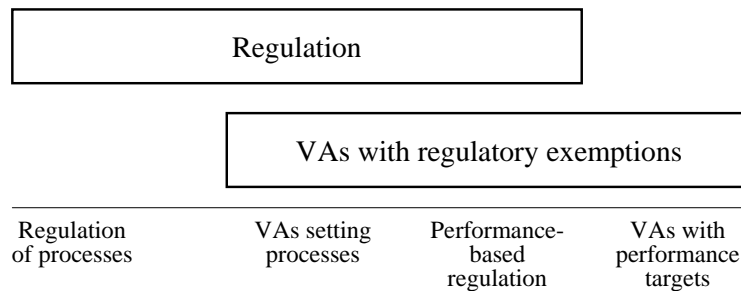


Figure 1.3 VAs vs. regulation in terms of polluter discretion

- In voluntary approaches, there must be an interest for polluters to make an effort, material or ideal. Therefore, contrary to other instruments, the literature on VAs emphasizes the analysis of the motives for making those efforts and how to encourage them. Since participation in VAs is voluntary and based on a number of motives, the regulator must entice the firms when drafting public voluntary programmes or proposing a negotiated agreement. Often it is something the regulator took first or would take in the absence of agreement such as taxes or regulation. Thus, a particular feature of VAs in modelling exercises is that the ideal regulator maximizes welfare under a participation constraint. The regulator can use threats to strengthen his bargaining power, but he must make sure that his threats are credible.
- Much more than other instruments, VAs emphasize targets for abatement efforts. Those targets are often a matter of negotiation between regulator and polluter. That makes it particularly important to determine how the targets are set. Popular analysis of VAs often focuses on target setting and forgets sometimes to examine how (and whether) the targets are actually met.
- Flexibility is another feature that is often presented as a positive characteristic of VAs. Flexibility concerns both target setting and how

those targets are reached. Non-contractual commitments or even contracts are easier to revise than legislation. They can be content with vague terms and objectives, which is useful when uncertainty is great. Regulation demands precision. It is generally more directive on abatement measures, but it need not be, if it imposes performance targets rather than specific solutions (see Figure 1.4). Economic instruments give the polluter as much flexibility as VAs. In some cases, VAs promote a specific technology, process or product, which makes them less flexible than the other instruments. Where VAs are clearly more flexible than the other instruments is that participation is not required. In the case of unilateral efforts, polluters are not even committed to keep their promises. That is of course the ‘voluntary’ dimension, which is not, however, always necessarily desirable.



Increasing abatement flexibility →

Figure 1.4 VAs vs. regulation in terms of abatement flexibility

- Contrary to other policy instruments, VAs imply and often explicitly ask some form of co-operation and co-ordination among polluters. That is the case if they agree jointly on a VA and shared targets, for example, at the industry level. However, co-operation is often weak, because firms do not share economic values such as assets, costs or profits. Co-operation rather involves the sharing of information, while sharing of efforts is a challenging issue, which is often not dealt with in a systematic (and cost-efficient) way.
- Like regulation and freely distributed tradable permits and unlike taxes, subsidies or sold tradable permits, VAs can dispense with direct impact on public budgets. However, negotiated agreements and public voluntary programmes often involve subsidies and tax waivers, which burden public budgets. VAs that involve cash transfers from the polluters to the public

vaults are extremely rare, which of course contributes largely to their popularity with polluters.

WHAT IS SPECIAL ABOUT CLIMATE CHANGE?

What is special in the area of climate change as opposed to other environmental issues? There is probably not a single distinguishing feature with respect to other pollution and environmental problems, but it is *the combination* of a number of features that makes climate change a particularly challenging problem. Some of the main features are listed below:

- There exists undeniably great scientific and socio-economic uncertainty on climate change impacts, combined with a high degree of irreversibility (for example, CO₂ will remain in the atmosphere for decades to centuries, while other GHGs will stay even for thousands of years), with main impacts presumably in the long-term (this is shared by nuclear waste). Climate change is a stock pollution problem (shared by many other environmental problems), since it is GHG concentrations in the atmosphere that may cause global warming.
- The main impacts of climate change are global instead of local, so there is no clear and identified group of victims who could sue polluters, who are also very diffuse (this is shared by sea pollution and the ozone layer). Nevertheless, some countries and groups of people are bound to suffer more than others from climate change. Often, GHG abatement measures also diminish local impacts (for example, better air quality from the reduced use of fossil fuels, that is, the so-called ‘secondary benefits’ of climate policy measures).

Table 1.2 Shares of different sources in CO₂ emissions (EU and USA, 2000, in %)

	European Union	USA
Energy industries	33	40
Manufacturing industries and construction	18	14
Transport	25	31
Other sources	25	15

Source: UNFCCC, greenhouse gas inventory database (as of 29 October, 2002).

- Everyone contributes to GHG emissions (Table 1.2), so a large number of polluters would have to be brought to reduce their GHG emissions. In addition, climate change has non-rivalry characteristics, which raise fundamental free-rider issues. Next to some important point sources of pollution (for example, power plants), there are also many non-point sources in the case of GHGs. For all this, Coasian negotiation is not feasible or too costly (also negotiation among countries is difficult).
- GHG emissions are partly process-related (how goods are produced), like other forms of pollution, but they are also very much product-related (GHGs emitted during the use of products such as houses, cars and appliances). So, next to the production sector, it becomes important to bring consumers to choose products that generate lower emissions during consumption. In addition, abatement measures take mainly the form of increasing resource (for example, energy) efficiency. Presently, there are practically no economically viable end-of-pipe solutions, except maybe planting trees to stock some CO₂ emissions. However, in a number of cases, there exists a great potential for no regret (or ‘win-win’) actions and measures. It is difficult to convince all consumers of the advantages of buying products with lesser climate impact, but in some cases it may even lead to financial advantages to them (cost savings).
- There is a strong link between GHG emissions and economic activities. International competitiveness concerns are very strong. Domestic measures are linked to and depend also on the outcome of international negotiations and efforts.

We have briefly shown what the main distinguishing features of VAs are, as compared to other instruments, and what is special in the area of climate change as compared to other environmental problems. There remains to show why VAs might be interesting for addressing climate change. This is of course a central question in the contributions to this book. Our conclusions on that question are gathered at the end of this chapter.

MOTIVES FOR PARTICIPATION IN VAs

We list here the main, but by no means the only, motives for unilateral efforts and participation in VAs. The terms by which those motives are often referred to are highlighted. We also indicate which chapters particularly analyse them. Please refer also to Table 1.3, which provides the reverse information of which motives are particularly analysed in each chapter.

- Abatement may actually lower production costs in the net, particularly if it involves saving resources. This is often referred to as ‘*no regret actions*’ or ‘*win-win opportunities*’. In that case, either emitters would take those measures anyway, or the VA helps them overcome some barrier. This motive is analysed in Chapters 3 and 10.
- Subsidies or tax rebates granted in exchange of abatement may be sufficient to make it profitable for the polluter. These ‘*financial incentives*’ are analysed in Chapters 3, 6, 13, 14 and 15.
- Participants benefit from exemptions from existing regulation or from the replacement of blanket regulation by tailor-made regulation, so that abatement is less expensive for them. This is called ‘*regulatory relief*’. This motive is analysed in Chapter 11.
- Participants fight more demanding policies such as strict regulation and taxes. This motive is generally referred to as ‘*background threat*’ or ‘*pre-emptive behaviour*’. It is analysed in Chapters 3, 4, 5, 6 (with an original twist: legislators reject strong measures in anticipation of VAs), 7, 8 and 14.
- Participants learn about abatement solutions, possibilities and costs, but also about environmental problems and impacts. The regulator may support that *collective learning* and information sharing process through technical assistance, which can be interpreted as implicit subsidies. This motive is analysed in Chapters 5, 10 and 12.
- Participants increase the demand for their product through a green image, an ‘*environmental reputation*’, either for their product or for themselves. They thereby appeal to ‘*green preferences*’ of consumers and procurement agencies. Some procurement agencies, typically those of public administrations, may require some environmental certification of their suppliers. This motive is analysed in Chapters 4, 5 and 10.
- Participants may gain *strategic advantages* in competition. An oligopolist may make unilateral abatement efforts to signal low abatement costs and thereby influence the regulator towards stricter regulation that hurts the oligopolist’s competitors. Or competitors may use joint initiatives as screens behind which they hide anti-competitive agreements. Those motives are analysed in Chapters 4 and 5.
- Participants save on insurance costs and increase their value on the capital market because their efforts lower the risk of environmental damages they could be fined or sued for. We might call this the ‘*insurance motive*’. This motive is analysed in Chapter 2, along with almost all other motives.
- Participants simply feel they share responsibility for the environment and need to take steps to reduce their environmental impact. This is referred to as ‘*environmental stewardship*’. This motive is also analysed in Chapter 2.

Not all motives are equally important for all types of VAs. Self-regulation generally relies on a background threat or environmental stewardship. Negotiated agreements offer regulatory relief and financial incentives. Also, several motives are generally at play. One could even say that the firms seek multiple advantages in abatement, like the legendary seven flies killed in one stroke.

Some chapters in this book, in particular 6, 7 and 8, also discuss and analyse why public administrations would chose VAs over other instruments. VAs are generally seen as less efficient from the point of view of a regulator, so they may be acceptable when directive regulation is not available. The regulator might also accept them when Parliament or the citizens prefer that approach, which they might consider more participative or less costly.

THE CONTRIBUTIONS TO THIS BOOK

We invited contributions to this book with a view to obtaining many different inputs from leading researchers in Europe and the United States. The authors were not directed as to the topic they should develop. But they were asked to use the terminology jointly developed above and to review the academic literature and examples of implemented VAs in order to highlight policy implications. As a result, the contributions cover a large part of the participation motives, but not all, with some overlap. Table 1.3 indicates for each contribution the type of VA analysed and the participation motives emphasized.

The first two contributions, by Khanna and Ramirez and by Segerson and Roti Jones, survey the academic literature and policy experience with VAs.

Madhu Khanna and Donna Ramirez survey VAs for climate change implemented in the USA, Europe and Japan, and the literature on the properties of such climate policy instruments. They examine what characteristics of VAs could motivate firms to participate, to what extent existing VAs feature those characteristics and whether firms actually respond to those characteristics. By surveying the existing literature on the environmental effectiveness of VAs, they observe that the task is daunting. Indeed, it is difficult to define the baseline for emissions in the absence of the VA and possibly in the presence of other regulations that were pre-empted by the VA.

Table 1.3 Types of VA and participation motives analysed in the contributions to this book

Chap.	Author	Summary	Type of VA	Participation motives
2	Khanna and Ramirez	Broad overview of VAs and VA programmes in USA and All types in Europe: typology, effectiveness and examples.	All types	Almost all motives
3	Segerson and Roti Jones	Examine efficiency of different types of VA, often compared to regulation.	NA between competitors	No regret actions, financial incentives, background threat
4	Brau and Carraro	Analyse how VAs affect competition, by promoting a green product or pre-empting regulation. World of certainty, oligopoly.	NA and PVP, agreements between competitors	Environmental reputation, pre-emptive behaviour, strategic advantages
5	Cavaliere	Strategic interaction between firms and consumers and between firms and regulator. World of uncertainty, monopoly.	PVP	Environmental reputation, pre-emptive behaviour, strategic advantages, collective learning
6	Lyon and Maxwell	VA pre-empts tougher legislation by influencing legislators to reject it in view of future VA.	NA	Financial incentives (implicit subsidy), pre-emptive behaviour
7	Langpap and Wu	Landowners and regulator agree on logging ban if that avoids stricter but not assured legislation.	NA	Pre-emptive behaviour
8	Grepperud and Pedersen	Regulator offers firms an attractive target in a NA, in order to satisfy the citizens, who prefer negotiation to regulation.	NA	Pre-emptive behaviour

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Chap.	Author	Summary	Type of VA	Participation motives
9	Glasbergen	VAs as a steering instrument between <i>laissez-faire</i> and regulation. Illustrated by Dutch Long-Term Agreements on energy efficiency and Benchmark Agreement.	NA and PVP	Pre-emptive behaviour
10	Howarth, Haddad and Paton	Public voluntary programmes Green Light and Energy Star work because they address failures of firms, consumers and markets.	PVP	No regret actions, collective learning, green preferences
11	Delmas and Mazurek	Interaction between firms and regulator; decision process of regulator.	NA	Regulatory relief
12	Albrecht	Combination of NAs with regulation and emissions trading in the EU. PVPs to promote the development and use of low-energy appliances.	NA, PVP	Pre-emptive behaviour, collective learning
13	De Muiizon and Glachant	Analysis of UK Climate Change Programme's mix of VAs, energy tax and emissions trading.	NA	Financial incentives (tax rebate)
14	Baranzini, Thalmann and Gonseth	Analysis of Swiss CO ₂ and energy laws, which offer a PVP under threat of CO ₂ tax.	PVP, NA	Pre-emptive behaviour, financial incentives (tax rebate)
15	Bjørner	Econometric model of energy consumption in Denmark depending on prices (incl. tax), subsidies and VAs.	NA	Financial incentives (tax rebate)

Khanna and Ramirez conclude their impressive *tour-de-force* review of this fast-growing literature by drawing interesting policy implications for climate related VAs. They indicate that VAs are not a guarantee for effectiveness in environmental protection unless they are part of a full package of climate mitigation measures that have clearly quantifiable baseline and firm-specific goals, a strong threat of environmental regulation and a credible authority to sanction non-compliant firms, and mechanisms to engage the public, consumers and investors to reward firms that do undertake voluntary reductions.

Kathleen Segerson and Kristin Roti Jones examine the economic efficiency of VAs in general and in the climate context in particular. The condition for efficiency is split into two intertwined conditions, one about the level of (net) abatement and one about how that level is achieved. The level of abatement is efficient if abating one more tonne of GHGs would cost more to society than it benefits from doing so, and vice-versa. The level of abatement is achieved efficiently if the abatement effort is allocated among polluters in such a way that it is not possible to abate as much at a lower cost (cost-effectiveness).

Splitting the analysis of efficiency in this manner is particularly relevant in the case of VAs. Indeed, setting targets for abatement is an important and specific dimension of VAs (see above). Segerson and Roti Jones show under what conditions a VA can yield an efficient target, distinguishing between VAs in which a regulator sets the target unilaterally (PVPs) and VAs in which the target is a matter of negotiation (NAs). Since a key element of the VA is the participation constraint, this amounts to identifying the conditions under which the participation constraint affects the level of social welfare that can be attained. Thus, VAs may be able to lead to an efficient abatement level, but the parties to actual VAs may decide or agree on an amount of abatement that is not efficient. However, just as VAs may be imperfect instruments for obtaining abatement efforts, so are other real-world instruments such as command-and-control, incentive taxes and tradable emission permits. In the context of this chapter, it was not possible to analyse the difficult issue of defining the benchmark to which VAs should be compared in assessing their relative efficiency.

As regards the second condition for global efficiency, Segerson and Roti Jones show the virtues of VAs: by leaving much flexibility to polluters on how they reach the target, VAs make it very likely that least-cost solutions are chosen, at least when VAs are combined with a tradable permit programme that facilitates the allocation of abatement efforts among participating firms. However, they also point to the main drawback of VAs: since participation is voluntary, firms that remain on the sidelines might have lower abatement costs. They make the distinction, which is very pertinent in

the energy and climate change area, between abatement during the production of goods and abatement during their use.

Segerson and Roti Jones highlight the list of conditions that must be met, in order to design efficient VAs. Of course, the various existing VAs that are presented in the other chapters of this book could be assessed against this list.

Rinaldo Brau and Carlo Carraro analyse the connections between VAs (which are formal contracts between competitors in their analysis) and market structure. They show that VAs could be adopted with the strategic objective of increasing market concentration and introducing barriers to entry. However, in general, a more concentrated market structure increases the environmental effectiveness of actions undertaken under a VA. This creates a trade-off between the goal of maintaining competition in the market and the objective of exploiting the well-recognized flexibility that generally characterizes VAs. This bi-directional relationship between market structure and VAs depends and can be assessed according to the motives that move firms to adopt VAs, that is, whether they principally aim at improving the environmental reputation of their products or at influencing policy interventions based on regulatory or economic instruments.

Brau and Carraro apply many results from the industrial organization literature (oligopolistic competition, strategic interaction, dynamic games) in order to understand to what extent climate policy can be based on VAs without harming competition in industrial markets. Contrary to Cavaliere, they assume that information on environmental quality is perfect.

In a sense, Alberto Cavaliere's chapter is a survey of the ways in which the theory of incomplete information, contracts and strategic games can be applied to VAs in the environmental area. Indeed, he notes that VAs often imply implicit or explicit contracts that face the same incompleteness and enforcement problems as more common business contracts. He also notes that those contracts may affect competition and social welfare. Cavaliere provides interesting illustrations in the climate change context and related to CO₂ agreements.

More specifically, he focuses on three distinct strategic settings: (1) the signalling of environmental quality to consumers; (2) the signalling of abatement costs to the regulator; and (3) the exchange of abatement information between competitors. In this last case, competition is reduced, but the losses in consumer surplus may be offset by the environmental gains. When there is little regulatory intervention, like in climate policy, environmental gains may not be significant. In the second case, competition may become fiercer, while in the first case the author considers a monopolist.

Thomas Lyon and John Maxwell examine (with the help of formal game-theoretic analysis) why the regulator and firms agree on a public voluntary programmes (PVP) in the absence of threat of regulation or tax. In order to

eliminate clearly that threat, their analysis assumes that the regulator's decision to set up the programme and the firms' decision to join are made *after* the legislators rejected a carbon/energy tax. However, the perspective of the PVP influences legislators towards rejecting the tax. That is how a VA can pre-empt regulation even if the decision on regulation precedes the VA. Hence the result forcefully put forward by Lyon and Maxwell, that PVPs might be a bad instrument, if they lead to the rejection of socially preferable green taxes. The tax is basically preferable because it generates fiscal revenues, whereas the PVP uses government revenue to subsidize the participation of firms. However, the results rest very much on the assumption that this is the only difference between the mandatory and the voluntary approach. Nevertheless, the analysis in this chapter helps assess climate change initiatives of the Clinton and Bush Administrations. In particular, Lyon and Maxwell evaluate the programme of early reduction credits for voluntary GHG abatement proposed by the Bush Administration.

Christian Langpap and JunJie Wu examine the likelihood of agreement on a negotiated agreement (NA) by the 'polluter' and the regulator in a model of forest conservation. An interesting feature of their contribution, which is very relevant in climate policies, is that they analyse when such agreements arise and what level of conservation they generate in the presence of uncertainty about future conservation benefits and irreversibility of resource losses. They assume that if the polluter and the regulator fail to agree, the regulator imposes regulation. In their setting, where all polluters are identical, regulation is basically better than VAs because it allows setting the optimal level of abatement after uncertainty is resolved. Indeed, a central characteristic of their NAs is that they set future abatement levels. The 'polluter' agrees to the NA if it protects him from regulation, or at least reduces the risk that he is subject to it. The regulator agrees to the NA if he is not sure that the legislature would approve regulation. The higher the probability of approval of regulation, the more the polluter likes the NA and the less the regulator does.

Langpap and Wu show that the polluter is more likely to agree to a NA if the regulator cannot later tighten its requirements. Hence the somewhat paradoxical result that rigid NAs are more likely than those that allow for renegotiation and that they may generate higher levels of conservation and higher net social benefits. However, the resulting level of conservation will not be optimal, and may be lower than that attainable under regulation. Hence, the regulator faces a trade-off: he may be able to encourage participation and increase conservation effort by offering a commitment regarding future regulation, but by doing so he loses the flexibility to use new information, and thus may have to settle for inefficient levels of conservation. Obviously, we should note that the kind of flexibility VAs are generally

credited with is not the possibility to modify the terms of the agreement (as in Langpap and Wu's chapter), but the choices the polluter has available for meeting its targets.

Sverre Grepperud and Pål Pedersen address the question of why firms and regulator choose VAs instead of other instruments. There are of course many possible reasons, as we have listed above. However, the authors of this chapter develop an original motive, which is related to the Public Choice literature: citizens care about how public decisions are made and prefer cooperative, negotiated approaches instead of measures that are imposed. The regulator cares about those preferences and tries to obtain an agreement. Since the firms are aware of the regulator's decision context, they even reinforce such preferences and manage to obtain VAs with lenient targets. The whole argument stands and falls with the preference of citizens for bargaining over command and control. We should note that, although this assumption is reasonable, there exists little empirical evidence of those kinds of citizens' preferences, other than the increased use of VAs. We might also note that comparing VAs with other instruments is not just a matter of comparing targets but also of how the targets are met (see the chapter by Segerson and Roti Jones).

Pieter Glasbergen's chapter is a country study designed to illustrate cooperative policy making. He first defines cooperative policymaking and places it in the broad spectrum between *laissez-faire* and central planning. Then he shows how it works and what results it yields in the case of Dutch energy policy, which pioneered voluntary approaches with its long-term agreements programme (LTAs). LTAs are really a mix of negotiated agreements with large individual firms or sectors and a public voluntary programme for smaller firms. They are designed to encourage industry to exploit all profitable means to increase its energy efficiency in exchange for the regulator renouncing more stringent regulation. When it seemed that those means were exhausted, but that CO₂ emissions did not decline enough, the Netherlands moved to an umbrella agreement. This agreement asks the industry to implement best practices, in exchange for wavers from environmental permitting and the continued promise that nothing more stringent (like, for example, energy taxes) would be imposed. Glasbergen concludes that those policies have yielded important results, bringing Dutch firms to world-leadership in terms of energy efficiency. However, they are not sufficient to meet absolute targets for CO₂ emissions reductions. It seems that it will be necessary to be more demanding on the Dutch economy, probably by involving also the other sources of CO₂ or GHG emissions.

Richard Howarth, Brent Haddad and Bruce Paton analyse two successful USA public voluntary programmes: the Green Lights and Energy Star Office Products programmes, which promote the adoption of energy-efficient

technologies by firms. The two programmes are in fact quite different in the inefficiencies they address. The Green Light programme addresses intra-firm inefficiencies, namely that firms forego profitable energy saving investment, because agency problems restrict lower-tiers investment rights and because the investment costs and the energy savings concern two different departments. A government programme can help firms overcome those inefficiencies – provided they are able to make the efficient decision to join the programme! Indeed, Howarth, Haddad and Paton show that the Green Light programme led many firms to make profitable investments in saving lighting electricity, with a sizable windfall for the environment. The other USA PVP analysed, the Energy Star Office Products programme, addresses inefficient decision-making by consumers and poor coordination between consumers and producers. Consumers make poor decisions by lack of information and bounded rationality. By labelling ‘green’ products, the programme helps them choose those products and creates incentives for producers to develop and market such products. The authors contend that the programme has led suppliers of computers and electronic equipment to substantially improve the energy efficiency of their products in ways that confer net cost savings on equipment users.

The great interest of that contribution is that it uses the insights of new institutional economics to show how programmes that emphasize information sharing and coordination between actors can yield gains for the economy and the environment. Howarth, Haddad and Paton argue that the success of those programmes is based on their ability to reduce market failures related to problems of imperfect information and bounded rationality that impair the effectiveness of both intra-firm organization and the coordination between equipment suppliers and their customers. It stops short, however, of testing whether those programmes yield all the environmental improvements that are socially desirable.

Magali Delmas and Janice Mazurek examine the important issue of transaction costs. More precisely, their chapter analyses the costs for firms of setting up a negotiated agreement with the regulator. The regulator is modelled as a complex decision mechanism with a severe credibility problem: the legislature may change the rules of the game and third parties may challenge the regulator’s decisions in court. Delmas and Mazurek explain the role of transaction costs in this particular context and the difficulty for regulators to commit. They illustrate the magnitude and determinants of negotiation costs and the transaction costs incurred in setting up agreements in the case of agreements on development permits reached under the US EPA Programme XL. The EPA grants site-specific exemptions from regulatory requirements in exchange for better results on environmental performance. That may lead to complex and costly negotiation, particularly

as the business side of the deal tries to protect itself from later changes in legal background and third party legal suits. Delmas and Mazurek identify determinants of those costs. There are few instances of permits that directly bear on climate change, but they nevertheless extrapolate from their evidence that the negotiation of agreements involving GHGs and climate objectives might be particularly costly, largely invalidating that approach in the US context.

Unfortunately, Delmas and Mazurek cannot really provide evidence that firms saved costs in joining Programme XL. One might suspect that if they freely chose to join the programme, they must have gained from it. But that is only true insofar as they held accurate expectations about the transaction costs they would meet and the flexibility they would gain when they entered into XL negotiation. Still, the chapter provides very interesting information on the barriers to agreements between polluters and the regulator. It puts more emphasis on the requirements to the regulator than much of the research on VAs, which emphasizes the choices and capabilities of the firms.

There are really two parts in Johan Albrecht's chapter. A first part deals with reducing GHG emissions at plant level using combinations of regulation, permit trading and industry-wide commitments on emissions targets. A second part deals with reducing GHG emissions over the life cycle of consumer products through cooperatively decided regulation. The first part shows that the demanding production regulation chosen by the European Union, which requires the use of best-available technology, leaves almost no room for VAs (or tradable permits for that matter) in production. However, there is still room for VAs or co-operative elaboration of regulation for reducing GHG emissions in the consumption phase of products. However, the agreements would not be made between consumers and regulator, although consumer representatives might sit at the negotiation table. The agreement would instead really be between the industry and regulator to withdraw products that use too much energy and to develop and promote low-energy products.

Gildas de Muizon and Matthieu Glachant examine the recent implementation of the UK Climate Change Levy Agreements and discuss their environmental and cost effectiveness (which they call 'cost efficiency'). This programme is a mix of VAs, energy tax and emissions trading. The analysis is theoretical, since the implementation of the programme is relatively recent. However, the policy implications are particularly powerful. The VAs are both umbrella NAs concluded between the regulator and sector associations and sub-NAs concluded between the regulator and the individual firms. Signing a NA brings an 80% tax rebate and the possibility to trade emission credits. Not surprisingly, all eligible sectors adopted an umbrella NA. The sub-NAs avoid free-riding. They risk causing an inefficient

allocation of abatement efforts, which is, however, offset by a parallel emissions trading programme. De Muizon and Glachant show that such a policy mix is both quite effective and efficient, but that the NAs contribute little to that result and could be dispensed with.

Andrea Baranzini, Philippe Thalmann and Camille Gonseth examine the Swiss approach to CO₂ emissions reduction, which results from intensive democratic preparation. Switzerland's CO₂ Law is original in providing explicitly for a CO₂ tax to be implemented if VAs appear insufficient for meeting the emissions reduction target. The tax threat is seldom so explicit. Emitters are invited to make declarations of self-regulation to make the tax unnecessary. If they fail, they can still sign negotiated agreements with the authority and be exempted from the tax. Baranzini, Thalmann and Gonseth describe that set-up in detail and assess its environmental effectiveness and efficiency. They show that such an approach does not fully overcome the credibility problem of a tax threat and that it is finally very complicated and costly.

Thomas Bjørner's contribution is empirical. There is as yet little empirical work on VAs (see the chapter of Khanna and Ramirez for a survey). The only other one in this book is that of Delmas and Mazurek, who explain negotiation costs of NAs. Most empirical work either explains participation in a VA or examines, like Bjørner, its environmental effectiveness. The latter is less common, because more difficult to assess. Indeed, effectiveness must be measured by comparing emissions to those of a baseline that does not have the VA but other instruments that would have been adopted or from which the VA granted exemption. Even if an industry-wide baseline is found, it may not be the average baseline for the firms that choose to participate in the VA, because the VA attracts the firms that can most easily improve their environmental score.

Bjørner examines the environmental effectiveness of the energy agreements negotiated between the Danish regulator and large energy consumers. The regulator's contribution is a reduction in the CO₂ tax. Bjørner gets around the baseline problem by estimating an energy consumption equation that includes both firms that negotiated agreements and those that did not, as well as data for both before and after agreement. He finds that the reduction in energy consumption under the agreements was greater than would have been obtained through the full energy tax alone. That suggests that specific energy-saving programmes are more effective than the tax when firms can simply pass the tax on to inelastic consumers. Maybe the simple fact of drawing management's attention to energy consumption furthers the adoption of no-regret measures, as shown in the chapter by Howarth, Haddad and Paton.

POLICY LESSONS

Without being exhaustive of all the relevant and rich policy implications that can be drawn from the chapters included in this book, we would like to highlight the following ones:

- The economy generally possesses several motives to commit to voluntary emissions abatement or energy saving efforts. In general, participation in VAs is greater when targets are defined in terms of energy or CO₂ intensity, as such targets are easier to attain than absolute reductions in energy use or CO₂ emissions. Indeed, the targets to be attained in implemented VAs are often in terms of intensities. As a result, countries that committed to absolute emissions reduction targets (for example, in the context of the Kyoto Protocol) cannot rely on VAs alone, since a reduction in emissions intensity does not ensure that total emissions will decrease.
- VAs perform best as long as no-regret options are available and decreasing emissions is not really costly. In this context, it is difficult to distinguish emissions reductions due to VAs from those that would have occurred anyway, as a result of business-as-usual energy savings. In such cases, VAs can sometimes be interpreted as a form of regulatory capture by the economy (OECD, 2003). However, the contribution of VAs is not always a trifle, because they can help overcome barriers (for example, the lack of information) that prevent the implementation of no-regret options in firms and the development of product designs that benefit all. In addition, VAs also foster environmental awareness and the management's attention.
- In general, VAs achieve the goals that were set for them, but those goals are often not very demanding, since of course the economy is frequently part of the negotiations that define them. In fact, some VAs imply a shift of responsibility from the environmental authority to industry to set its own emissions reduction targets (Higley, Convery and Lévêque, 2001). In some instances, this shift of responsibility may conflict with existing domestic laws, in particular those concerning the principles of democracy and states' responsibility towards the health and safety of their citizens (Bart and Dette, 2001).
- VAs are more effective when the environmental authority's bargaining power is stronger. A strong background threat or some reward is needed to prompt emitters to make efforts that are really costly for them. In addition, although often targets of VAs are not legally binding, environmental effectiveness strongly depends on clearly defined and quantifiable firm-specific or at least industry-specific goals; on mechanisms to monitor emissions reductions; and on the existence of sufficient sanctions for non-

compliance. The environmental effectiveness of VAs thus depends very much on those accompanying measures.

- An important barrier to effective VAs is the environmental authority's difficulty to commit when a higher authority can change the rules or when it might itself get new information calling for tighter abatement requirements. This barrier is particularly constraining in climate policies, given the many scientific uncertainties and thus possibilities for the reassessment of policy objectives. In addition, climate policy possesses many connections with other fields, in particular economic policies, which implies that several government authorities are usually implicated or have an impact in the definition of climate policies.
- VAs may offer a platform for decision-making that involves the different stakeholders. Collective decision-making is preferable to command-and-control for very heterogeneous production technologies or consumer products in a context of imperfect information. However, this is true only if the process defining VAs is transparent and if all the stakeholders, including non-governmental organizations, affected third parties and the civil society, can effectively access and negotiate in the policy-making process.
- As a result, VAs may be quite costly in terms of transaction costs, both when setting them up and when auditing and monitoring their application. Set-up costs increase with the number of stakeholders involved and the object specificity of the agreement, although there is a learning curve that decreases those costs. Transaction costs are also higher when the alternative to agreement is not clearly defined and when the industry lobbies to weaken the environmental authority's bargaining position. Monitoring costs, on the other hand, may be lowered by the fact that emitters feel they are in part owners of the VA.
- Compared with command-and-control, in particular when it is based on technology standards or emissions abatement uniformly imposed at the firm level, VAs may offer greater flexibility to firms. VAs are thus generally more cost-efficient than command-and-control, provided that targets are set (at least) at the industry level and based on performance.
- When a VA is offered as an alternative to a tax on emissions or energy, it can lead individual emitters to commit to greater emissions abatement than if they were subject to the tax. Indeed, the VA allows them to avoid the tax on their residual emissions. However, this quality of VAs may only be true in static terms. Indeed, contrary to a VA, it is precisely because emitters pay on their residual emissions, that a CO₂ or carbon tax will generally give a greater incentive to change behaviour and to adopt or develop new technologies in order to lessen the tax burden. In this sense, VAs are similar to traditional command-and-control: when the firm

complies with the target, VAs do not provide any additional incentive to increase abatement.

- VAs tend to reduce competition by facilitating collusion and preventing entry. Dominant firms may even abuse VAs and over-comply to strengthen their market dominance. However, VAs are more likely to be adopted in a more concentrated industry, since concentrated markets can better co-ordinate emission reductions and control for free-riding behaviour. As a result, there could be a trade-off between environmental effectiveness of VAs and their impacts on competition. Climate and competition policies have thus to be coordinated. The distortions to competition are less if VAs focus on the quality and reputation of products rather than on production processes and on fending off regulation. Furthermore, a careful design of the VA and accompanying measures can eliminate the economic costs of anti-competitive behaviour and free-riding and achieve the desired abatement level.
- Poorly designed VAs may be inefficient, because they fail to involve all emitters and they cannot guarantee that abatement efforts are shared so as to equate marginal abatement costs. Indeed, contrary to economic instruments, VAs do not automatically contain a financial incentive to allocate abatement efforts among emitters with a view to minimize total costs. Thus, VAs should not be narrowly designed and target only a small number of emitters. From an efficiency point of view, VAs should cover several sectors and be based on performance standards. To ensure the widest participation, it should provide non-costly incentives such as a strong background threat (for example, in the form of an emissions tax). In addition, VAs must be combined with some mechanism such as emissions trading to allocate abatement efficiently across participants.
- VAs are not new instruments that the regulator will use durably in climate policy. VAs are rather transition measures preparing the ground for more standard instruments such as fuel or carbon taxes and tradable emission permits.

These results suggest that policymakers should have relatively low expectations for VAs and that they should use them when other, less costly and more effective approaches are not available. Political reasons often prevent the use of more efficient instruments or make VAs more preferable. The availability of other approaches depends on the institutional setting of a given country, which needs thus to be taken into account before deciding whether and what type of a VA might be implemented. However, the availability of other approaches is also influenced by the availability of VAs. Indeed, often opponents to traditional policy instruments (for example, command-and-control, economic instruments) are those groups of emitters

who have to support the costs and thus habitually brandish the option of VAs to avert the more demanding and usually more efficient instruments. It is much easier to define VAs when the environmental authority can credibly commit to return to existing regulation if negotiations break down or if voluntary efforts are insufficient. This is still seldom the case in the context of climate policies.

Just as climate policies are necessarily inter-temporal, the setting-up of such policies is a dynamic process, as shown in several chapters of this book. VAs often appear at an early stage of that process, when the uncertainty about the damages from no action makes it difficult to gather sufficient support for tough measures, but when there is already enough evidence for emitters to accept to make some efforts. A consensual approach may be required at that first stage, particularly if firms are to make efforts while international competitors are not required to support costly abatement measures. At a second stage, VAs may facilitate the preparation and implementation of traditional policy instruments. Indeed, they foster collective learning about costs and benefits of abatement. In some market settings, incumbent firms may even signal lower than true abatement costs in order to secure tight regulation that prevents market entry. Some VAs reward participants with promises of tax breaks or tradable permits, which creates a constituency for the legislative requirements necessary to make those promises valuable. On the other hand, VAs may delay regulation by providing opponents with evidence that it is not needed. VAs that include subsidies for participants further increase their resistance to costly regulation. At a third stage, when VAs prove insufficient to meet the targets, traditional policy instruments are introduced, but they do not drive VAs fully out. To the contrary, VAs add flexibility, allowing for tailor-made solutions for individual emitters in the form of negotiated agreements.

Increasingly a mix of measures is called for, because pure solutions are not considered acceptable. Think of an emissions tax at its full incentive level. Even in this case we have a mix of measures, because there is always some regulation, which is never repealed when economic instruments are introduced. VAs are often implemented in combination with other instruments such as subsidies, tax rebates and regulatory relief. Such breaks from other environmental regulation are generally seen as necessary to obtain participation in VAs, even though there exists a large proven potential for reducing GHG emissions at no cost (Hendriks, 2001). In some cases, the contribution of the VAs to the effectiveness and efficiency of the mix of measures is quite small. They rather facilitate its acceptance and influence the sharing of burdens.

Of the contributions in this book, like the whole scientific literature on VAs, some conclude very favourably about the value of VAs, while others

are much more sceptical. These differences in assessment arise partly from the features of VAs each author chooses to emphasize. Indeed, VAs have features that make them preferable to other approaches of environmental policy, at least for certain criteria or certain groups, and other features that make them less attractive. Authors who emphasize co-operative decision making, learning and the exchange of information conclude in favour of them. Authors who emphasize the subsidies or exemptions from taxes and regulation that firms must be granted to accept to participate in VAs, or who focus on their potential for anti-competitive behaviour or the high transaction costs they seem to require, conclude against them.

More importantly, the differences in assessment are an illustration of the half-full/half-empty glass paradox. Those authors who compare the results achieved with VAs with what would theoretically be achieved with efficient economic instruments (the full glass) see that the glass is half empty. Those who compare achievements with VAs with basic economics, which suggests that emitters would hardly do anything without constraint, see the glass as half full.

TOPICS AND QUESTIONS FOR FURTHER RESEARCH

Several chapters highlight interesting avenues for additional research related to VAs and their design and implementation. Without being exhaustive, the following are some questions left open by the research presented or surveyed in this book:

- A more detailed taxonomy than the usual tri- or quadri-partite schemes is needed. It should take into account the modes of agreement and cooperation among signatories of a collective agreement. It should also consider the degree of commitment.
- VAs are more and more often combined with other climate policy instruments, but there is still little research on how that combination could be made economically efficient and environmentally effective. In particular, research should also consider how combining different instruments might increase inter-temporal incentives to adopt or develop new emissions-saving technologies. Indeed, in the area of climate change, it will be very difficult to obtain real reductions in energy use, so a lot will depend on technical progress and the substitution of fossil fuel by renewable energy. How can VAs help foster that progress and substitution? How is it possible to increase the impact of VAs, by combining them with other instruments? For example, more research is needed on the implications when current VAs yield credits for future

tradable emissions programmes or when they help prepare the industry and the environmental authority for regulation.

- There is currently a growing literature on the impacts of VAs on market structure, although it is still difficult to combine assumptions of imperfect information with different models of market structure. This literature should also be combined with the now sizeable literature comparing environmental policy instruments in the context of imperfect competition and information failures. In addition, very little is known about the impacts of VAs on the position of firms in the face of imports or their position as exporters, or on the impacts of trans-national VAs on competition.
- More theoretical work is warranted on the dynamics of VAs, taking into account information issues and political issues. Do VAs pave the way for regulation by increasing information or do they delay it by luring policy-makers?
- It is still hard to generalize from the experiences of different countries because of the differences between their institutions and circumstances. More work on how VAs fit into the existing institutional endowment of a country would facilitate such generalization. A key dimension is the possibility for higher authorities to modify the regulatory setting within which the environmental authority bargained with the emitters.
- A related question is how to adapt the legal framework to implement effective VAs and to include relevant stakeholders in the negotiation process. Questions of monitoring, compliance, liability and arbitration should receive additional research attention, including country-specific institutions, for example, federal structures, and implications for supranational issues, for example, related to regional or international economic agreements, and international environmental treaties.
- There are relatively few empirical studies assessing the specific impacts of VAs on emissions reductions, compared to business-as-usual emissions abatement. In addition, more empirical analysis of the performance of different types of VAs is still needed, both as regards their ability to hit the targets they pick and their cost-effectiveness compared to other instruments.
- Do VAs really improve over regulation when participation is obtained by the threat of such regulation? Emitters for whom such regulation would be a particularly heavy burden might do more under a VA to ward off that threat, which is precisely the inefficiency of command-and-control regulation.
- How can VAs be used for non-point sources (Shortle and Horan, 2001)? VAs have a great potential in that area, simply because the standard

effluent-based instruments fail from the difficulties of identifying sources and measuring emissions.

The research on VAs has drawn many interesting insights by expressing them in familiar problems of, for example, industrial organization, game theory or public choice. We believe that much could also be learned by expressing them in terms of compliance. Indeed, we feel the research on VAs is in an early stage akin to the early stage of the tax compliance literature, when it tried to explain compliance solely by the balancing of benefits of evasion with the expected costs of detection (Allingham and Sandmo, 1972). Empirical work shows that compliance generally exceeds what can be explained by expected penalties. Similarly, several authors have shown that monitoring and penalties for infringement of environmental regulation are small and that businesses that are not dramatically risk averse save costs by not complying. Therefore, the extensive compliance that is observed in spite of those conditions is a puzzle several authors have tried to explain. The arguments they advance are very similar to those that explain why businesses should or would engage into VAs (for an excellent survey, see Cohen, 1999). The analogy with the tax compliance literature suggests, for example, that coercive measures could stifle voluntary efforts just like audits stifle compliance.

One recurring issue in the research on VAs is why firms commit to costly environmental efforts or, if they are not costly, why they need the VA context to make the investments. Many interesting answers have been offered without departing from the neoclassical theory of the firm, by showing that participants gain economic advantages from VAs, for example, in the form of a stronger market position or of benefits from the authorities. Some authors argue that the potential for VAs to help overcome market or organizational imperfections is the key advantage they offer. That invites non-neoclassical approaches such as institutional and evolutionary economics.

NOTES

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1. The main anthropogenic greenhouse gases include carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and ozone in the lower part of the atmosphere. Aerosols from anthropogenic sulphur emissions are likely to partially offset the warming effects of increasing concentrations of greenhouse gases, but only temporarily.

2. Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).
3. In some cases, enforcement of regulation is so weak that compliance alone qualifies as voluntary abatement.
4. This is often called 'unilateral initiatives'.
5. Often a negotiated agreement is later proposed as a public voluntary programme to firms that did not participate in the negotiations.
6. Carraro and Lévêque (1999) call them 'public voluntary schemes'.

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