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**THE ECONOMIC ANALYSIS OF VOLUNTARY
APPROACHES TO ENVIRONMENTAL PROTECTION.
A SURVEY**

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Abstract

This paper surveys the recent literature on voluntary (or negotiated) approaches as an environmental policy tool. Rather than adopting a positive perspective and describing different types of voluntary approaches (VAs) and their main features or their pros and cons, this survey focuses on the economic incentives for firms or industries to adopt VAs. The consequent role that VAs may play within a set of policy tools designed to address environmental problems is then assessed. A careful understanding of the economic incentives that induce a firm to sign a VA is indeed crucial to identify and design the policy mix that makes the VA both environmentally effective and economically efficient.

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1. Introduction

Voluntary approaches (henceforth VAs) are nowadays considered as one of the most important policy instruments to reach environmental targets. Following their increased use in addressing domestic and international environmental issues, several authors have analysed their main pros and cons.¹ On the one hand, it has been highlighted that there are advantages in terms of increased flexibility for polluters and regulators in facing specific problems, and that VAs potentially foster environmental innovation and the sharing of information on cleaner technologies. On the other hand, concerns about their real effectiveness and problems of regulatory capture have been repeatedly expressed.

At an institutional level, the use and the official recognition of these policy instruments has continued to grow. For instance, in the recent adoption of the Action Plan “Simplifying and Improving the Regulatory Environment” (CEC, 2002a) by the European Union it has been stressed the role of regulatory practices explicitly referred to as *coregulation*, *self-regulation* and *voluntary sectoral agreements*, terms which are now familiar to academics and policymakers who deal with VAs in environmental policy. In the light of the adoption of this Action Plan, the EC has issued a new Communication on “Environmental Agreements at Community Level Within the Framework of the Action Plan on the Simplification and Improvement of the Regulatory Environment” (CEC, 2002b) which complements the well known 1996 Communication (CEC, 1996).

In order to better define the subject of this survey, let us start by presenting the most widely used definitions of VAs. By the term ‘voluntary approaches’ we refer to “commitments from polluting firms or industrial sectors to improve their environmental performance” (Lévêque, 1997). According to terminology which is gaining increasing consensus (e.g., OECD, 1999; Lyon and Maxwell, 2001), VAs can be placed into three main categories, which can be ordered as a function of the public sector’s degree of participation.

The first category is that of *unilateral commitments*, which consist of environmental improvement programmes established by firms themselves and communicated to their stakeholders. The public sector in this case does not participate in the design of the environmental initiative. The term ‘self-regulation’ basically refers to this kind of VA.

The second category is that of *negotiated agreements*, which are contracts between the public (national, federal or regional) authorities and industry. The role of the former may be either a leading or a secondary one, but usually implies the undertaking of specific commitments (e.g. provision of technical or financial assistance, giving up the use or the threat to use command and control and/or economic instruments, granting the polluter flexibility in other activities).

¹ See the surveys by Lyon and Maxwell (2001), Khanna (2001), Alberini and Segerson (2002) and the books edited by Carraro and Lévêque (1999) and Baranzini and Thalman (2004).

The third category is that of *public voluntary schemes*, in which firms that sign the VA agree to standardised rules developed by the public authorities. EPA schemes, such as Energy Star and Green Lights, or initiatives by the European Union, such as the Eco-Management and Auditing Scheme (EMAS) and the European Ecolabel, are examples of this third category.²

This survey, rather than distinguishing between the three aforesaid types of VAs, takes a different approach. We argue that what actually matters is not the degree of involvement by the public sector, but the economic incentives to adopt a VA that addresses a specific environmental problem. Therefore, this paper will identify conditions under which a VA is most likely to be adopted, and will illustrate instances where they can become a strategic tool in the hands of firms.

This ‘firm’s viewpoint’ is perhaps a major simplification of the existing categorizations of VAs and the related incentives to adopt them. In the next section, we argue that we can simply distinguish between *demand-side* or *supply-side* incentives to adopt VAs. This distinction helps us to better focus on the following two main objectives: a) to identify which economic factors actually favour the adoption of VAs and affect their environmental effectiveness and economic efficiency; b) to derive some policy conclusions that may help analysts and policymakers to assess the economic trade-offs associated with the use of VAs.

The theoretical framework employed in this paper is centred on imperfect competition and oligopoly theory. There are at least two main reasons which explain this choice. The first one is theoretical and is closely linked with the aforementioned goals. As is well-known, the empirical evidence about the participation of firms and environmental effectiveness is mixed, with some firms participating in VAs, while others do not, and with cases of VAs recognised as a public success and others in which firms remain committed to their business as usual targets. The oligopoly framework is therefore crucial if we are to account for such heterogeneity. The second reason has to do with the very nature of VAs, which can be seen as a specific policy instrument lying somewhere between direct regulation and economic instruments. From such a policy perspective, the use of VAs, either *vis-à-vis* or in combination with other environmental policy instruments, can be justified in several cases. The common denominator in these cases is the presence of inefficiency, market failures and strategic behaviour, which are all strictly related to imperfect competition in the product market, and can therefore be effectively captured by an oligopolistic theoretical framework.

A case in point is when environmental protection is to be achieved through technological innovation, because in such cases standards, environmental taxes or emission permits are a sub-optimal instrument for

² The OECD (2003) survey of VAs actually implemented in OECD countries partially amends the above terminology, and also considers a fourth category, ie. private contracts between polluters and polluted. We will not deal with this Coasean solutions in this survey.

achieving adequate levels of technological innovation.³ Therefore, there is room for the adoption of VAs or at least of a policy mix to which VAs belong.

This paper is structured as follows. The next section illustrates how the economic analysis of VAs can be classified according to demand-side and supply-side adoption incentives. Then section three focuses on demand side incentives and distinguishes between cases in which VAs are mainly aimed at enhancing the environmental reputation of a firm's product, and those where the polluter's action is fundamentally motivated by the competitive advantages accruing from product differentiation. Supply-side effects are analysed in section 4. The traditional view that VAs are a strategy for pre-empting regulatory threats belong to the supply side incentives discussed in section 4. However, this section also includes an economic analysis of participation incentives that cannot be described as being a regulator's 'sticks', but that still affect company's and market supply, whether in the form of public incentives, savings on the cost side, or competitive advantages arising from voluntary over-compliance. A final section highlights the policy implications of this survey.

2. Strategic incentives for voluntary over-compliance.

Let us focus on the motives behind a firm's decision to adopt a VA. The OECD (1999) report distinguishes between 'regulatory gains' motives, which may be in the form of a lower pollution abatement level or lower complying costs; 'saving inputs' derived from the managerial and technical expertise which firms acquire thanks to the voluntary scheme; and 'increasing sales' or 'enhancing reputation' motives, which are related to the exploitation of consumers' 'green preferences' (the so-called green consumerism phenomenon), of investors' strategies rewarding firms with good environmental performances, and of stakeholders' green attitudes that determine the social environment in which the firm operates. The same motives are basically indicated by Lyon and Maxwell (2001), who distinguish between 'improving of corporate productivity', 'responses to green consumers and investors', 'shaping of regulatory decision' (pre-emption' and 'weakening' of forthcoming regulations, or even induction of regulation, if the firm wants to exploit its environmental performance to raise costs incurred by rivals). As an additional category of incentives to adopt VAs, Khanna (2001) points to the cases of technical assistance or financial incentives which often come with the signing of a VA. With a partially different perspective, Alberini and Segerson (2002) distinguish between "market based" incentives (in the form of exploitation of green preferences for a firm's products or stocks), 'government-created incentives' (whether positive ones like financial and technical incentives, or negative ones such as the threat to impose a command and control or tax solution to the environmental problem), 'free-riding incentives' (which may induce a group of firms to sign an agreement in order to be certain that an industry target is met), and 'targeting incentives' (when, through a VA, regulators are able to induce a voluntary environmental

³ See Carraro and Siniscalco (1994), or Carraro, Lanza and Tudini (1994).

effort from firms whose environmental performance could not have been regulated otherwise). Finally, other authors consider incentives that cannot be directly incorporated into the previous categories. These include ‘shared uncertainty’ (Glachant, 1999), ‘innovation effects’ (Aggeri, 1999; Carraro and Siniscalco, 1994), and market structure or competitive advantages (Denicolò, 2000; Videras, 2001).

Instead of the using previous ‘structural interpretations’ of the main incentives to voluntary participation to review and orientate our theoretical and empirical research, this paper proposes a ‘reduced form’ interpretation of why profit maximising firms may decide to sign VAs. Our (basic, but useful) statement is as follows.

A firm adopts a VA only if it raises its profits. If a VA enables a firm to raise its profits, then the VA must have an effect on the demand or supply schedule, whether at the firm or market level.

Thus, we argue that all the aforementioned explanations for the adoption of VAs can be modelled as a demand and/or supply effect. Figure 1 provides a representation of our statement: the adoption of a VA (i.e. a shift of the firm equilibrium from E to E^{VA}) is accompanied by a shift in either the demand or supply curve, or both. For example, a self-regulation initiative recognized by consumers is likely to determine an outward demand shift (Figure 1a). Conversely, if such initiative enhances the stock market performance is registered (e.g. Konar and Cohen, 2001), then a shift in the supply curve must occur, due to the reduced cost of the capital input (Figure 1b). Similarly, a VA undertaken by a subgroup of firms in an industry which pre-empts costlier forms of direct regulation (e.g. as in Dawson and Segerson, 2000) will essentially have a positive effect on the supply function of the firms in the industry.⁴ Finally, both demand and supply effects occur in models where a VA affects the regulator’s choices in a vertically differentiated market with regard to the environmental characteristics of firms’ products (Lutz-Lyon-Maxwell, 2000).

In the next sections, the distinction between demand and supply effects that may induce a firm to adopt a VA will be used to provide a different interpretation of the existing literature on VAs and to provide an assessment of VAs as environmental policy instruments. From this latter viewpoint, VAs provide environmental benefits with which other social costs and benefits can be associated. The former are usually measured in terms of reduced consumer surplus and lower company profits, while the latter may consist, for example, of reduced public costs (be they monitoring or transaction costs), diminished implementation time or greater understanding of environmental policies. In particular, it is crucial to check whether the adoption of VAs actually maximises social welfare *vis à vis* other environmental policy tools. The identification of firms’ strategic incentives to undertake a VA represents the analytical base from

⁴ In this case, there still is an effect at the firm level, although as a by-product of participation and emission abatement decisions taken by a collection of agents. These situations are sometimes called ‘collective environmental agreements’ (Millock and Salanié, 2000) or ‘coalitional VAs’ (Brau, Carraro and Golfetto, 2001). See also Dixit and Olson (2000).

which to assess social benefits and costs, and also possible trade-offs between different government objectives.

3. Voluntary approaches driven by demand effects

VAs where the demand effect is predominant represent a quite homogeneous category. In these models, the participation motive is the 'capture' of consumers' willingness to pay for the environmental attributes of a firm's product, i.e. VAs become a product enhancing and/or a differentiation strategy that helps create niche markets, and/or identify a firm's product. Notice that this explanation is only valid in conditions of imperfect competition, where firms can affect the industry demand schedule, and that a basic assumption is that in their demand for goods or services consumers associate an additional value for environment-friendly products or processes.

Some empirical evidence to support this assumption has been provided,⁵ although not all authors consider it as conclusive (Cf. Alberini and Segerson, 2002) and the common belief is that the extent of these effects is limited. By way of indirect support, Arora and Cason (1995, 1996), Khanna and Damon (1999) and Videras and Alberini (2000) note a higher than average likelihood of participation in EPA voluntary programs (namely "33/50", Green Lights and WasteWise) by firms producing final goods, whereas Arora and Gangopadhyay (1995) refer to a survey by a British product-development consultancy agency in 1989, which revealed that 53% of people questioned had declined to buy a product because worried about the effects of the product or its packaging on the environment.

VAs driven by demand motives may take the form of unilateral commitments (often supported by an advertising and publicity campaign) or of public voluntary schemes. An example of the latter category is the European Union Ecolabel.

In principle, a firm's environmental performance may affect its own and market demand curve by means of three main effects:

- a) a demand upward shift;
- b) a higher slope of the demand due to a change in consumers' awareness of environmental issues;
- c) a higher slope of the demand due to product differentiation.

The first effect is a quite straightforward one. If consumers value a clean environment in their utility function, they are ready to pay a higher price for non-polluting products produced using a more environment-friendly technology. Hence, as shown in figure 2, market demand shifts upward when a 'cleaning up' activity is carried out. From a normative viewpoint, this kind of effect is welfare improving. On the one hand, if an incentive exists for firms to voluntarily carry out emission abatement policies that can be framed within a VA, this must be in the form of a profit increase. On the other hand,

⁵ See Khanna (2001) for a summary of these studies.

consumers are also generally better-off if they can enjoy the better environment that they are ready to pay for.

However, as shown by Carraro and Soubeyran (1996) and Garvie (1999), if consumers care (care more) about the environment, the demand curve is also steeper for any output level (see figure 2). Intuitively, the presence (the increase) of 'green consumerism', makes the other characteristics of a good (the others which determine total utility) relatively less important. Considered alone (without any demand shift), this reduced demand elasticity usually entails a profit loss for the firm, although accompanied by an increase in its market power. However, if there is a voluntary abatement initiative, more widespread consumer information would lead first of all, to an increase in demand. Hence, in equilibrium, profits may well increase. As for welfare effects, the sign is not a priori determined, given that a trade-off arises between firms' profits and higher prices which may reduce the consumers' surplus.

Finally, firms can also try to increase profits by differentiating their product or process from those of the other firms in the industry. This is the third effect, which differs from the others inasmuch as it is a relative effect that benefits only a subgroup of firms. In this case, consumer's surplus may not be reduced, and profits and environmental benefits are usually increased.

Are these effects VA specific? As for demand upward shifts, they also seem to occur when a firm improves its environmental performance because of the imposition of a standard or a tax. Therefore, they cannot be considered as VA specific. Conversely, the two increased demand slope effects are more related to a firm 'free' decision: a) when there is an increase in consumer awareness, VAs may offer an 'information disclosure' opportunity, as well as a way to 'convince' consumers if green products are to be considered as 'credence goods';⁶ b) when there is environmental product differentiation, the effect is certainly VA specific, being a direct outcome of a voluntary action which is not undertaken by the industry as a whole.

3.1. VAs in models of environmental quality enhancing

Cases where consumer's environmental preferences affect the whole industry market demand for a homogeneous good are analysed by Garvie (1999). His model includes the two *market demand shift* and *increased slope* effects discussed above.

Garvie's paper studies the behaviour of (identical) firms involved in Cournot competition and coping with a market characterised by the presence of green consumerism (for the sake of simplicity, consumers' preferences are assumed to be separable into product and environmental characteristics). When at least one firm improves its environmental performance, industry demand shifts outwards. In order to consider a quite general case, it is assumed that consumers perceive only a fraction of the total environmental damage resulting

⁶ For a discussion of the implications of this hypothesis, see Cavaliere (2000).

from the production process,⁷ with the two polar situations of zero and total information as special cases. The more consumers are informed, the larger the market demand outward shift induced by a voluntary emission reduction, and the steeper the demand curve. Given the presence of demand effects, firms will use both their production and emission reduction decisions as strategic variables (both the quantity produced and the related emissions affect market price).

A number of quite interesting findings do emerge from this theoretical setting:

- The optimal firms' voluntary effort to reduce emissions is equal to zero only if consumers attribute no value to the environmental damage caused by the production of the good. Moreover, voluntary abatement is an increasing function of consumers' sensitivity to environmental variables.
- However, when consumers have a partial awareness of environmental damage, firms' abatement is sub-optimal with respect to the socially optimal abatement level.
- Firms strategies are strategic complements with respect to abatement efforts. Hence, if an appropriate policy for VA adoption is found for some polluters, other firms will react accordingly by also reducing their emissions.
- VAs may have strong anticompetitive effects. Market power is enhanced when VAs are adopted. This effect is higher the greater access consumers have to information and the larger the marginal damage produced by the industry production process.
- Market structure affects social welfare:
 - a) As a result of free-riding on market demand effects, a larger number of firms results in a lowering of the total abatement effort;
 - b) A higher welfare level can be achieved if firms are allowed to co-operate in their emission strategies, e.g. through an industrial association which determines a voluntary abatement code for all firms in the industry, although this entails higher market prices.

The last result is particularly interesting because they show that more concentrated industries, where co-ordination among firms can be achieved more easily, can guarantee higher abatement levels (higher environmental effectiveness) as well as increased social welfare (higher economic efficiency).

Although Garvie's analysis deals mainly with unilateral commitments, its findings are directly applicable and possess strong policy implications for the whole family of VAs. In particular, the results regarding the positive effects ensuing from consumers' increased awareness of firms' environmental performances highlight the importance of information disclosure policies in spite of an increase in firms' market power (or higher demand slope effect). In contrast, the superior performance of a concentrated market structure basically

⁷ A few convincing explanations of why consumers may be imperfectly informed about the intrinsic environmental quality of purchased goods are offered by Nadei and Morel (1999).

calls for a positive attitude by public authorities towards horizontal agreements undertaken with a view to protecting the environment.

An example of a generalization of the basic industry-wide demand effect is when VAs are also used as a means to increment consumer sensitivity to a firm's environmental performance. In other words, VAs can be considered as a way to increase a firm's reputation *vis à vis* imperfectly informed consumers, which are characterised by green preferences, but are unable to assess the quality of the commodities they purchase.

Numerous studies have sought solutions to this asymmetric information problem. In particular, we know that possible solutions are attained because firms have strong incentives to build a green reputation for their goods. Such incentives enable consumers to evaluate the environmental quality of a product from a given period onwards. As pointed out by Cavaliere (2000), two cases correspond to this situation:

- a) a firm's environmental performance is an 'experience good', i.e. individuals can infer the environmental quality of a good when consuming it;⁸
- b) environmental quality becomes 'common knowledge' once some form of a publicly recognised VA is adopted.

Indeed, in the latter case, in which environmental quality is a 'credence good', i.e. a situation where the environmental impact of a product cannot be ascertained either by purchasing it, the adoption of a VA enables firms to acquire a reputation otherwise impossible to reach.

This point is shown by Cavaliere (2000) by using a model with repeated interactions between a monopolist⁹ (or an industrial association) and a large number of uninformed consumers. In the model, the main result regarding the firm's behaviour is that, if the firm characterises its type as a high quality one, it will find it optimal to produce a high quality good in every period. If the firm characterises its type as a low quality one, it will find it optimal to randomize its production between a 'green' or a 'brown' good at least in the first periods of the repeated game.

Hence, the main lesson is that unawareness by consumers may induce a self-enforcing solution of the market failure in the form of voluntary over-compliance. More precisely, it is the presence of poorly informed consumers that forces firms to adopt VAs, at least in the long run.

3.2. Quality differentiation and voluntary over-compliance

As discussed above, consumers' sensitivity to environment quality may also provide a firm with an incentive to increase its own demand and market share *vis à vis* its competitors. This can be done by differentiating its products

⁸ For example, this could be the case of tourism destination mainly based on environmental resources.

⁹ In particular, Cavaliere (2000) considers the case of a monopolist who may be exogenously less or more suited to undertaking a VA. This fact is private information, so that consumers do not know what type of firm they are facing.

with respect to those offered by competitors, thus creating a niche market where a higher market price can be imposed.

The standard Hotelling's model of product differentiation can be applied to analyse firms' green differentiation strategies. Assume that the market is segmented because consumers display a different attitude towards "green" efforts by firms or 'green' product characteristics. Also assume that there are only two firms and that, as usual in this kind of model, the interaction between the two firms is modelled as a two-stage game; a first stage in which firms decide their product's identifying characteristic, and a second stage in which price competition takes place.

The choice of emission levels is equivalent to the location choice in Hotelling's model. Hence, as is well known from the work by D'Aspremont and Gabszewicz (1986), if costs for consumers that cannot buy the most preferred product are non-linear, the firms' optimal choice in this kind of model is to differentiate. This point is formally shown for example by Arora and Gangopadhyay (1995). When firms can choose their emission technology, in equilibrium there will be two types of firms in the market, one with high and the other one with low emissions per unit of output. Lutz, Lyon and Maxwell (2001) generalise these findings to the case in which consumers do not have complete awareness of the environmental benefits. In both cases, the VA can be seen as the choice by the "greener" firms to engage in non-mandatory abatement levels, while the less environmental efficient firm will simply meet the already existing standards.

With regard to policy design, it seems that although it may be welfare improving, the optimality of a purely voluntary outcome is questionable. On the one hand, Cremer and Thisse (1999), in a vertical differentiation model, find that the market tends to under-provide environmental quality even in the absence of externalities or spillovers. More recently, Bagnoli and Watts (2003) have confirmed this outcome, apart from in a few cases in which the nature of competition (in particular Cournot *vs* Bertrand) may lead to 'excessive' voluntary emission reduction.¹⁰

An advantage of VAs is that they can be used in a policy mix. Therefore, product differentiation models can constitute a useful starting point for an analysis of how VAs perform when 'command and control' or other 'economic' environmental policy tools are also adopted by the regulator. The conclusion by Arora and Gangopadhyay (1995) and Lutz *et al.* (2000)¹¹ is that *in a framework of heterogeneous tastes and product differentiation the use of an effective minimum standard is recommended*. Intuitively, the 'worst' firm wants to move as little as possible from its optimum and, as a consequence, will meet the mandatory standard exactly. Then, in order to maintain product differentiation, the best firm will over-comply with the standard. In other words, when a firm chooses a higher

¹⁰ More in general, higher voluntary abatement levels are shown to occur in the case of Cournot competition *vis à vis* a case of Bertrand competition. Given the worst outcome of the first competition regime, a trade-off between environmental effectiveness and competition arises.

¹¹ For example, see Ronnen (1991).

emission control level, other firms will also have an incentive to choose a higher level. Therefore, a regulator can increase the whole industry emission abatement by forcing the most polluting firm to reduce its emissions.

Reverse effects arise when VAs are accompanied by an environmental tax. Arora and Gangopadhyay (1995) show that the tax reduces a firm's abatement effort, which would otherwise be stimulated by product differentiation. Hence, if more emission abatement is to be achieved, the production of the good must be subsidised. With a subsidy, a firm can increase its clean-up effort at the same price, thus increasing its market share. To avoid this outcome, non-subsidised firms will react with an enhancement of their environmental performance.¹²

Finally, in the case of tradable emission permits, the introduction of a VA modifies the traditional condition that states that permit trading will occur until the marginal abatement costs of different firms are equalised. Being a net seller of permits becomes a way of reinforcing the clean image of the firm. In equilibrium, there will be fewer trades than predicted by the rule based on the equalisation of marginal costs.

As in the case of homogeneous commodities, product differentiation may be related to the consumers' inability to directly assess the 'green' nature of the good they purchase. In this case, we should expect that some goods would find their way onto the market pretending to be 'green', even though they are not, thus bringing about 'adverse selection', like market failures.¹³ Under these circumstances, one may raise the question if a 'certification' of the environmental quality of the product, in the form of a green label, may solve the market failure. Unfortunately, existing economic literature on this is mostly sceptical.

For example Kuhn (1999) analyses the case of a public agency that can optimally design a series of requirements to be satisfied by firms that want to be granted an 'ecolabel'. As usual in this kind of model, what the public agency is aiming at is a 'separating' equilibrium, in which the 'green' and the 'bad' firm reveal their nature by voluntarily choosing different remuneration schemes. Environmentally effective solutions are found only under quite specific conditions.

The firm's side of this framework is analysed in depth by Nadaï and Morel (1999, 2000). Similarly to Cavaliere (2000), these authors have a pessimistic view of consumers' cognitive gap: environmental quality is a 'credence good', so that a 'green label' (and a regulator entitled to issue it) is needed in order to direct green consumers' willingness to pay. The effectiveness and consensus to such policy depends on the assumptions regarding market structure. In the case of a heterogeneous industry in which firms produce only one (more or less 'green') good, the worst ('brown') firm would always lose out from the implementation of an ecolabel. Moreover, only selective criteria by the regulator

¹² However, subsidies have a social cost that may offset the environmental benefit that they provide in this setting.

¹³ For a laboratory experiment dealing with this problem, see Cason and Gangadharan (2002).

seem to be able to ensure environmental effectiveness.¹⁴ Put together, the previous two findings imply that most firms would oppose the implementation of an effective green label.

Less pessimistic results are obtained when firms are able to produce goods of different quality. Under such framework - which mimics the case of EU firms that have adopted the system of European labels for domestic appliances – Nadaï and Morel (2000) argue that all firms could be better off after the implementation of an ecolabel, although the relative competitiveness among them is affected. In addition, by choosing the selectivity criteria of the ecolabel, there is room for *win-win* criteria, which not only ensure environmental effectiveness but also leave firms better off with respect to the situation without the green label option. However, regulators cannot stimulate environmental innovation by firms with optimal ecolabels alone, at least for innovation costs of a magnitude comparable to that of production costs. The pre-requisite for successful industry self-regulation with badly informed consumers seems to be the presence of low innovation costs and technological homogeneity (Nadaï and Morel, 2000).

In short, a situation in which markets are oligopolistic and products are differentiated can actually favour the emergence of environmental VAs. In this setting, VAs become a form of ‘strategic social corporate responsibility’ (Bagnoli and Watts, 2003), where differentiation is aimed at increasing profits. From the public perspective, regulators on the one hand usually face a trade-off between guaranteeing competition and protecting the environment at a minimum cost; on the other hand, they know that the adoption of VAs usually alters the regular effectiveness of other policy instruments, be they minimum mandatory requirements, taxes or permits.

4. VAs affecting a firm’s supply side

Among the motives for adopting VAs usually identified in current literature, the strongest ones share the common characteristic of affecting a firm’s supply function. In comparison with demand effects, supply side incentives to adopt VAs represent a more heterogeneous category, encompassing quite different phenomena in spite of a (potentially) similar analytical representation.

As represented in figure 3a, one can imagine the equilibrium effect of a VA as a downward shift of the firm’s (and market) supply curve (although, when considered in isolation, the adoption of VAs may be viewed as a costly activity). This usually leads to higher output and profits. In other words, when a VA is adopted, it yields a ‘net’ cost reduction. Intuitively, one could draw an analogy with the effect produced by the installation of a new, more efficient, machine in a firms’ plant. The purchase of the machine has a cost (as does the

¹⁴ For a similar result, see also Dosi and Moretto (2001).

adoption of a VA) but, once in place, the improved efficiency brought by the machine, determines a decrease of the firm's overall production costs.¹⁵

The main cases in which this effect occurs are when VAs are aimed at shaping regulatory activities and obtaining savings in the cost of firm's inputs or in the use of them. The first case is sometimes referred to as a *regulatory gain*, identifiable in the larger profits accruing to firms from avoiding the costs of some form of environmental regulation (the so-called regulatory threat). In particular, by signing a VA, firms can avoid or postpone the introduction of more costly regulations or regulatory instruments, or weaken the pressure from existing or forthcoming public intervention policies. In a more diluted form, this advantage may arise not merely from the behaviour of a specific regulator, but rather from the changed attitude of a local community, which generates a more friendly public environment in which the firm can operate.

However, the above is an incomplete picture of what may be considered a regulator gain. Regulators use 'sticks' as well as 'carrots'; i.e. certain advantages may accrue to firms from subsidies or services granted by the regulator and aimed at addressing the environmental problem. This is a common situation in the US (e.g., the 'Climate Change Action Plan' or the 'XL project' by EPA¹⁶). Of course, in all these cases there is no 'regulatory threat', but a 'regulatory promise'.

Another category of absolute supply shifts not related to any regulatory threat is linked instead to the so-called 'saving inputs' effect (OECD, 1999). This term refers to the increased efficiency of the overall manufacturing process which can be associated with the adoption of a voluntary environmental code.¹⁷ In other words, firms adopting a VA may consequently learn to optimise their production process or acquire information about best available technologies.

Very similar to the previous one is an additional motive to adopt in the form of achieving input price reductions, which basically gives easier and more convenient access to the stock market (see Khanna, 2001 for a few examples). Existing literature often places this case in the general category of 'market incentives', but it should be pointed out that there is no significant change in demand for the goods produced by the firm.

Finally, the case of upward supply curve shifts can also be considered, as illustrated in Figure 3b. We will discuss below how this less intuitive effect may occur when firms strategically use VAs to affect market structure. For example, it can be argued that a VA by firms with low abatement costs could be aimed at 'inducing regulation'. By 'raising rival costs', these firms could force less efficient firms to exit the market and gain more market shares for themselves. In other cases, a VA could promote the conditions for collusion among firms.

There is some empirical evidence to support the statement that supply-side effects represent the strongest incentive to the 'voluntary' reduction of

¹⁵ An analytical representation for these cost effects which take into account the firm's individual effort and the number of participants into the VA is proposed by Brau and Carraro (2004).

¹⁶ As for European cases, ten Brink, Morere and Wallace Jones (2002) report many examples referring to a series of national programs aimed at meeting Kyoto's greenhouse gas reduction targets.

¹⁷ For a discussion about VAs efficiency see Alberini and Segerson (2002).

polluting emissions. As for regulatory threats, Maxwell, Lyon and Hackett (2000) analysed data on toxic chemicals releases in the U.S. from 1987 to 1992 and found that States with proportionally higher estimated membership of conservation groups (interpreted as a key variable in affecting regulatory threats) registered a lower level of toxic emissions.¹⁸ More directly, Khanna and Damon (1999) looked at the threat of mandatory regulation as an explanatory variable of firms' participation in the EPA's 33/50 voluntary program and found it to be statistically significant. Videras and Alberini (2000) get a similar result in the case of the WasteWise program. In another study, Darrell and Schwartz (1997) find statistically significant differences in the quantity and quality of environmental disclosure in 53 corporate reports in the years 1988, 1989 and 1990 (post Exxon Valdez) in response to public policy pressure. For Europe, we can cite the well known (and controversial) 'Declaration by German Industry and Trade on Global Warming Prevention', motivated by the concern that legislative measures aimed at reducing CO₂ emissions may have been established (e.g. Kristof and Rameshold, 1999). A similar incentive is behind the adoption of most national negotiated agreements, as studied in De Clercq (2002).

The relevance of adoption incentives from the input market has also been widely studied. As for the effect of 'information disclosure strategies' (Tietenberg and Wheeler, 2001), Konar and Kohen (2001), among others, found that legally emitted toxic chemicals (as reported in the TRI) negatively affected firms' market value.¹⁹ The same authors (Konar and Kohen, 1997) found that firms which experienced the largest negative returns from the stock market reacted with above average improvements of their environmental performances.²⁰ As for the reaction of markets to the adoption of a VA, Khanna and Damon (1999) found mixed results in the case of the 33/50 scheme, with negative effects on short run indicators and positive effects in the long run.²¹

The role of the 'saving inputs' effect has been observed in various cases. For example, Lyon and Maxwell (2001) highlight this factor in the case of the 3M "Pollution Prevention Pays" program. In the European experience, cost savings resulted as the most important benefit from the adoption of the EMAS scheme in a sample survey on accredited firms (Hillary *et al.*, 1998).

Finally, a few pilot examples of how VAs may be used to affect market structure have come out from the decisions of the EU DG Competition and some national competition authorities (Vedder, 2001; Martinez Lopez, 2002; Gremminger, Laurila and Miersch, 2001).

¹⁸ See also Maxwell and Lyon (2001).

¹⁹ See also Lanoie, Laplante and Roy (1997).

²⁰ See also Khanna, Quimio and Bojilova (1998).

²¹ This, and more pessimistic results such as those by Laplante and Lanoie (1994), cast some doubts about the real importance of this effect. For a similar assessment see Alberini and Segerson (2002). For a survey of the empirical literature see Tietenberg and Wheeler (2001).

4.1 Regulatory gains related to the presence of a regulatory threat.

According to this interpretation, firms adopt a VA because they value this option as the most appropriate way of minimising the costs associated with the regulatory decisions of public authorities. The baseline assumption is that,

by reducing emissions through a voluntary action, firms reach a given objective at lower costs than in circumstances where they are forced to meet a compulsory standard (OECD, 1999).

There exist several explanations for why a voluntary regime can be less costly for both firms and the public sector. They include the greater flexibility associated to VAs in implementing environmental targets and the reduction in the size of transaction costs as a consequence of shared uncertainty between firms and public authorities (Glachant, 1999).

Another possible scenario is when a well chosen abatement level can definitively pre-empt a regulatory intervention that would have imposed a tighter standard. In this case, however, the environmental target is less ambitious under the VA regime. This hypothesis represents the extreme of a situation where putting a legislative action into effect is costly and the benefits offered by the agreement are always greater than the fixed costs imposed by the legal intervention. Intuitively, in this case, the results in terms of the VA's environmental effectiveness may not be satisfactory, given that a small voluntary abatement may pre-empt a strict compulsory requirement. Such situations will tend to occur when the public institution charged with signing a VA (e.g. the regulator) has a private agenda to satisfy which does not coincide with the objective of the institution (e.g. the legislator) charged with implementing other environmental policies. In this case, to sign a VA is, first of all, a 'shortcut' to satisfying the regulator's interests. Therefore, firms may be able to sign a VA which is less stringent than a truly effective environmental policy.

4.1.1. Basic models of bilateral bargaining

In the sequel, we will discuss both theoretical examples where firms use VAs to pre-empt a stricter regulation that they cannot influence and models in which firms can also influence the severity of the regulatory threat, i.e. in which regulatory capture is also considered. In order to analyse the different aspects of a firm's behaviour, it may be useful to start from a basic model introduced by Segerson and Miceli (1998, 1999), where the regulatory threat comes in the form of a mandatory regulation.

This model considers the strategic interaction between a single firm (it may well be an industry association) and a regulator, and its key point is represented by the lower costs faced by the firm when it undertakes a VA negotiated with a regulator, as compared to when regulation is enforced through legislation. The results can be applied whatever the regulatory threat, including taxation schemes, and even when there is uncertainty about future regulations.

Let us assume that the regulator is entitled to bargain over the level of emission abatement by the firm, while being subject to a social welfare maximisation constraint. For the social welfare, a negotiated agreement would be the preferred outcome if it is assumed that transaction costs for the public side are lower under the voluntary regime or that the social value of the establishment of a mandatory standard is hampered by uncertainty regarding the actual intervention by a legislative assembly. The agreement is potentially profitable for the firm as well, since it can pre-empt the legislative standard (which would entail higher compliance costs).

The outcome of a bargaining process is closely affected by the payoff that the parts would get if no agreement is reached. The regulator maximises the expected net social benefit by offering a given abatement level to the polluting firm. The latter decides whether or not to sign the agreement. If it accepts the offer, unitary costs of abatement are lower than if it was to satisfy a legal standard. If it rejects the offer, it is faced with a (possible) intervention by a legislative authority which can impose a minimum standard with higher unitary implementation costs. The probability of intervention (in the baseline case independent of the fact that the regulator offers an agreement) usually affects the level of abatement which is implemented under the voluntary regime.

On the whole, the main result of Segerson and Miceli's model is that, given that the unitary costs of pollution reduction are lower when an agreement is signed, an interval of abatement levels for which a VA is signed emerges, i.e. both parties find it optimal to adopt the VA. The only pre-requisite is that the existence of a legislative threat (even weak) is perceived by the firm.

The basic model can be extended in several ways. For example, one may wonder whether or not the regulator might affect the interval in which an agreement can occur by acting on the firm's costs under the voluntary regime. In this case, Segerson and Miceli (1998) show that a subsidy to firms that accept to sign the agreement makes it possible to enlarge the interval in which an agreement is possible and desirable.²² One may also ask what happens when the assumption about lower costs on the public side is relaxed. By considering the above framework, the existence of an equilibrium voluntary abatement is no longer ensured, being instead contingent on the regulator's and firm's payoffs (Segerson, 1998).²³

However, the existence of a 'negotiation interval' emerges again if the hypothesis of a welfare maximising regulator is discarded. This is done by Hansen (1999) and Glachant (2004), who consider the case where the regulator and the legislator have two different objective functions, with different

²² The size of this interval depends on the severity of the threat and on the social cost of public funds employed in financing the subsidy. The stronger the threat and the lower the social cost of public funds, the more likely is that a VA will be signed.

²³ It is however confirmed that there exists a positive relationship between the severity of the threat, the extent of transaction costs under the mandatory regime and the width of the range of abatement levels which allow for the negotiation to take place.

evaluations of consumers' surplus, firms' profits and environmental goals.²⁴ These differences can be primarily explained by contrasting political views. Alternatively, a regulatory agency could have special interests consisting, for example, in the saving of its time or budget resources, as well as direct fringe or monetary benefits granted by the firm to the members of the agency. The legislative body may also be subject to lobbying by the polluters. Whatever the arguments of the regulator's private agenda or the political biases of legislative assemblies, both Hansen (1999) and Glachant (2004) show that an interval of abatement levels at which the regulator and firms agree to sign a VA may exist, in particular when there is a sufficiently strong disagreement about policy priorities between the legislator and the regulator, and when the firm's discount rates are high.

The intuition behind this result is that, when leaving the decision on the abatement level to the legislative body, the regulator could be faced with a situation which may prove very harmful to achieving its own objectives. In this case, the legislative threat is also affecting the regulator. Rather than a case of 'regulatory capture', it is a case of legislative pre-emption from the regulator's side. Optimality of the negotiated VA can be quite problematical. If the 'benevolent social planner' is the regulator, the use of VAs should usually be seen as a welfare improving policy. Conversely, if it is reasonable to assume that the legislator is relatively more resistant to lobbying activities than the regulator, the implementation of a VA could be socially harmful.

In general, this approach explains why the use of VAs is more often encouraged by the executive branches of the government rather than by the legislative bodies.

4.1.2. *The multi-firm case*

What limits the previous analysis is the hypothesis of bilateral bargaining, which implies the absence of strategic competition by firms, or the presence of an industry association whose behaviour is not affected by the number and the nature of its members. By extending their model to the case of a duopoly, Segerson and Miceli (1999) argue that two cases must be considered. A first is one in which a VA with only one of the two firms is sufficient to pre-empt a legislative intervention, and the second is where pre-emption is certain only if both firms adopt the VA.

The first case directly leads to the issue of free-riding. If pre-emption benefits yielded by the adoption of a VA are not fully excludable, then firms have an incentive to under-supply their own level of emission abatement. From a general economic theory perspective, free riding is likely to depend directly on the number of firms in the industry. Moreover, the phenomenon is stronger when the possibility of voluntary participation is accounted for (Dixit and Olson, 2000). In Segerson and Miceli (1999) it is shown that only one firm signs

²⁴ In Segerson and Miceli (1998) the optimal abatement levels for the legislator and the regulator differ only because of the lower costs in the case of negotiation and not because of a conflict in their objectives.

the agreement. This result is independent of the firms' cost structure, which implies that there is no automatic identification of the kind of firms which actually sign the agreement. When an industry with n firms is considered, the important question is if free-riding is actually able to completely undermine the signing of any efficient VA.

The theoretical results derived by Dawson and Segerson (2000, 2003), with a model with homogeneous firms and a fixed environmental target to be met, support the conclusion that partial agreements signed by a subset of firms are possible, as long as the avoided cost from the occurrence of regulatory intervention is greater than or equal to the participation cost (i.e., a 'chicken game' like situation). Brau and Carraro (2004), in a model with asymmetric spillovers, i.e. where the benefits of the VA go to the signatory firms and only partly to free-riders, show that a VA can be signed even without a fixed environmental target. In this case, provided that a minimum participation level is reached, a VA will be signed, and is likely to be joined by all firms in the industry.²⁵

Free-riding problems disappear when pre-emption is certain only if all firms adopt the VA, but at the cost of a lower probability of reaching an agreement. This probability depends on the dispersion of the distribution of firms' costs, and on the number of firms. *Ceteris paribus*, in the bargaining process the regulator has now to rely on a higher probability of legislative intervention. An in depth analysis of the latter case has been provided by Manzini and Mariotti (2003). By applying the Rubinstein's (1982) model of alternating offers, they show that a 'toughest firm principle' holds, i.e. negotiations in a multifirm case are driven by the firm which, in a bilateral agreement with the regulator, would obtain the lowest abatement level. Moreover, the main comparative statics results (e.g. those related to variations in marginal abatement costs) are driven by how the change in parameters affects the market position of the 'toughest' (or pivotal) firm.

In addition to the probability of legislative intervention, another tool that increases the power of the threat in a multiple firm case is the possibility of 'firm-specific pre-emption'. This situation was introduced by Segerson (1998) and consists of the provision of a compulsory intervention in the event that a given standard is not reached by some of the firms entering the market. The free-riding problem is of course solved because pre-emption becomes an 'excludable good'. Notice that, in order to implement this situation, the regulator must possess the ability to intervene against non signing firms. Legislative schemes that threaten the automatic introduction of taxation or direct regulation if the VA is not adopted seem to satisfy this requirement.²⁶

Is the relevance of the free-riding problem affected by dynamic considerations? When no agreement is signed because of opportunistic

²⁵ According to Brau and Carraro (2004), a policy mix approach can additionally reduce the negative effects from free-riding. Namely, Pareto improving situations can be reached if an adequate minimum abatement constraint is imposed.

²⁶ The reader may recognise that this description can apply to the Dutch and Danish CO₂ taxation-VA schemes.

behaviour, we expect that in an environment where polluters are allowed to “learn” and repeat their game (i.e. a situation in which there is no certain implementation of the regulatory threat), free-riding incentives should become less harmful. Moreover, when pre-emption by a partial agreement is allowed, the possibility of entry in the industry can be taken into account. In this case, Dawson and Segerson (2003) show that with zero entry costs, the free-riding incentive is offset and full industry participation occurs in the long run. With positive entry cost, partial participation is still possible, but to a smaller extent than when only a short run equilibrium is considered.

The conclusions that these results lead us to are probably still preliminary. They can be summarised as follows: a) In the multi-firm case, a free-riding problem emerges and this reduces the likelihood of adoption and the effectiveness of VAs; b) The free-riding problem can be solved, either by implementing the agreement only when all firms sign it, or by promoting entry of new firms in the industry, or by designing policy mixes which incorporate firm-specific threats or incentives. c) An increase in the number of firms, i.e. a more competitive market structure, makes the previous options less effective in favouring the adoption of VAs. In addition, the occurrence of a ‘toughest firm principle’ is likely to undermine the environmental effectiveness of signed VAs when abatement costs are highly heterogeneous.

4.1.3. Shaping the severity of the regulatory intervention:

Regarding VAs as merely a tool for pre-empting mandatory regulation sometimes seems too simplistic. On the one hand, regulators may simply want something more than what firms are offering voluntarily. On the other hand, and more importantly, firms might strategically use some kinds of VAs in order to affect the size of the overall level of emission reduction.

When the latter possibility is considered, the assessment of some of the cases analysed so far may change significantly. For example, in section 3.2, the option of product differentiation was viewed as an example of voluntary over-compliance beneficial for the economy as a whole, and the setting of a minimum environmental quality standard resulted in a policy that improved welfare. However, according to Lutz *et al.* (2000), in a product differentiated industry, a firm may reduce its total voluntary environmental effort and the size of the industry’s mandatory requirements (compared to a situation where the firms and the regulator set these levels simultaneously) *if it is able to anticipate the regulator’s definition of the minimum standard with some level of voluntary emission reduction*. More importantly, social welfare is lower when this happens.

The intuition is that, when a firm undertakes a quality improving investment, it usually ‘ties’ itself to that specific quality level, i.e. any move away from the latter is likely to require a fixed cost to sustain a new change in quality. For a ‘not pre-committed and welfare maximiser’ regulator this is relevant since firms’ profits are part of social welfare. Without any previous voluntary action by the firm, the regulator would set its optimum mandatory abatement requirement. If the regulator imposed the same standard after the VA, firms’ profits would be lower due to the need for new positioning. Hence,

by acting first, a high quality firm can commit to a relatively lower quality level which maximises its profits given the regulator's reaction function. This (social welfare) function induces the regulator to set a weaker minimum quality level which will balance firms' marginal profit losses with marginal consumer surplus and environmental benefits.

Broadly speaking, there is a first mover advantage. Social welfare will be higher if the regulator can set a minimum standard prior to or simultaneously with the definition of the best firm's performance within the VA. The obvious policy implication therefore is that the regulator must intervene by enhancing mandatory standards before the VA (which sometimes takes years to be implemented) has displaced all its *lock-in* effects. On closer inspection, one can interpret the choice of ex post weaker standards by the regulator when firms 'move first' as a 'textbook case' of dynamic inconsistency.

Petrakis and Xepapadeas (1999) specifically analyse the regulation of polluting emissions through environmental taxation in a dynamic setting to clarify the time inconsistency issue. They consider that voluntary compliance and the setting of a taxation time path (the threat) are part of a repeated game that the firm is playing with the government. With perfect information, by choosing its own voluntary abatement level, the firm knows perfectly well what the final tax rate will be. The main conclusion favours the adoption of a policy mix approach. In particular, if the government can pre-commit itself to a fixed tax rate, voluntary abatement (or environmental innovation) would be lower than without pre-commitment, but social welfare would be usually higher.²⁷ Therefore, as already mentioned when presenting the results in Lutz *et al.* (2000), a more widespread adoption of VAs does not necessarily lead to higher social welfare.

This negative view of pure self-regulation initiatives can be toned down by considering that the adoption of a unilateral VA is only one of the ways in which firms can pre-empt regulatory intervention. Lobbying activities are probably the most common tool used by firms to achieve their goals. The economic literature on VAs has pointed out the risk of 'cosmetic agreements' concealing lobbying actions on governments; and special attention has been devoted to regulatory capture processes. It has been noted (OECD, 1999) that, for this phenomenon to occur in the case of VAs, the regulator must derive a utility from these lobbying activities.²⁸ In the presence of such a regulator, an 'appropriate' combination of environmental VAs and lobbying activities may lead to the elimination or, at least, the mitigation of the environmental regulation.

The issues of regulatory capture, lobbying activities and their relationship with the nature and effectiveness of VAs are specifically discussed by Maxwell *et*

²⁷ With some degree of caution, Petrakis and Xepapadeas (1999) note that their result could depend on the linear specification of the damage function employed in their model.

²⁸ The 'size' of the capture is partially exogenous (the regulator satisfies its private agenda instead of social welfare), and partially endogenous (to the extent that firms' lobbying activities have an effect on the regulator's decisions). Basic references to a theory of regulatory capture are Stigler (1971) and Becker (1983). See also Laffont and Tirole (1991).

al. (2000). The setting of a continuum of equilibrium mandatory standards (between zero and the social optimal level) is accounted for within a framework where firms undertake VAs and lobbying activities aimed at modifying the abatement level defined by the regulator. Broadly speaking, firms are seen as being able to set a ‘policy mix’ through which they tackle the regulatory threat. Both activities are, however, costly initiatives. The resulting model enables us to address a number of issues, from the desirability of stakeholders’ participation to the interactions between market structure and VAs.

In Maxwell *et al.* (2000) by choosing whether and how much to voluntarily abate a firm is aiming at three objectives: to pre-empt stakeholders (e.g. consumers) and the regulator’s intervention; to influence the regulator’s intervention to its own advantage; to improve competitiveness with respect to other firms. Firms achieve these objectives sequentially and therefore the model is structured as a non-cooperative three-stage game. The ‘endogenization’ of the severity of the regulatory threat is modelled in the second stage as an ‘influence’ game played between firms and consumers,²⁹ with the latter favouring a stricter regulation and ready to ‘activate the game’ if the total cost of lobbying is smaller than the expected benefit in terms of stronger mandatory abatement levels. The payoff of the influence game is the definition of a mandatory abatement level to be added to the voluntary one. The total emission reduction achieved by the firms is thus the sum of the two components.

When firms self-regulate, they reduce consumers’ incentives to undertake lobbying activities, but must also compare the advantages of VAs *vis à vis* the gains from their lobbying activities. Different hypotheses can be made about the costs and benefits of lobbying. It is usually recognised that industries have a competitive advantage in the environmental policy arena, a ‘stylised fact’ which can be represented by assuming that lobbying costs are directly related to the number of components of the pressure group (due to organisational problems).

Maxwell *et al.* (2000) agree with this view and show that, within the influence game, the level of mandatory abatement is lower than when no lobbying activities are undertaken, but also argue that the VA option is even more cost effective in reducing mandatory requirements. Under reasonable conditions, a firm is even able to offer a VA which makes it unprofitable for consumers to engage in the influence game. Self-regulation by firms would therefore primarily be instigated by the aim of ‘keeping stakeholders quiet’.

This political economy approach leads to a number of interesting results:

- *Suitability of self-regulation.* When considering the costs of regulatory capture activities for both consumers and firms, pre-emption of the influence game Pareto-dominates the case when the influence game is played. The fact that it can actually be played indicates the occurrence of a prisoner’s dilemma situation.
- *Trade-off between market structure and environmental effectiveness.* The maximum voluntary abatement is higher when firms can collude in choosing their own abatement levels. As a consequence, an antitrust policy which allows

²⁹ For an application of influence games in the economic theory of regulation, see Becker (1983).

firms to co-ordinate on voluntary abatement³⁰ leads to beneficial self-regulation.

- *Voluntary abatement and regulatory threat.* An increased threat of government regulation, determined for example by a change consumer power, usually induces firms to increase their voluntary reduction of emissions.
- *Ambiguous effects of stakeholders involvement within a VA setting.* Bigger consumer power may induce firms to raise voluntary abatement, but it may crowd out self-regulation in favour of (lower) mandatory standards determined on the basis of lobbying fights. The policy implication is that the stakeholders' involvement in the political process should not be financed unless when organisational costs are so high as to 'block' consumers' entry into the influence game.

In brief, VAs can be a strategic variable through which firms can affect regulation. Regulatory gains arise from the avoidance of lobbying conflicts or, at least, from making these fights less intense. Given that the latter can usually be seen as an unproductive expense, this is another argument in favour of VAs.

4.2. Cost reductions not related to a regulatory threat

It is not uncommon to find examples in which there are no regulatory threats to motivate polluters' voluntary reduction of emissions. Lyon and Maxwell (2003) observe this in the case of some public voluntary schemes, such as those related to the U.S. Climate Change Action Plan. When there is no explicit regulatory threat, the cost advantage accruing from VAs is a somewhat more direct one, no longer in the form of the avoidance of a costlier regulatory regime, but in the form of a real cost decrease. We distinguish these cost advantages between those arising as a result of decisions made by public authorities and those coming from the input market.

4.2.1. "Subsidy based" VAs.

It is well known that many VAs provide for financial and or technical assistance. This is certainly common for public voluntary schemes, where polluters know ex ante the nature of the benefits designed by the regulator; but may also be likely with many negotiated agreements, where a role for public authorities is often established.

The easiest participation incentive is providing firms with a subsidy, which induces a downward shift of the supply curve and, under some regularity conditions on the demand side, an increase in their profits. Other than monetary, the incentive may be 'in kind', with specific services aimed at improving the abatement effort by the firm. The provision of these services can be modelled as a spillover effect which reduces firms' total production costs. Moreover, regulatory agencies may grant additional flexibility in some aspects of the production process not directly related to emission reduction. This

³⁰ Lawyers use the term of 'block exemptions' (from competition law). For a discussion of this aspect within the EU competition law see Vedder (2000, 2001) and Martinez Lopez (2002).

additional flexibility takes the form of a production cost reduction and shifts the supply curve downward. Referring to the EPA's 'XL Project', Boyd and Blackman (2002) label this form of negotiated agreement 'tailored regulation' and develop an analytical model of VA adoption by a 'tailored company' in an oligopolistic market framework.

This latter feature of the model is important because it allows us to design a firm's pay-off function defined not only by the cost difference under the voluntary regime, but also by the new market equilibrium resulting from the adoption of the VA. In particular, when an additional firm signs the VA, profits may be lower even when more participants in the VA lead to higher subsidies or larger marginal cost reductions.

Brau and Carraro (2004) show formally how this phenomenon may occur as a function of the shape of the demand function in a model of collective VAs, where the incentive to sign a VA is the technological spillover that signatory firms receive. In this case, signatory firms prefer that some of their competitors be excluded from the VA. In order to guarantee higher social welfare, the regulator should of course rule out 'close membership' rules in the VA.³¹

The latter is basically an indication for an efficient design of VAs. From a more general normative viewpoint, regulators should however offer a VA with technical and financial assistance only when it represents the most efficient solution. Wu and Babcock (1999) deal with this point by considering a model in which the regulator wants to achieve an environmental target by the n -firms in the market, either under a mandatory or a voluntary regime. If the regulator chooses to promote the VA option, then it must spend public funds for offering services and subsidies in order to induce firms' participation. The authors show that the voluntary regime will be advantageous if the cost of public funds used under the VA is less than the difference in implementation costs between mandatory and voluntary programs plus the difference between the private and public cost of government services.

Of special interest is how to identify which conditions may enhance the relative efficiency of VAs. Wu and Babcock (1999) find that the relative efficiency of a VA increases: i) when *the rivalry of government services is low*, i.e. when services have a high content of public good and the regulator is not forced to 'tailor' its intervention for each firm; ii) when *government services are less expensive than an equivalent private effort*, a condition which may depend on co-ordination or information constraints by the private sector; iii) when *enforcement costs of VAs are low compared to mandatory programs*.

The previous results can be additionally qualified with some dynamic considerations. It is well known that environmental taxes may induce under- or over-investment, as well as undesirable distorting effects. For example, Laffont and Tirole (1996) show that, in a dynamic framework, taxes or permits may induce firms to over-invest in environmental innovation in order to by-pass the

³¹ For a case in which the EC Directorate-General Competition has made inapplicable the provision of a VA which limited some advantages only to original members, see the article by Gremminger, Laurila and Miersch (2001) on the *Eco-Emballage* waste recovering system.

fiscal burden. A VA is theoretically able to perform better in this case (Carraro and Siniscalco, 1994; Carraro *et al.*, 1994). Still in a dynamic framework, VAs are also optimal when environmental innovation has positive spillovers on other firms, which need to be internalised in order to avoid underinvestment or delayed adoption (e.g., see D'Aspremont and Jacquemin, 1988; Carraro and Topa, 1994). In those in which the government needs two instruments to correct two externalities - one related to pollution and one to innovation - VAs play an important role in stimulating environmental friendly innovation in conditions of market failures and imperfect competition. It is also argued that in order to reduce pollution in strategic industries that produce tradable goods, VAs should be used instead of other effective instruments, such as command and control, permits and taxes, which distort competition (Carraro and Siniscalco, 1992). The same argument becomes even stronger when global externalities are at work.

VAs based on the granting of subsidies may be viewed in a positive perspective as well. This has been done by Lyon and Maxwell (2003), with a three stage game-theory model with heterogeneous firms. Firms can achieve some environmental targets either through a pre-emptive unilateral commitment (without financial incentives from the regulator), or stimulated by a pollution tax, or by joining a public voluntary scheme (which includes a subsidy by the regulator).³² The latter is offered only if the legislative process fails to introduce the pollution tax, since the subsidised voluntary program is preferred to inaction. A key feature of this model is the possibility for firms to influence the legislative process by 'investing' in political pressure in order to stop the adoption of a pollution tax.

Within this framework, the possible intervention of the regulator by means of a 'cost-cutting' VA, in addition to involve the use of costly public funds, may play a crucial role in targeting firms' strategies. However, Lyon and Maxwell (2003) conclude that public voluntary schemes are generally a suboptimal policy instrument. Thus:

- Under the hypothesis that voluntary actions are as costly as mandatory measures, the offer of a public voluntary scheme is preferred to taxation only when political opposition is high.
- In addition, if the taxation level is highly sensitive to political resistance, social welfare may be greater if the regulator agrees not to offer any public voluntary scheme.
- In any case, social welfare is higher when unilateral action pre-empts government action.

In sum, the use of subsidies can reduce welfare by increasing an industry's resistance to socially beneficial tax proposals and by reducing incentives for the industry to engage in welfare-enhancing self-regulation. Broadly speaking, if subsidies are made available firms become 'tougher' in their opposition to adopting environmental taxation, and they will view alternative self-regulation

³² In Maxwell and Lyon this form of VA is called public voluntary agreement.

initiatives as being relatively less convenient the alternative self-regulation initiatives. Lyon and Maxwell (2003) therefore conclude that policymakers should be diffident towards the use of publicly subsidised VAs. It remains unanswered if regulators may credibly commit not to opt for VAs when the legislation fails to address the environmental problem.

4.2.2. *VAs motivated by saving inputs incentives*

To conclude this section devoted to VAs induced by supply-side gains, let us briefly analyse the nature of cost advantages not directly related to the financial or technical services provided by public authorities.

A hypothesis often investigated in empirical studies is the positive effect that a firm's voluntary emission reductions would generate in the value of its stock market. Theoretical analyses which support this supposition are generally lacking. In particular, it is not fully understood if the (weak) responses noticed in capital markets are a possible cause of firms' undertaking VAs, or if these responses are the effect of higher profit prospects determined by the adoption of a VA.

In the framework of this paper, if we consider the input price reduction as a cause and not as an effect, the possible impact of the VA on the stock market value could be interpreted as a cost reduction. In addition, in accordance with the empirical literature, these effects should be analysed as firm-specific ones. To move to a 'structural' interpretation, one then needs some hypotheses on what actually drives investors' decisions. Some hypotheses which are consistent with the view of positive returns in the stock market as a cause of voluntary over-compliance are as follows (Cf. Lyon and Maxwell, 2001):

- *investors have green preferences, i.e., ceteris paribus, they reward environmental effort and disregard firms with bad environmental performances;*
- *investors link pollution to inefficient production.*

Admittedly, 'green funds' represent a very small segment in equity markets, and the relation between pollution and economic inefficiency is not yet supported by strong empirical evidence. Nonetheless, other explanations (e.g. those which explain the reaction of capital markets to VAs as related to a reduced probability of incurring in sanctions or command and control interventions) are again mixing causes with effects.

In principle, an input saving may also arise from a reduction of labour costs. For example, the adoption of environmental friendly technologies could reduce the 'premium' which employers must pay to convince their employees to work in firms with a bad environmental performance, in particular if the environmental damage is likely to affect health conditions within and nearby the factories where workers and their households work and live. To the best of our knowledge, the plausibility and the size of this hypothesis has not yet been empirically studied.

The association made above between pollution and inefficiency leads to cases where cost saving arises not from a reduction in the cost of inputs, but from a reduction in the quantities employed in production. Cost cutting is

usually recognised as the main explanation for the voluntary adoption of VAs in which the firms commit to adopt effective environmental management systems (Hillary *et al.*, 1998). However, existing economic literature lacks convincing explanations as to why cleaning up activities may constitute a ‘free lunch’ and is often uncomfortable with the occurrence of these conditions. For example, Lyon and Maxwell (2001) state that, in the case of “...*‘win/win’ solutions in which the adoption of environmentally-friendly technology lowers cost, economic analysis is not needed to conclude that these actions are desirable, nor are subsidies required to induce adoption*”.

This view is probably motivated by the argument that ‘win-win’ solutions are not consistent with traditional assumptions about perfect rationality. However, the saving input motive may not be trivial in the presence of information constraints. In particular, *VAs may represent a rational cost efficient way to collect and re-distribute information in industries where information about cleaner technologies is imperfectly or asymmetrically distributed*. Therefore, information circulated through a public voluntary scheme or a well established self-regulation practice (e.g. ISO 14001) could be ‘cheaper’ because of its ‘certification’ which reduces uncertainty.

In a multi-firm framework, a rational explanation for VA adoption is that polluters can share their incomplete information in order to achieve better environmental performances. The idea of ‘information sharing’ between firms as a base for the adoption of VAs is formally developed by Glachant (1999) and Cavaliere and Frontoso Silvestri (2000). From a normative viewpoint, this action is considered to be cost efficient *vis à vis* other policy instruments (Glachant, 1999) in the case of ‘shared uncertainty’, and detrimental in the case of asymmetric information. Market structure is also crucial for determining if cost savings outweigh the possible loss of consumer surplus (see Cavaliere and Frontoso Silvestri, 2000).

4.3. VAs and competition advantages

VAs are sometimes accused of having negative effects on competition. Worries about these effects have arisen first of all because, by signing an agreement, firms have the opportunity to adopt cooperative rules that implicitly affect market prices and quantities. But explicit effects of VAs on market concentration can also be identified. Namely, a VA can be a barrier to entry for new firms that are not necessarily allowed to share the benefits of the VAs (e.g. in terms of reputation effects). Alternatively, a VA adopted by a subset of firms modifies the distribution of production costs across firms in the industry, thus also modifying industry concentration.

Let us consider two cases in which a VA may increase a firm’s profits through its effects on competition, i.e. *a) by boosting the possibility of collusive behaviour; b) by affecting the competitiveness of the other firms in the industry*. In both cases, an upward shift of the supply curve will occur, with higher equilibrium prices, reduced output, and possible losses in consumer surplus.

4.3.1. VAs and collusion strategies

The setting up of a VA may directly enhance collusive behaviour simply because it is usually accompanied by a series of organisational tools (collection of information, coordination and monitoring of production decisions), all of which favour the implementation of price or quantity fixing. It may also do so indirectly, through its role in the implicit collusive strategies which firms may undertake.

To analyse this latter case, a common tool is the theory of repeated games. Tacit collusive equilibria are shown to occur by assuming that a firm follows some ‘trigger strategies’ following ‘defection’ by its competitors. The simplest trigger strategy states that the firm will maintain the monopoly price at time t if other firms did the same in the previous periods, whilst it will fix the price at the marginal cost from period t to infinity if competitors previously decreased the price.

With this elementary framework, Brau and Carraro (1999) show, on the one hand, that a credible mandatory threat makes collusion among firms more difficult; on the other hand, that the adoption of a VA aimed at completely pre-empting or lessening a regulatory threat reinforces collusive strategies among firms.³³ Intuitively, the presence of a regulatory threat acts as an additional discount factor on future gains, while leaving unaffected the possibility of ‘one shot’ monopoly gains with anti-collusive behaviour. The expected return brought by collusion therefore becomes smaller. Conversely, by pre-empting the regulatory intervention, future profits become less uncertain for firms, which is equivalent to assigning a smaller discount rate to expected profits.

It appears quite clear that the establishment of collusive behaviour in relation to the adoption of a VA would lead to the paradoxical result of cost reductions inducing higher prices and lower output at the equilibrium. The policy conclusion is therefore that a regulator should closely monitor the market behaviour of signatory firms.

4.3.2. *Shaping the competitiveness of the other firms in the industry through a VA*

Some VAs may actually represent a real cost for a firm, net of any reduction in the probability of incurring in costlier regulatory regimes or accessing to financial or technical incentives. Then why does a firm sign a VA in this case? An easy justification can be found if the cost increase is associated with an upward shift in the market demand function, due to the effects of green consumerism. This can easily be shown by using the results on environmental taxation in oligopolistic markets contained in Carraro and Soubeyran (1996). They show that some firms may increase their profits when costs increase, in particular if they have a low market share.

Without demand shifts, one can instead refer to a stream of literature which has analysed the possibilities of profit increases due to higher taxation in

³³ The authors also show that, with respect to the baseline case, the existence of a regulatory threat makes collusion among firms more difficult.

oligopolies where market demand has a peculiar configuration, such as an isoelastic functional form.³⁴

In order to understand why firms may undertake a costly action, we can consider the case in which a VA constitutes a barrier aimed at deterring entry or forcing exit of some firms in the industry. In particular, it may be of interest to assess to what extent VAs can be used: *a) as a strategic barrier to entry by incumbent firms; b) to influence the behaviour of entrant firms, once entry is ineluctable or even desirable.*

Let us consider first the case of a VA which induces demand effects but does not deter entry. With Cournot competition (Garvie's model, 1999), the implementation of a VA represents a 'fat cat strategy'. A single company has an incentive to adopt a VA even if it increases the demand for the other firm. In a less intuitive example, Lutz *et al.* (2000) show that the same strategy can also be undertaken by a high quality firm in the case of environmental quality differentiation. The key to this result is the existence of a public good benefit (a regulatory gain or a total demand effect) in addition to the private benefit of product differentiation models (a specific demand increase due to consumers' green preferences).

Conversely, when entry is deterred, the use of VAs aimed at capturing the willingness to pay due to green consumerism represents a 'Top Dog' behaviour, which satisfies the most sensitive preferences (usually from the richest consumers) with a large environmental investment, while leaving the dirtier and less profitable production to the entrant firm. Product differentiation could also allow for strategic barrier to entry of the 'brand proliferation' type, which will occur when the same company tries to fill-in the market by occupying the largest possible number of market niches. In the case of VAs, we can think of a firm or industry association which, by means of a VA, enters the market with a new 'clean' product while continuing to produce an old (and 'dirty') similar good. By doing so, the incumbent firm or cartel is deterring entry because it is limiting the maximum distance in the space of environmental characteristics that the entrant could obtain.

In the case of VAs primarily involving strategic supply shifts, the most interesting case is the one of "induced regulation". Again, it is possible to distinguish between cases of accommodated and deterred entry. An example of the first case is offered by Lutz *et al.* (2000). As we saw in section 4.2, in their model the regulator operates in a complete information framework and is primarily interested in total emission reductions. Strategic over-compliance by a high quality firm aims to lessen the equilibrium minimum standard set by the regulator, while increasing competitors' profits *vis à vis* a situation in which no voluntary action is undertaken. The VA makes the adopting firm 'soft', since the regulatory gains are seen as non-excludable. A similar situation (with stronger advantages for free-riders) can be found in the model by Dawson and Segerson (2000).

³⁴ For the relationship between changes of the industry cost structure and industry concentration see Dung (1993).

Conversely, deterred entry will lead to a ‘Top Dog’ strategy whenever the effects of the VA are appropriable in a way which makes the firm “tough”. An example is the case where additional voluntary abatement is reached through large R&D investments or by building a new large plant. This may create a barrier to entry in terms of economies of scale or of absolute cost advantages, if the investment is such that it determines a high minimum efficient scale.

Another possible case is when, through voluntary over-compliance, firms try to induce future stronger regulation which prevents entry of new firms (Barrett, 1991; Salop and Scheffman, 1983). This situation can turn out to be particularly relevant in the case of asymmetric information between public and private agents. With respect to VAs, this analysis is developed in depth by Denicolo (2000), who shows how a VA can become the appropriate tool by means of which the firm with the lowest abatement costs reveals its own ‘type’ and shows itself willing to comply with a stricter regulation (with which its competitors cannot comply). In all these cases, the incumbent firm is ‘tough’, because the regulation, or even the threat of it, reduces the entrant’s expected profits.

To Sum up, let us first note that the non-compulsory nature of VAs is likely to facilitate their strategic use as a barrier to entry. Secondly, when either a VA deters the entry of new firms in the industry or when it makes the activity of new firms less profitable, industry concentration is likely to increase. Therefore, the adoption of VAs may reduce competition, and thus induce economic costs that partly offset the environmental benefits produced by the firms’ voluntary emission abatement.

5. Conclusions

This paper has proposed an overview of the existing economic literature on voluntary approaches to environmental protection. The focus of this survey is on the incentives for firms to sign a VA. These incentives have been grouped into two main categories, strictly related to demand and supply effects. This classification makes it easier to link the pros and cons of VAs as an environmental policy tool to some basic economic incentives.

The conclusions derived from the theoretical literature surveyed partly support the scepticism which has accompanied the adoption of VAs in environmental policy. In particular, the presence of regulatory capture, substantial weakening of regulatory threats, free-riding incentives, distortions on competition, are some of the main reasons that limit the environmental effectiveness of VAs.

However, this survey has also shown how a mix of policy tools, which includes VAs, can be appropriate in dealing with many environmental problems. For example, the introduction of minimum mandatory requirements is usually welfare improving in models with whether supply side or demand side participation incentives.

In addition, we have seen that VAs may become more environmentally effective thanks to the concentrated structure of the industry. It may indeed be

easier to undertake a VA, and design the features of the VA to achieve the desired emission reduction. Negotiations among a small number of parties may facilitate mutual understanding and trust. The high visibility of the VA may benefit emission-abating companies by increasing their market demand. Minimum abatement efforts may be more easily imposed. Technological cooperation and joint R&D investments can probably be implemented. Large companies may find it convenient to couple a VA - where an emission target is set - with an internal emission trading scheme designed to minimise abatement costs.

In this context, a conflict between environmental policy and competition policy may occur. The two policies may have conflicting objectives if the adoption of a VA and the consequent environmental benefits are associated with reduced competition within the industry. In other words, if a VA is the optimal environmental policy tool to deal with a given environmental problem, an environmental regulator may prefer a concentrated industry structure in which the VA can more easily be implemented and is likely to be more effective. But a competition authority may not accept a trade-off of the environmental benefits of the VA with the economic costs determined possibly by a more concentrated industry. Hence, the many benefits that can be achieved from the adoption of VAs should be carefully compared with their potential costs in terms of reduced competition.

The solution to this trade-off is consistent with the well known nature of solutions to other economic trade-off, and lies in the adoption of two instruments to achieve two objectives. For example, a regulator could intervene with a second policy tool (whether an environmental subsidy for entrant firms or sanctions on collusive behaviour).

As another example, consider the case in which the effectiveness of an industry-wide VA is weakened by the presence of free-riding. The regulator can however design a policy mix which offsets the free-riding incentives and designs the VA in order to enhance its environmental and economic effectiveness. Here are some suggestions derived from Brau and Carraro (2004):

- The expected benefits of the VA (in terms of regulatory pre-emption, technological co-operation, etc.) should go mainly to the firms which sign the VA. Free-riders should, at least partly, be excluded from these benefits (e.g. they are taxed whereas signatories are not).
- A minimum participation constraint should be introduced for the VA to be operational, i.e. for firms to enjoy its expected benefits (e.g. direct regulation or taxation is not introduced only if a sufficient number of firms sign the VA).
- A minimum abatement level should be introduced to avoid “cosmetic” emission abatements, but also to offset the negative effects on production and profits of a non-cooperative behaviour on abatement levels.
- If the environmental objective is mostly relevant, the regulator should also impose open access to the VA in order to exclude an anti-competitive, discriminatory use of the VA by firms.

All these policy recommendations constitute a well-defined policy mix that enables the regulator to achieve the environmental benefits that a VA can provide without incurring in VA related economic costs.

Therefore, the main lessons derived from this survey can be phrased as follows. VAs sometimes are a more feasible policy than usual economic instruments. In this cases, a careful understanding of the economic incentives beneath that induce a firm to adopt a given VA is crucial in order to identify and design those policy mixes that make the VA both environmentally effective and economically efficient.

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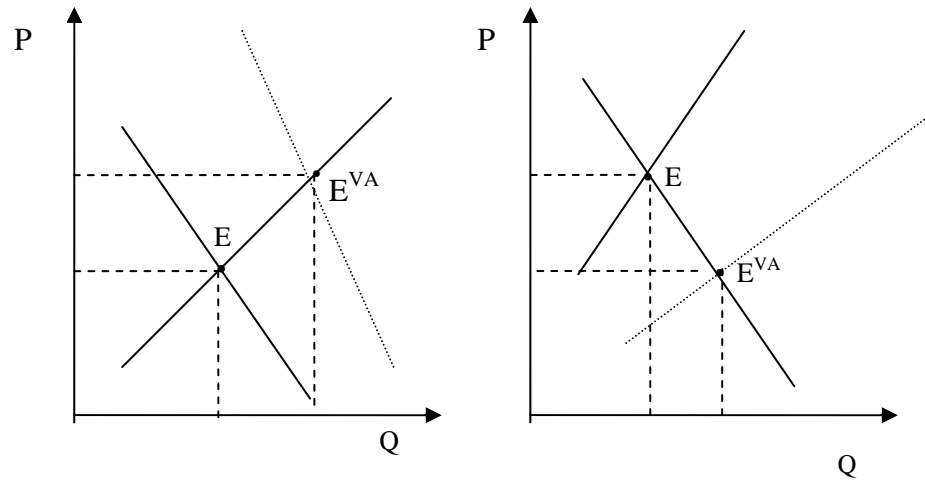
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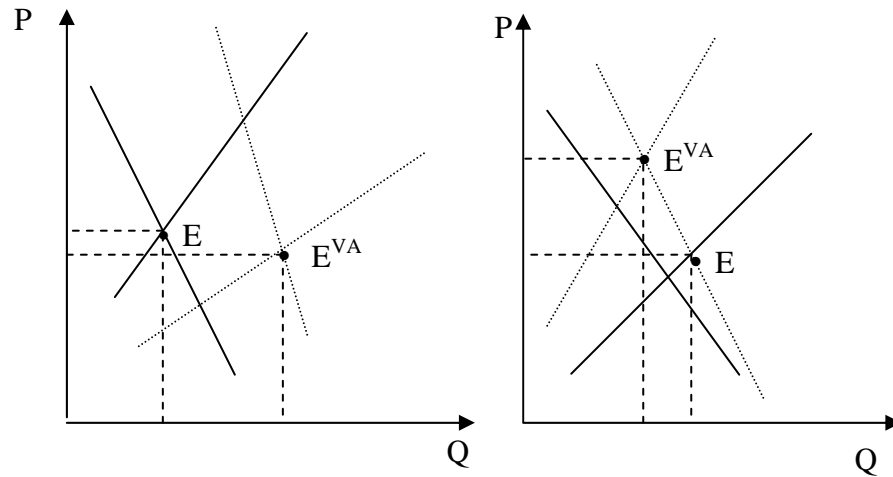
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Figure 1: *Summary of demand and supply effects*



1a and 1b: Representation of VAs with demand or supply side effects only



1c and 1d: Representation of VAs with both demand and supply side effects

Figure 2: *The effects of an increase of environmental quality in case of “green consumerism” in an oligopolistic market*

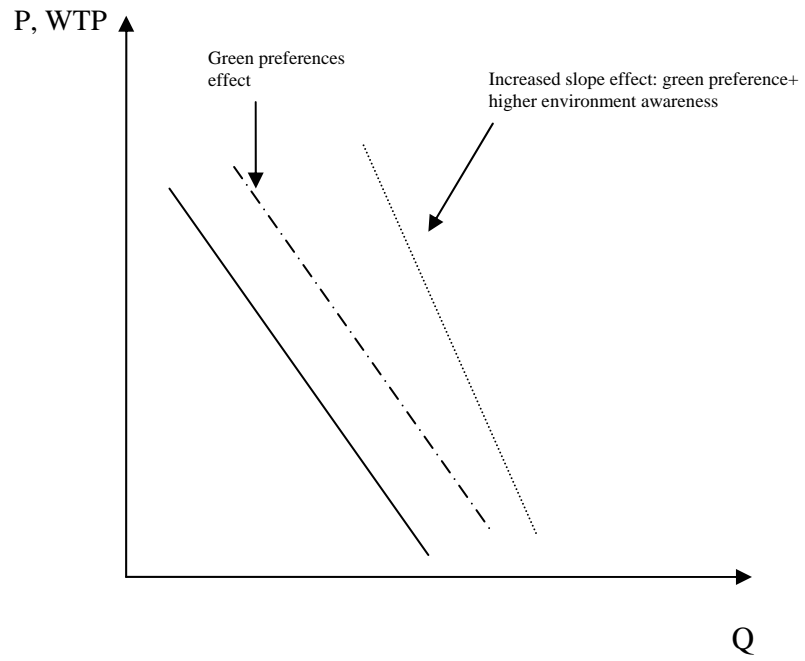
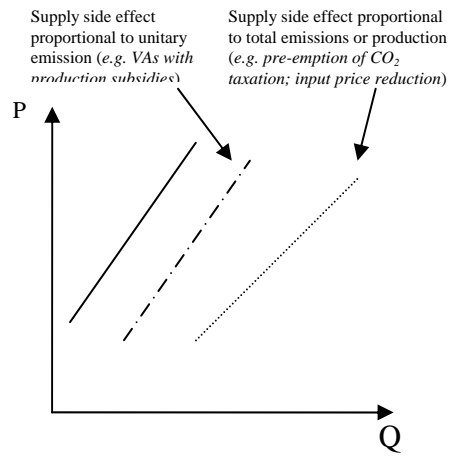
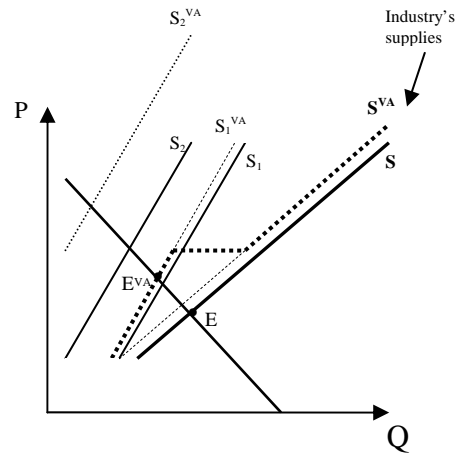


Figure 3: VAs' supply effects



3a: Representation of standard VAs supply side effects



3b: Representation of a VA by firm 1 aimed at increasing firm 2 costs.