Choosing policy instruments for controlling ozone depleting substances in a developing context: The case of Chile

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Abstract

Chile ratified the Montreal Protocol in 1990 which sets out an agenda for the reduction and then elimination of ozone depleting substances (ODS); however, by 1998 the country had not yet defined a strategy to encourage greater compliance, so that in the same year the National Environmental Commission decided to examine the policy options available. This paper examines the process followed to develop this strategy. As a first step it was necessary to look at how far the implicit policy of "business as usual" could be stretched without jeopardizing Chile's compliance obligations. A second step included quantifying compliance costs and their impact on different policy instruments and so policy choice. Finally, the attitudes of decision-makers or participants were identified, by interviews with officials of the different public agents involved, in order to weigh their views about policy. A strategy was proposed, based on this information, which the Chilean regulator has used, although not in its entirety. The methodology developed could well be useful for developing-country Protocol signatories building their own appropriate compliance strategy.

Keywords: Montreal protocol; Policy instrument choice; Cost-effectiveness; Program assessment; Environmental economics

1. Introduction

In 1987 twenty-one countries signed the Montreal Protocol on Substances that Deplete the Ozone Layer, making a commitment to first cut their consumption and then totally phase it out. To date 183 countries have ratified the Protocol, of which around two-thirds are in the "developing" countries category.[2] Following several amendments to the Protocol,[3] different compliance targets and deadlines have been set for developed and developing countries. For example, the Protocol establishes that consumption and production of chlorofluorocarbons (CFCs) should be eliminated as of January 1st 1996; however developing countries have until January 2010 to comply,[4] while having to meet intermediate production phase-out deadlines.

Although Chile is a marginal user of ozone depleting substances (ODS), it is among the countries most affected by the depletion of the ozone layer, since an important part of the hole is over its southern territory. For this reason, Chile ratified this Protocol in March 1990. Table 1 summarizes the main obligations entered into under the Protocol and its subsequent amendments, some of which are already in force. For example, by now trade in certain controlled substances should have been banned with all countries that are not parties to the Protocol. The table

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[1]CONAMA.

[2]Paragraph 1, Article 5 of the Protocol lists the countries considered as "developing". This classification is granted with a per-capita consumption of ODS (ODP weighted) of less than 0.3 kg/yr. There are also 21 countries with this classification pending. Countries not classified as developing are considered as "developed."

[3]The most important Amendments are those of London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999). Henceforth, references are to the Montreal Protocol in its amended form.

[4]Developed countries can produce up to 15% of the agreed base level to meet the basic needs of developing countries.

Table 1
Chile's obligations
Information obligations:
Submit data relating to the production, import and export of controlled substances.
Obligations relating to international trade:
(a) Ban on trade in substances controlled under Annex A with any country that is not a party to the Protocol.
(b) Ban on import of products containing substances listed in Annex A. Deadline met June 21st 1992.

Obligations relating to phase-out of ODS consumption

Substances	Deadlines	Restrictions
Annex A, Group I		
CFC	July 1st 1999	Not to exceed level
Level: Average 1995–1997	January 1st 2005	Not to exceed 50% of level
	January 1st 2007	Not to exceed 15% of level
	January 1st 2010	Total phase-out
Annex A, Group II		
Halons	January 1st 2002	Not to exceed level
Level: Average 1995–1997	January 1st 2005	Not to exceed 50% of level
	January 1st 2010	Total phase-out
Annex B, Group II		
Carbon tetrachloride	January 1st 2005	Not to exceed level
Level: Average 1998–2000	January 1st 2010	Total phase-out
Annex B, Group III		
1,1,1-Trichloroethane	January 1st 2003	Not to exceed level
(Methyl chloroform)	January 1st 2005	Not to exceed 70% of level
Level: Average 1998–2000	January 1st 2010	Not to exceed 30% of level
	January 1st 2015	Total phase-out
Annex C, Group I		
Hydrochlorofluorocarbons	January 1st 2016	Not to exceed level
(HCFC)	January 1st 2040	Total phase-out
Level: Average 2015		
Annex C, Group II		
Hydrobromofluorocarbons	January 1st 1996	Total phase-out
Annex E		
Methyl bromide		
Level: Average 1995–1998 (1)	January 1st 2002	Not to exceed level
	January 1st 2005	Not to exceed 80% of level
	January 1st 2015	Total phase-out

(1) Not including amounts used by the parties for quarantine and pre-shipment purposes.

shows that CFC consumption had to be frozen at 1999 levels, and by the year 2005 it should be cut to 50%,[5] before being finally eliminated on January 1st 2010. In addition, by the same date, the consumption of halons and carbon tetrachloride (CTC) must be frozen and subsequently phased out. Finally, there are additional restrictions on methyl bromide (MB), as well as hydrofluorocarbons (HCFCs) and methyl chloroform. It should be pointed out that Chile is not a producer but importer of these substances. Hence the restrictions imposed on producers do not apply.

Developed countries have chosen various strategies for meeting their obligations as a response to more stringent requirements and deadlines. In general, these include setting reduction targets to be met by each sector; running programs to promote alternative technologies; raising public awareness of products that may contain ODS or have been made with them; and the harm caused by destruction of the ozone layer. In some cases specific labeling programs have been setup (UNEP and SEI, 1996).

Developing countries more recently have begun to concern themselves about this issue with most progress being made by Asian economies (Mathur and Desai, 1995; Metroeconómica, 1996). To support these countries to meet their commitments the Montreal Protocol has established the Multilateral Fund. Developed countries contribute to this fund and agencies such as the World Bank or UNEP are in charge of the implementation of specific projects. These projects have been common in Latin America and have been key in ODS reductions experienced so far. Most progress has been made in refrigeration and aerosols. However, other sectors such as foams and halon related sectors have still to be addressed.

[5]Level calculated as the average consumption between 1995 and 1997 inclusive.

Moreover, other substances such as HCFCs and MB will have to be regulated. The World Bank predicts that in spite of reaching the CFC targets in 2005, most likely the region will experience hard times in complying in 2007 and 2008. Therefore, the Bank suggests these countries adapt their policies and strategies to meet the targets as the assistance funds provided by the Multilateral Fund do not suffice (World Bank, 2002).

Up to 1998, Chile, like most developing countries, had not defined its strategy towards the Protocol. Its obligations were being met through the market, i.e. through decisions made by importers due to changes in prices and availability, rather than by any specific policy. The only specific instruments applied were associated with the Multilateral Fund[6] that provided financial cooperation to set up the Ozone Team within the National Commission of Environment (CONAMA) and support for a few specific actions.

However, in that year the National Environmental Commission (CONAMA)[7] decided to examine the policies available in order to choose the most appropriate national strategy. This paper examines the way that Chile developed this strategy. The first step was to look at how far a "business as usual" approach, then being followed, could be stretched without jeopardizing Chile's compliance. The second step was to quantify the costs of compliance—were they high or low? How different were the costs among different instruments? In particular, could the use of flexible instruments such as marketable permits allow significant cost reductions? Although Chile is a Protocol signatory, strong opposition to compliance was expected from the affected parties and politicians if this meant high costs for some sectors. On the other hand, if compliance costs were relatively low, Chile had the opportunity of implementing a strategy in a timely way, and quite possibly with little opposition from those affected by the proposed changes.

Regulation must pay attention to costs and timing in determining how changes effect the degree of acceptability of interested parties—but neither is sufficient to make a final decision. The choice should involve additional criteria—attributes or attitudes—that have value for a regulator such as the instrument's effectiveness, and the administrative, legal and institutional context. (IPCC, 1996). Accordingly, the third step was to identify these attributes by interviewing the different public agents involved, and then making a qualitative assessment of their value. A national strategy was proposed on the basis of this information and which the regulator has used. This methodology could well be helpful for other developing-country Protocol signatories, which like Chile have to draw up an appropriate compliance strategy.

[6]To encourage compliance with the targets agreed by developing countries, Article 10 of the Protocol established this mechanism to provide financial and technical cooperation, as well as technology transfer, to these countries. This mechanism has made it possible to generate reduction initiatives in various countries, Chile included.

[7]Comisión Nacional del Medio Ambiente.

Section 2 presents the baseline situation in Chile in 1997 regarding the import and use of ODS by sector. The third section evaluates CFC consumption between 1997 and 2010 under different assumptions, considering five potential scenarios. Section 4 discusses control options and reduction costs for each user. Section 5 identifies the relevant attributes of each policy instrument and makes a qualitative and quantitative appraisal of those that are of most interest to the regulator. Section 6 presents a strategy proposal for controlling ODS based on these findings, and Section 7 presents the study's main conclusions.

2. Base situation: import and use of ODS in Chile

As pointed out above, Chile is only an importer of ODS. Table 2 shows the evolution of imports of each substance in the period 1992–1997. At the time the policy strategy was being developed information was only available until 1997. There were ten substances affected by the Protocol, with imports in 1997 varying from one ton per year of CFCs to 600 tons in the case of HCFCs.

The existing import data showed that total CFC and HCFC consumption in Chile declined in the period 1990–1992, rose between 1994 and 1996 and then declined again in 1997. Average CFC growth in this period was 3%. The trend, however, seems to suggest that use will decline again due to changes expected in the CFC consuming sector.

These figures should be corrected for their ozone-layer depletion potential (ODP),[8] a better measure of their impact on the ozone layer, showing the emission of each substance into the atmosphere. These are found in the final column of Table 2. Looking at 1997, the most important substance is CFC-11 with 38.5% of total ODS imports,[9] followed by CFC-12 (32%) and MB (22%). The remaining substances have little weight in total ODS consumption.[10]

The main uses of ODS are described in Table 3. CFC-11 is used mostly for insulation, especially in household and industrial refrigeration equipment. The main use of CFC-12 is as a coolant gas, and MB for fumigation in the agricultural and forestry sectors.

Only CFCs, because of their total ozone depletion potential, are examined in the quantitative analysis carried out in the sections below; options for MB, in terms of their technical and economic feasibility, have only recently begun to be studied.[11] Further, neither MB nor HCFCs (with a total phase-out deadline more distant than for

[8]A compound's ODP is a measure of its capacity to destroy ozone in the stratosphere. It is a relative measure, with the ODP of CFC-11 being set at 1.0 and those for other compounds calculated on the basis of this benchmark.

[9]In ozone deletion potential terms; unless stated otherwise, this will be the measure used henceforth.

[10]And, except for HCFCs (which have little weight in total ODS) they are expected to continue decreasing.

[11]As will be seen below, conversion costs for Halons, CTC and methyl choloroform are quite low compared with those of CFC.

Table 2
Import of substances controlled by the Montreal Protocol (1990–1997)

	ODP	1992 (ton)	1994 (ton)	1996 (ton)	1997 (ton)	1997 (KODP)	1997 (%ODP)
CFC-11	1.00	315.0	438.0	461.9	351.3	351.3	38.50%
CFC-12	1.00	235.6	382.5	407.7	293.8	293.8	32.20%
CFC-113	0.80	12.5	28.3	19.0	22.9	18.32	2.01%
CFC-115	0.60	20.1	15.6	0.0	17.7	10.62	1.16%
HCFC-21	0.04	7.2	13.2	0.0	0	0	0.00%
HCFC-22	0.055	357.3	338.8	543.5	580.8	31.944	3.50%
HCFC-141	0.04	0.0	0.0	25.1	68.9	0	0.00%
Other CFCs and HCFCs	0.72	48.6	113.2	50.9	0	0	0.00%
Total CFCs and HCFCs		996.3	1329.5	1508.1	1335.4		0.00%
Methyl chloroform	0.10	345.2	467.4	105.9	23.0	2.3	0.25%
Methyl bromide	0.70	319.5	199.0	393.6	291.6	204.12	22.37%
Halon-1301	10.00	0.0	1.8	0.0	0.0	0	0.00%
Halon-1211	3.00	28.2	9.8	5.3	0.0	0	0.00%
Total Halons		28.2	11.6	5.3	0.0	0	0.00%
		0.0	0.0	0.0	0.0	0	0.00%
Total ODS		1689.1	2007.6	2012.8	1650.1	912.4	100.00%

Notes: (1) Information based on CONAMA data. (2) In the row "Other CFCs and HCFCs" an ODP was used equivalent to the weighted average of ODP for the CFCs and HCFCs listed by amount imported in 1996. (3) CFC-115 is a coolant gas that is not imported into Chile in pure form; it is marketed as Azeotropic Mixture R-502.
The records show no shipments of this substance; however, according to the main importing firms, nearly 40 tons of R-502 was imported in 1996.

Table 3
ODS uses in Chile (1995)

ODS	ODS uses in Chile	(%) of total ODP consumption
CFC-11	Foam agent used in the manufacture of rigid and flexible foam rubber.	**36.8**
	Solvent.	33.3
	Refrigerant charge in centrifuge units.	3.5
CFC-12		**32.4**
	Coolant charge used in domestic and commercial equipment, and to a lesser extent in industrial and air conditioning units.	27.5
	Propellant in sterilization equipment and aerosols.	**4.9**
CFC-13	Solvent and cleaner of precision electronic equipment.	**1.2**
CFC-115	Component of coolant gas R-502[a]	—
HCFC-22	Coolant charge used in the air conditioning, industrial and commercial refrigeration.	
	Eventually may be a temporary alternative to CFC-11 in the manufacture of rigid foam rubbers.	**2.4**
HCFC-141b	Widely used as a temporary alternative for CFC-11 in the manufacture of rigid foam rubbers.	**0.1**
Methyl bromide	Used for fumigation in the agriculture and forestry sectors and in the quarantine treatment of fruit for export.	**21.9**
1-1-1 Trichloroethane and carbon tetrachloride	Solvents.	**1**
Halons	Extinguisher agent used in manual and installed fire extinguishers.	**1.3**

Source: CONAMA. GERENS (1995).
Source: G. Asencio (1998), Thesis.
[a]Azeotropic mixture composed of 48.8% CFC-115 and 51.2% HCFC-22.

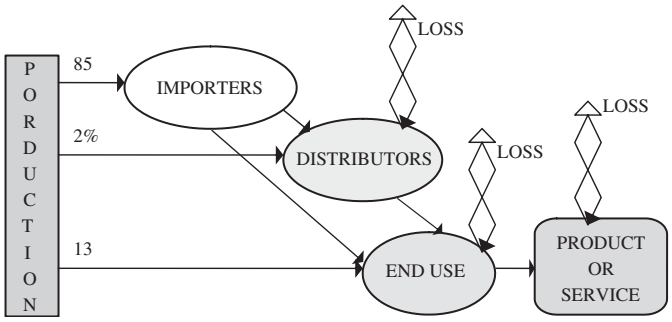


Fig. 1. Schematic view of CFC consumption chain in Chile.

other substances) are included in the strategy proposal of 1998.

In Chile, CFC imports involve few importing firms, because of scale economies associated with importing large quantities, and the presence of exclusive representations.[12] In fact, six firms account for 85% of all imports, with over half the total brought into the country by two firms only; a single end-user firm imported 13% as shown in Fig. 1.

In 1995 five large companies accounted for 35% of CFC end-use consumption. However, during 1997, two of these carried out technological conversion (TECFIN) or retrofitting,[13] with the result that in 1998 nearly 26% of consumption was in the hands of three companies—two refrigerator producers and one mattress manufacturer. Thirty medium-size firms accounted for an additional 30% with consumption levels of between 1 and 15 tons per year.[14] The rest are made up of small firms, stock for future consumption, and refrigeration technicians. In total, it is estimated that there could be more than 400 end-users of CFCs.

The National Commission for the Environment (CONAMA), with support from the World Bank and financed by the Multilateral Fund, set up an Ozone Team responsible for implementing the Country Program for the Protection of the Ozone Layer. This was initiated in 1994 with four components: a Campaign to Mobilize Public Opinion; the implementation of an Ozone Environmental Quality Seal; a sub-program promoting incentives for TECFIN; and training and education courses in alternative technologies. In addition, there are various studies that analyze Chile's compliance with the Protocol.[15]

Up to 1998, the most advanced activity was TECFIN, to which US$ 4.8 million had been assigned to subsidize process conversion between 1996 and 2000. The first phase of the TECFIN program, in early 1996, aimed at financing firms involved in refrigeration and foam rubber production. Allocations made by the Fund distinguished between, on the one hand, small- and medium-size firms (consumption below 10 tons of ODP-weighted ODS per year), and on the other, large firms (more than 10 tons of ODP-weighted ODS per year). Small- and medium-size could receive a maximum contribution of US$ 20,000 from the Fund while larger firms had an upper limit of US$ 2 per kg of ODP eliminated. The criterion for support was cost–effectiveness and firms were accepted until funds ran out. Thirty firms were chosen, three of which were large CFC consumers and leaders in their respective markets. In all, this managed to eliminate 494 tons of ODS by providing a subsidy of US$ 2.637 million to participating firms with a cost/effectiveness equal to US$ 5.3 per kg.

3. CFC consumption baseline scenarios: 1997–2010

In order to define an ODS control strategy it was necessary to estimate how far an approach based on "business as usual" would allow Chile to comply with its Protocol obligations. This estimate was the baseline for alternative assessments over the whole period (1997–2010). However, there was considerable uncertainty about how ODS consumption would evolve in Chile. The Protocol would result in various actions that would affect the price and availability of ODS, as well as alternative substances and technologies. These were difficult to quantify. So, it was necessary to develop general quantitative scenarios about trends between 1997 and 2010, under three assumptions—base, moderate and optimistic—about the evolution of ODS consumption. Clearly, the specific characteristics of each strategy (timing, type of measure applied) and its costs, depends on what happens in practice.

Five potential scenarios were defined for CFC-11 and CFC-12 consumption:

- *Base scenario*. This assumes that CFC consumption will continue growing at a constant rate of 3% between 1997 and 2010, similar to the consumption behavior of CFC-11 and CFC-12 between 1994 and 1996. Beginning in 2010, it is assumed that there will be no external supply of CFCs due to restrictions on producer countries,[16] and consumption will fall to zero. This scenario was considered a maximum or pessimistic consumption scenario given 1998 CFC consumption trends.
- *Moderate scenario*. Assumes that the three large firms that are still operating with CFCs in 1998 will stop using them in the year 2000.[17] The three firms have expressed interest in abandoning the CFC usage in the near

[12]For example, freon is imported by a single importer, and one large user-firm imports it directly.

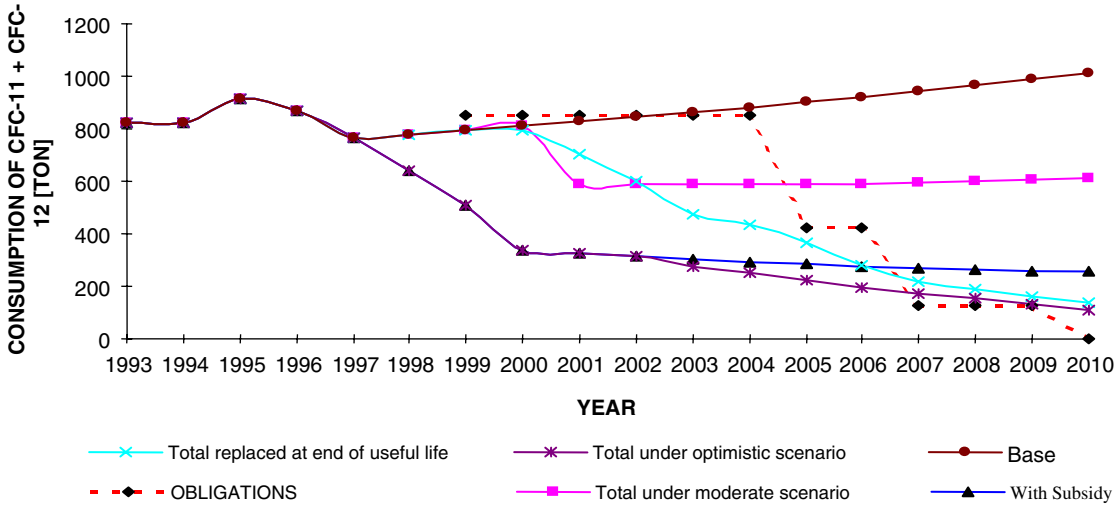
[13]In commercial refrigeration the conversion was from CFC-11/ CFC-12 to HCFC-141b/HCFC-134a., whereas in insulation panels it was from CFC-11 to HCFC-22.

[14]They include, for example, firms that produce rigid polyurethane foam, as well as the manufacture of commercial refrigeration units.

[15]For example, GERENS (1995), O'Ryan and Ulloa (1995), Gomez (1997), and Asencio (1998).

[16]It should be noted that gas from existing equipment would be recovered, generating a domestic market for recycled CFC. In addition, contraband ODS is being seen in developed countries, taking advantage of the high prices resulting from production and trade restrictions for these substances (EIA, 1997).

[17]It must be borne in mind that this evaluation was undertaken in 1998.



Graph 1. Comparison of scenarios with obligations.

future.[18] However, their behavior ultimately depends on both export market pressure to produce without CFCs, and the domestic market competition, in particular from imported refrigerators that do not use CFCs. If these three companies convert, CFC consumption will drop by 26%. However, consumption by all other firms and users is assumed to continue growing by 3%.

- *With subsidy scenario*. Considers the impact of providing a total of US$ 4 million, from the Multilateral Fund, as a subsidy to help firms convert, reducing consumption in the different sectors as a function of the maximum cost/effectiveness permitted by the World Bank. In this case, between 1998 and 2000, total consumption would be cut by nearly 50%, while it would continue to grow in sectors not carrying out the conversion.
- *Useful life scenario*. Assumes that, as current equipment comes to the end of its useful life (between 2000 and 2015), all present CFC users will replace it with equipment that uses alternative substances. In this way, consumption will be gradually reduced until total phase-out is attained, by the manufacture of new products. This assumption is based on firm investment behavior that decides on replacement technology by taking into account the restrictions imposed by the Protocol, the rise in the price of controlled substances, and a growing supply of low-cost alternatives.
- *Optimistic scenario*. Combines the two previous scenarios. It is assumed that an efficient granting of subsidies, as well as a fall in consumption because of equipment depreciation and replacement occur together.

It is important to notice the base and moderate scenarios are independent from the regulation. The useful life-scenario projects what would happen if processes that use CFC end when their useful-life is over and shows how timely decisions from the view of firms would be applied. The with-subsidy scenario shows the reaction of firms to subsidies; therefore the level of feasibility was clearly dependent on the regulator. The importance of these two last scenarios is they provide an optimistic scenario together and would result in timely and more reasonably low-cost reductions.

Graph 1 shows CFC consumption for each scenario, as well as the obligations entered into by Chile. It can be seen that in the base scenario the country would meet its CFC consumption obligations until 2002, after which the limit would be exceeded, by more than double the required amount in 2005. Under the moderate scenario, there is a significant fall in consumption in the year 2000, which enables obligations to be met until 2004. From then onwards targets are exceeded, by 50% in 2005 and by nearly five times after 2007. In the "with-subsidy" scenario, targets are met up to 2006, but CFC consumption would be more than double the amount stipulated in the Protocol for 2007. The scenario which assumes that TECFIN takes place as equipment comes to the end of its useful life also complies up to 2006. In 2007 the anticipated targets are exceeded, although to a lesser extent than in the previous scenario, targets being surpassed by 70%. However, by 2009 the target is only exceeded by 29%. By 2010 only consumption arising from the recharging of existing cooling equipment would remain unreduced (approximately 200 tons per year). Finally, under the optimistic scenario where the subsidy is fully effective and firms change their technologies as their equipment comes to the end of its useful life, the consumption of controlled substances would come quite closely in line with obligations: in fact the limits would be surpassed by just 30% in 2007, but compliance would be achieved by 2009. As in the previous scenario, nearly 200 tons of consumption would still need to be eliminated in 2010.

[18]Both to the authors of this paper, and to those in charge of the CONAMA country program. In fact, SINDELEN applied for the conversion subsidy in 1997.

Table 4
conversion alternatives and costs

Sector	Substance		Conversion costs
	Traditional	Alternative	(US$/kg)
Foam rubbers			
Flexible, mattresses	CFC-11	Methyl chloride	n.a.
	CFC-11	Rapid Cooling	0.44
Rigid			
Panels	CFC-11	HCFC-141b	1.57
Other rigid foam rubbers	CFC-11	HCFC-141b	1.09
Refrigeration			
Domestic	CFC-11/CFC-12	HCFC-141b/HFC-134a	16.26
		Cyclopentane/isobutane	17.20
Domestic by substance	CFC-11	HCFC-141b	10.45
	CFC-12	HFC-134a	39.48
Commercial	CFC-11/CFC-12	HCFC-141b/HFC-134a	4.59
		Cyclopentane/isobutane	n.a.
Commercial by substance	CFC-11	HCFC-141b	1.80
	CFC-12	HFC-134a	12.96
Industrial and other	CFC-12	HFC-134a	39.63
Repair and recharging of domestic and commercial equipment	CFC-12	Recycling	10.89
	CFC-12	HCFC-141b/HFC-134a	n.a.
	CFC-12	Cyclopentane/isobutane	n.a.
Propellant			
Aerosols	CFC-12	CO_2	0.22
Sterilization	CFC-12	CO_2	0.05

Source: Authors' calculations based on GERENS (1995), Technological Conversion Incentive Program—TECFIN I (1994–1996), Customs statistics and interviews with users and experts.

In conclusion, in order for Chile to comply with its Protocol obligations, a strategy of incentives must be developed to support the optimistic scenario. Further additional instruments will need to be defined to assure compliance with 2007 and 2010 targets. These are anticipated as being the most difficult to achieve.

4. Reduction options and costs

The most important decision variable for an ODS reduction strategy is the cost of different options. These costs are discussed in this section.

Cuts in CFC consumption can be achieved in various ways. Specifically, it is possible to (i) replace the controlled substance by an alternative, without changing technology; (ii) replace current equipment by new alternative technology; (iii) modify the equipment currently in use to enable it to work with alternative substances; and (iv) develop substitute products to replace those made with CFCs. The most economically viable option depends on the manufacturing sector in question and the process to be converted. The CFC consumption conversion cost is estimated as the cost differences between the investment with CFC-using equipment and equipment that uses an alternative substance—plus the difference in operating costs associated with using the alternative. As a result it is possible to determine annual equivalent costs of production with alternatives to CFC for each kg of this substance replaced. Conversion case studies were analyzed to estimate these costs per sector,[19] and the results are presented in Table 4. When applicable, both transitory alternative substances[20] and permanent ones are included.

For example, in the production of flexible foam rubber and mattresses, changing CFC-11 for a rapid-cooling process increases costs by almost 22%, resulting in a yearly cost differential of US$ 0.44 per kg of CFC-11 replaced.[21]

[19]To make this estimation, important assumptions are made. Specifically it is assumed that the observed price differential between the use of CFC and its alternative, at the present time, is maintained. If costs are actually lower, this assumption would overestimate potential cost gains from market instruments. In addition it is assumed that there are no scale economies associated with conversion technologies for Chile. This latter is a reasonable assumption given the small size of the Chilean market.

[20]This distinction is due to the fact that some of the alternatives are themselves substances which deplete the ozone layer, but with different phase-out deadlines compared to CFC due to their lower ODP. Thus, HCFCs are alternatives to CFCs in many cases, but due to their condition as ODS substances, they are considered as transitional alternatives, as their phase-out deadlines stretch to 2040. A series of substances are being developed as permanent alternatives to CFCs with similar characteristics, but which do not contain chlorine and so are not subject to the Montreal Protocol, like HFCs. While these substances are not controlled by the Montreal Protocol they do have high global warming potential (GWP) and so it is possible that these substances will be controlled in their production and consumption, like ODS, under future global warming agreements.

[21]See http://www.dii.uchile.cl/progeawww.dii.uchile.cl/progea where the estimation is presented in detail (PROGEA, 1997).

Table 5
Total reduction costs per user sector

Product line	CFC	Annual cons. 1996 (kg)	Accumulated cons. (kg)	Accumulated cons. (%)	Annual cost (US$ per yr/kg eliminated)	Cost per sector (US$ per yr)	NPV (10%,1998) per sector (US$ DE 1998)
Sterilization	12	57,143	57,143	7	0.05	3100	19,468
Flexible foam rubber	11	61,540	118,683	14	0.44	27,044	7337
Aerosols	12	4800	123,483	14	0.22	1,077	184,269
Other rigid foam rubbers	11	54,000	177,483	20	1.09	58,748	400,290
Rigid foam rubber	11	163,500	340,983	39	1.57	256,873	1,750,255
Commercial	11	15,213	356,196	41	1.80	27,359	186,414
Domestic	11	123,715	479,912	55	10.45	1,293,136	8,811,029
Equipment cleaning	11	43,941	523,853	60	10.89	478,705	3,261,748
Dom. and Com. repair	12	185,971	709,823	82	10.89	2,025,997	13,804,522
Commercial	12	27,864	737,687	85	12.96	360,993	2,459,697
Domestic	12	30,929	768,616	88	39.48	1,221,051	8,319,862
Industrial ref.	12	100,990	869,606	100	39.63	4,002,245	27,270,066
Total		869,606				9,756,328	66,474,956

The present conversion cost of all firms that currently use CFCs can be quantified using these figures. This is a useful benchmark for comparing the costs of strategies that make gradual cuts over time consistent with Protocol obligations. Table 5 shows the cost for each substance by sector. For these calculations it is assumed that all firms in a given sector undertake conversion at the beginning of 1998 with an assessment horizon up to 2010.

From Table 5, it can be seen that the present value of CFC conversion amounts to US$ 66 million, a significant sum for a developing country, considering that the Protocol is voluntary. The cost of converting other substances (halons, CTC, methyl chloroform) is of very little relevance. GERENS (1995) estimates that CFCs account for more than 97%[22] of industry total conversion costs, including CFCs, halons and MB.

5. Evaluation of regulatory instruments for CFCs

Regulation has to deal with three areas in order to reduce Chile's ODS consumption; the import of controlled substances; the import of products containing such substances or produced with them; and the production in Chile of products that contain or use CFCs.

There are five regulatory instruments which, based on international experience and Chile's specific characteristics, appear capable of achieving the desired reductions. Three involve direct regulation and two use the market. The first set includes production standards; a ban on importing controlled substances (or groups thereof) and import quotas. The second set of market-based instruments are import tariffs and a system of tradable import permits (TIPs).

An optimum strategy should balance a series of attributes or policy attitudes relevant for the decision-maker and the careful selection of the regulatory instruments. Various studies (Bohm and Russell, 1985; OTA, 1995; IPCC, 1996; Richards, 1998) discuss these attributes, which include effectiveness in terms of the environmental goal, institutional capacity (including political influence) and economic and social aspects in general. A final decision about an instrument is likely have a policy balance (based on technical characteristics), with each attribute being accorded an appropriate policy weight by the regulator.

From interviews, authorities responsible for implementing the strategy identified the following attributes as relevant for decision-making. The order does not imply priority:

(a) *Economic impact*: The economic impact on firms and consumers must be as low as possible.
(b) *Effectiveness*: the proposed targets should be complied with.
(c) *Legal feasibility*: their use should be feasible and relatively simple to apply within Chile's existing legal framework and environmental practice.
(d) *Ease of monitoring and inspection*: the level of control or management needed for effective regulation should be feasible with current or expected resources.
(e) *Acceptability*: the willingness of both regulated parties and the regulators to accept the regulation.

The five instruments were both quantitatively and qualitatively evaluated to assist the decision-making process. The fist step was to assess and quantify the economic

[22]Although the absolute values provided by GERENS over estimate total costs it is estimated that the relative values are approximately correct.

impact of each instrument, the total costs of each to producers, and its cost–effectiveness, i.e. whether it enables cuts to be made by the firms at lowest cost. A complete assessment would require an examination of each instrument's direct and indirect costs but this was unfortunately beyond the scope of this evaluation.[23] The results are presented in the following sections using the qualitative analysis, in terms of the attributes/policy attitudes discussed above, in order to discriminate between the most appropriate instruments. Then, the efficiency and effectiveness of each instrument is evaluated quantitatively.

5.1. Description and qualitative analysis of regulatory instruments

The discussion below is the result of interviews with relevant decision-makers and experts about each instrument. Their advantages and disadvantages for utilization are also commented on.

5.1.1. Product standard

A product standard sets conditions which have to be met by an industrial product, for example where the use of CFCs are restricted in the manufacture of items such as cooling systems or aerosols.

In order to enhance the measure's economic efficiency, the regulator may choose to restrict CFC use in products where the substance can be replaced most cheaply. The regulator must then obtain information about the costs of available options for each type of product. The resulting list of regulated products is a weakness of this instrument, as decisions about which products to include or exclude could be discriminatory, and the affected sectors are likely to oppose its application.

It is important to mention that nearly 30% of CFC consumption occurs in the repair and recharging of cooling units, which cannot be regulated with a product standard. As will be seen in the next section, this instrument does not therefore make it possible to comply with certain intermediate obligations. Thus a product standard is not an effective instrument unless combined with other instruments that allow compliance. In addition, this measure requires end-use control. Further, there is another disadvantage for if CFC trade continues unrestricted, there is no incentive for better management of this substance.

A strong advantage in Chile is that it can be approved and implemented via an administrative procedure and does not require new legislation, so avoiding bureaucratic procedures and the sometimes unpredictable results of Parliamentary discussion.[24]

5.1.2. Import ban on controlled substances

A ban prevents the import of certain substances from the date when it comes into force. In some cases this can be highly inefficient, requiring the user of these substances to change to high-cost alternatives, losing competitiveness or directly going out of business.

A less costly alternative would be to introduce staggered prohibitions substance by substance. For example a ban in 2005 on the use of CFC-11—which has the lowest conversion costs—might be imposed, and then a ban on the remaining CFCs in 2010.[25] However, this does not ensure compliance with intermediate targets as discussed in the following section. Another option would be to accelerate CFC-12 prohibition to 2007 so as to ensure compliance. This places additional costs on existing resources, which would need to be evaluated, as the firms would have to speed up the conversion process.

One complication with prohibitions is that imports may not be controlled up to the phase-out date, so that it might become attractive to build up inventories of each substance prior to the ban, making them available for later use. As with product standards, this measure might be considered discriminatory, as the only reason to justify banning CFC-11 first is its lower conversion cost. As terms of Chilean law the Health Ministry could ban substances on health grounds by using Article No. 90[26] of the Sanitary Code that would only require a decree being issued.

5.1.3. Import quotas

Import quotas define the total amount of each substance that can be imported in a given year or period and/or the total that each authorized firm can import during that same period. This results in a highly effective measure, as a total can be set to comply exactly with Protocol obligations.

However, its efficiency depends crucially on who is assigned the quotas. If quotas are handed out free of charge, the authority may not have the necessary information to ensure the first awards go to higher-cost producers. The problem is diminished if quotas are auctioned as the users who most need quotas (i.e. those with highest conversion costs) will buy them.

However, the inflexibility of quotas, i.e. the impossibility to break them down into smaller fractions, imposes efficiency losses in any event.

[23] A complete cost–benefit assessment exceeds the scope and purpose of this paper, but the available data suggests it is unlikely to contribute much to the discussion. From the consumers' point of view, prices will not increase significantly in the case of refrigeration. As regards insulators, there are close substitutes for polyurethane for consumers who are not willing to pay the difference. In other sectors something similar happens, so it is estimated that there would not be a major loss for consumers. On the producers' side it is estimated that despite the rise in costs, few of them would see their current production level of the final product affected, as they can incorporate alternatives.

[24] For this purpose authority is conferred on the Ministry of Economics, Development and Reconstruction, subject to prior study and approval of the mentioned technical standards on products by the National Normalization Institute.

[25] In that year, the only CFC on the market would be CFC-12.

[26] Article 90 assumes toxic substances are to be regulated in use, production, imports, transport, possession and elimination. Import of toxic substances requires the approval of the Health Ministry.

An auction of quotas would make it possible to use the revenue generated and set up a fund to support conversion in other firms, finance the system of regulation and control, or support programs of promotion and prevention. The disadvantage is that costs to users will be greater.

However, auctioning might generate monopoly and oligopoly behavior, as the two biggest Chilean importers accounted for more than 50% of the total in 1998.

In conclusion, the use of an import quota is likely to be inconvenient for current users of controlled substances, unless they are regulated directly. However the broad range of users makes the implementation of this latter option very difficult and they could well oppose the use of this instrument.

In addition, the implementation of import quotas requires legislation, which makes its introduction more complicated.

Finally, in order to control this instrument's use an import registration system would have to be established to ensure that each unit imported had authorization. This requires greater administrative sophistication than simply banning the import of a substance.

5.1.4. *Import tariffs*

An import tariff consists of a surcharge on CFC imports so raising their price and encouraging the introduction of alternatives to the substance and reduced CFC use. Its application can be gradual, rising in value to adjust to the Protocol obligations established for each period.

In principle, this instrument is cost-effective, as it induces producers with lower conversion costs to change first. However, for this to be effective, the authority needs to have an idea of conversion costs so as to be able to set the tariff level. If this information is not available, the tariff could be set too low and fail to achieve the policy goals or else set too high and lead to excessive reductions.

An additional complication is that to avoid uncertainty for producers/importers, it is necessary to define in advance a stable timetable of the tariffs to be charged. However, the variability of international prices and national demand makes it difficult to set an invariable tax. As better information becomes available these schedules may have to be changed.

On the other hand, tariffs have the advantage of generating revenue for the state. Although these are likely to go into general tax funds, they could be redefined as a charge and designated as funds for conversion projects.

Like import quotas, the application of tariffs requires a law. This is unlikely in Chile. So far, for example, the authorities have been reluctant to introduce "green taxes" even for environmental problems that directly affect health.[27] Moreover, there is an established and efficient institutional framework available (Customs, Treasury), which would reduce the costs of implementation.

5.1.5. *Tradable import permits (TIPs)*

As a regulation instrument the TIP system runs on the same principle as import quotas, i.e. the maximum amount of imported CFCs is set and then permits issued for the imports. However, TIPs allows quotas to be freely traded on the market, thereby bringing flexibility and efficiency to regulation. Higher-cost firms would be more prepared to purchase permits and buy at a high price from firms with lower conversion costs, who would convert and sell their permits. Thus, an efficient result depends on lower cost firms being the first to convert.

Unlike import quotas, the initial permit allocations do not affect efficiency. Nor is the duration of the permit an issue. Firms are able to buy them on the open market when required.

However, as with import quotas, there is a significant distributive impact. If permits are granted free of charge, based on historic rights, importers will be benefited; and if they are auctioned, the state collects funds from users, and ultimately from consumers of the end products.

The likely market behavior with this regulation is that most permits are likely to be awarded to current importers. Small-scale users would have little incentive to buy permits, as there are significant economies of scale in the acquisition and distribution of CFCs. Besides, importing firms are usually brand representatives in Chile, and there is an overwhelming probability that permits would be acquired by exclusive representatives. This would facilitate apparent monopoly behavior, as was discussed with quotas—even more so, considering that a firm that failed to buy a sufficient quantity of permits in auction would most likely obtain them by purchasing from other firms. However, this is less likely in Chile as the largest CFC importing firm holds only 29% of the market. But in general, it is important to specify a mechanism to prevent this type of behavior.[28]

As with quotas, auctioning permits could enable surplus funds to be collected for redistributive purposes. Legislation would be required for it to be set up and be able to rely on a relatively sophisticated management system including an agency to promote and regulate exchange.

5.2. *Choice of regulation alternatives to be quantitatively evaluated*

The characteristics of each instrument, discussed above, are summarized in Table 6. The table shows there is no dominant option, i.e. one with a better classification than all the others for every feature.

[27]For example, CONAMA proposed introducing a gasoline tax at the beginning of 1998 to deal with the serious pollution problem in the city of Santiago, a proposal that was rejected out of hand by the Finance Minister.

[28]For a discussion on market power issues see Hahn (1984) and Lisky and Montero (2004). In both cases though market power is considered a potential problem, in practice this seems minor.

Table 6
Qualitative assessment of regulatory instruments

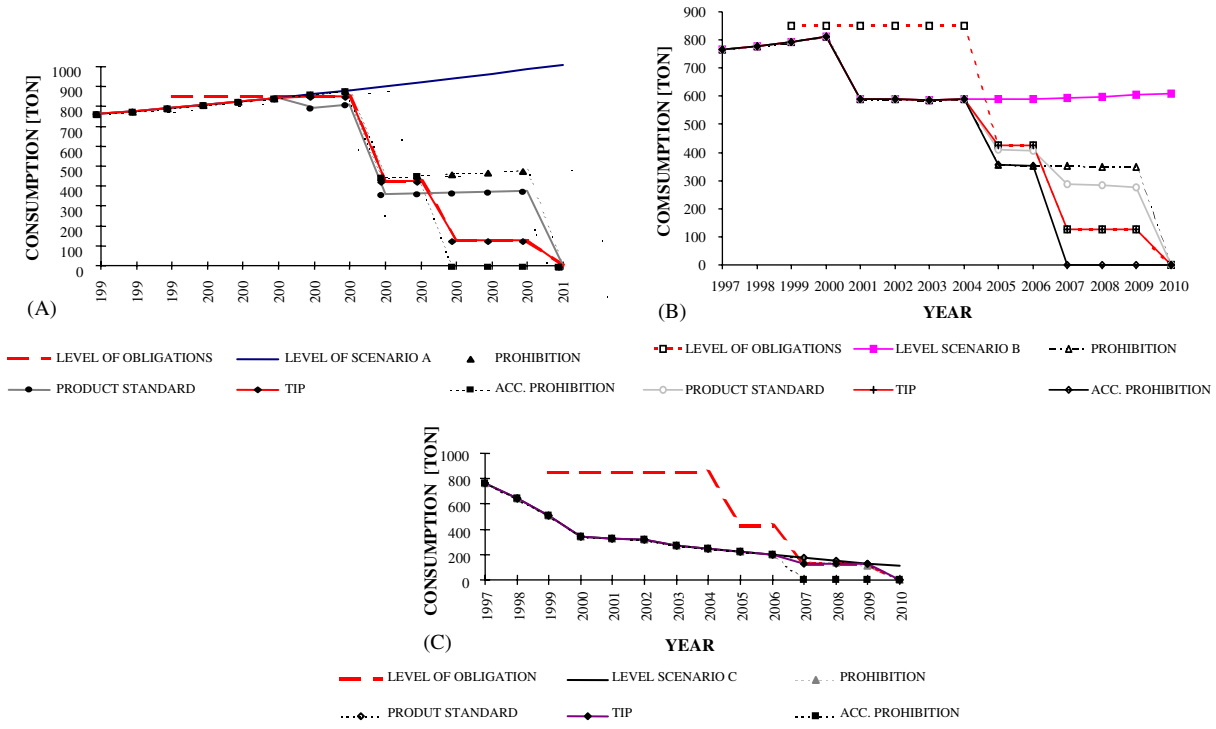
Regulatory instrument	Cost/effectiveness	Effectiveness	Legal feasibility	Ease of monitoring and enforcement	Acceptability	
					To users	To regulator
Product Standard	MEDIUM. It is possible to assess the average cost–effectiveness of each sector, but it is not incorporate cost variations within each sector.	LOW. Does not allow reductions below 30% of current consumption. Therefore, does not allow compliance with intermediate targets.	HIGH. Only requires administrative procedures	LOW. Necessary to inspect products that might contain controlled substances.	LOW. First producers affected might consider it discriminatory.	MEDIUM. Despite high legal feasibility, a lot of technical information needs to be handled for it to be cost-effective.
Substance import ban	LOW-MEDIUM. Not flexible; does not allow discrimination between different products with different cost–effectiveness.	MEDIUM. Either forces excessive reduction or fails to comply with targets.	HIGH. Only requires administrative procedure	HIGH. Only requires inspection of imports of controlled substances.	LOW-MEDIUM. First users affected might consider it discriminatory.	HIGH. Simple to apply.
Substance import quota	LOW-MEDIUM. Depends on initial allocation, which makes it unlikely to be cost-effective.	HIGH. Adjusts, by definition, to the target set.	LOW. Requires legislative approval.	HIGH. Only requires inspection of imports of controlled substances.	MEDIUM. Depends on initial allocation mechanism.	LOW. Requires legislation.
Substance import tariff	HIGH. Cost-effective by definition. Leads lowest-cost producers to refit.	MEDIUM. High degree of uncertainty of the effect of tariffs on consumption.	LOW. Requires legislative approval.	HIGH. Only requires inspection of imports of controlled substances	MEDIUM. Allows producers to decide when to refit, but obliges them to pay for each imported unit used.	LOW Requires legislation and its final acceptance as an instrument is highly uncertain.
Tradable import permits	HIGH. Highly flexible. Allows assigned rights to be traded.	HIGH. Adjusts, by definition, to the target set.	LOW. Requires legislative approval.	MEDIUM. Requires inspection of imports of controlled substances, and mechanism for permit trading.	HIGH. Allows producers to define when to refit, and if TIPs are initially allocated cost-free, they do not pay for each unit used.	LOW. Requires legislation and additional controls.

In principle both import quotas and tradable permits are effective as they meet targets on the stipulated dates. TIPs are efficient in affording maximum flexibility to users. Tariffs are similarly efficient, though they may not be effective. However, to become operative, these instruments require passing a law in Chile. However, the implementation of a substance ban or product standard only requires an administrative decree. This is a major difference since laws usually take a long time to be formulated and finally enacted. In particular, a tradeable emission permit law has been in discussion since 1995 in Parliament and has still not been approved due to opposition by environmental groups and many Legislators.

Nevertheless a product standard is difficult to manage as the consumption of all relevant substances from the time of import to final consumption should be tracked, to ensure that they are not being used in regulated products. In addition, it requires controlling imports which contain or have been made with CFCs from a range of importing countries. On the other hand, given an effective import control mechanism, other instruments can help regulate their importation and this reduces the cost of subsequent controls on the use of these substances and similar products.

In comparison to import quotas and tariffs, TIPs have clear advantages. Although the scheme also requires legislation, TIPs are efficient (something that cannot be said about quotas) and effective (not true of tariffs). In particular they sharply reduce uncertainty both for users and for the regulator. Moreover, regulators are likely to find TIPs more acceptable than tarrifs, as the latter are more sensitive to political and industry pressure.

Finally, the option of banning certain substances sequentially has the attraction of being easy to implement and control. The key question is whether there are significant efficiency losses in doing so. Given the conversion costs shown in Table 4, it can be seen that conversion in the plant using CFC-11 costs less than one that uses CFC-12. Hence CFC-11 should be prohibited first followed by CFC-12. The relevant dates for reduction of both



Graph 2. (A) Effectiveness of regulatory options under base scenario. (B) Effectiveness of regulatory options under moderate scenario. (C) Effectiveness of regulatory options under optimistic scenario.

CFC-11 and CFC-12 are 2005 (50%) and 2007 (15%), so it is helpful to evaluate a scenario that complies with these targets by prohibition.

These general conclusions were discussed with the CONAMA team responsible for drawing up the regulation. Given the regulator's priorities, the following instruments were analyzed quantitatively:

(1) *Tradable import permit*: With a perfectly functioning TIP system, it is assumed that users with lowest conversion costs reduce first. The number of permits required to comply with the Protocol is distributed annually in the following way: the average level for 1996–1998 is maintained for the period 1999–2004; from 2005 to 2006 it is reduced by 50%, and cut by 15% between 2007 and 2009 until totally phased out by 2010.
(2) *Accelerated prohibition*: A sequential banning of CFC-11 first and CFC-12 later, which enables the targets to be met, whichever scenario is considered. In this scenario, CFC-11 would be banned in 2005 and CFC-12 in 2007.
(3) *Prohibition*: The bans would follow a similar sequence as above but CFC-12 use would be continued until 2010.
(4) *Product standards*: A sequence of product standards that would come as close as possible to meeting the established target. Sectors affected are chosen from least cost to highest.

5.3. *Quantitative evaluation of regulatory instruments*

The cost of each of the four instruments was evaluated for its effectiveness and efficiency by using the consumption scenarios—baseline, moderate and optimistic—described above.

Graphs 2a–c, show the effectiveness of the different instruments in each scenario. As expected, the TIP system enables obligations to be fulfilled under any scenario. A total ban on CFCs from 2007 also enables compliance with the Protocol under the moderate and optimistic scenarios; however under the pessimistic scenario there is slight under-compliance from 2002 until 2006. However, if CFC-12 use is banned from 2010 only, compliance is not achieved under the pessimistic scenario, 2002–2010; while with the moderate scenario non-compliance occurs later, in 2007 continuing until 2010; with the optimistic scenario. There is slight non-compliance in 2007 only. In the first two scenarios (pessimistic, moderate) the committed levels are surpassed by more than two and even three times the planned levels.

Finally, the application of product standards permits compliance under any scenario up to the year 2007. However with the pessimistic and moderate scenarios total CFC use is more than twice the agreed level.

Table 7 shows the total cost of each instrument in every scenario,[29] in 1997 present-value terms, at a 10% annual

[29]This does not consider costs incurred from 2010 as CFC consumption is assumed to fall to zero by this date.

Table 7
Costs of regulatory options under each scenario, NPV 1997, 10%

Instrument	Scenario A base NPV (US$ million)	Scenario B moderate NPV (US$ million)	Scenario C optimistic NPV (US$ million)
Ban 2005–2010	8.7	3.6	1.1
Product standard	11.4	2.9	0.8
TIP	14.4	5.4	1.1
Accelerated prohibition	18.8	11.0	4.9

discount rate. The first conclusion is that, on aggregate, the Protocol does not always impose a significant additional cost for producers. In the worst case (base scenario and use of accelerated prohibition) the cost of complying with the regulation approaches US$ 20 million, compared with the case in the absence of regulatory action.[30]

It is important to emphasize that the cost of the chosen strategy is highly dependent on the actual scenario. Under an optimistic scenario, the cost of an accelerated prohibition instrument would be just US$ 5 million. This conclusion reaffirms the need to develop a strategy that encourages and supports the optimistic scenario.

Applying a flexible instrument (TIP) may reduce compliance costs between 23% (base scenario) and 78% (optimistic scenario) when compared to accelerated prohibition. Although this suggests that TIPs are very attractive, an examination of absolute values shows that potential savings are quite small—between US$ 4 and 5 million, depending on the scenario considered.

If instead of using accelerated prohibition, the regulator bans CFC-11 in 2005 and CFC-12 in 2010, about US$ 4 million would be saved and all commitments would be met under the optimistic scenario. If the base scenario occurs instead, the intermediate commitments would be very far from met (however savings would be close to US$ 10 million).

6. Chile's regulatory strategy for ODS

It was concluded, from the above information, that even without new instruments, Chile would not have problems complying with the Montreal Protocol agreements on CFCs up to the end of 2004, and very likely to the end of 2006. However, from 2006 onward compliance targets are met only under quite optimistic assumptions. Accordingly, the required regulatory strategy had to ensure that (1) the moderate or optimistic scenario does in fact occur, and (2) all obligations are complied with from 2005 onward.

The quantitative data show that compliance costs amount, at most, to US$ 20 million, in present-value terms, and could be substantially less. Such costs seemed perfectly affordable for the industry, particularly if small- and medium-size firms receive conversion support.

[30]However, since this is present value in 1998, and most of the investments occur after 2005, the true costs firms face in this latter year will be substantively higher.

If the TIP system was to be applied, the savings and costs (US$ 4–5 million) would not be very significant. The CONAMA authorities considered this additional expense to be a "lesser evil", compared to, for example, accelerated bans which would require submission to the legislature. Moreover, they did consider that if the ban on CFC-12 was brought forward to 2007 that it would penalize potential uses, provided sufficient advance warning was given.

After weighing the quantitative and qualitative data, the authority finally preferred the application of substance bans and bringing forward the prohibition of CFC-12 to 2007.

The other substances examined in this study (CTC, methyl chloroform and halons), all show significant downward trends, and so the chosen strategy was to ensure these substances continued to decrease to assure compliance with commitments. These results are the basis of the strategy proposal discussed in the next section.

6.1. Strategy proposal

The set of regulatory and complementary measures to ensure Chile's compliance with the Montreal Protocol are summarized in Table 8. The proposed regulatory actions had two components. The first involves specific measures to reinforce obligations currently applied in Chile. A set of prohibitions would be announced in order to reiterate the need for compliance with *all* these obligations, and act as a signal to users that Chile was committed to the Protocol. The prohibitions were not new, as these obligations were being followed, but *preventive* to ensure future compliance. Thus their application *would not generate major economic or administrative costs*, and it was not necessary to worry about their gradual application.

The second component set out measures to ensure compliance, for each substance, with intermediate and final Protocol obligations. These were the prohibition of CFC-11 and CFC-12 imports by the end of 2004 and 2006, respectively. Dates for banning the other substances were also proposed.

It was proposed that these measures be announced as soon as possible, to signal to firms and consumers that the Chilean State was serious about fulfilling its Protocol obligations.

These regulations, to be effective, had to be complemented with measures that encouraged producers and

Table 8
Proposal for regulatory and complementary measures for chile to comply with the Montreal Protocol

Proposed measure	Date of application	Purpose
Regulatory action		
Import ban on substances with current phase-out commitment (hydrobromofluorocarbons) and all substances and products containing them with non-party countries.	2000	Send a clear signal to users of ODS regarding the Chilean Government's determination to comply with the MP.
Import ban on CFC-11.	2005	Ensure compliance with intermediate and final obligations.
Import ban on CFC-12 and the other CFCs.	2007	Ensure compliance with intermediate and final obligations.
Import ban on products made with or containing CFC.	2005 (CFC-11) 2007(CFC-12)	Protect national producers from unfair competition.
Complementary actions		
Aimed at consumers		
Public information campaigns	1999 onwards	Provide information on the harm to the environment and the problems of buying products containing ODS.
Certification programs	1999 onwards	Enable consumers to distinguish between products that use ODS and those that do not.
Aimed at producers		
Maintain the subsidies program.	1999 onwards	Change large firms and serve as a demonstration effect for smaller ones.
Training in retrofitting techniques for small- and medium-size enterprises (SMEs).	1999 onwards	Support SME refitting
Voluntary agreements with large firms.	1999 onwards	Eliminate consumption of CFC-11 and CFC-12 by large firms in the near future.
Training in recovery and recycling for technical and professional workers.	1999 onwards	Provide incentives for the recovery and recycling of CFC.

consumers to make timely decisions consistent with the Montreal Protocol and a set of actions were proposed that involved industry as a participant. These measures were important to avoid a sense that producers, importers and consumers were the ''victims'' of the government regulations. The main actions aimed at consumers were:

- Public information campaigns to inform people about environmental damage caused by using products that contain or have been made with ODS; and consumers of the inconvenience of buying products that use substances soon to be phased out, and thus likely to become scarce and expensive.[31]
- Certification programs which distinguish, for consumers, products which use or have used ODS, from those using alternative substances. The ozone seal sponsored by CONAMA should play an important role in this campaign.

Actions aimed at producers include:

- A continuation of CONAMA subsidies. These can be effective in changing large firms and have a demonstration effect for the smaller ones.
- The provision of training in conversion techniques for small- and medium-size firms.
- A program of voluntary agreements with the largest firms to phase out their consumption of CFC-11 and CFC-12 in a short period of time.
- The provision of training for technicians and professionals to recover and recycle ODS.

Finally, it would be important to protect national producers from the unfair competition of imports that have been made with, or contain, prohibited substances. These products, containing or made with CFCs, should be banned as imports on the date their use is prohibited in Chile.

The timely announcement of a strategy that sets out clear phase-out deadlines with support measures for the most affected firms, together with information for users, would promote the moderate or optimistic scenario to actually come about.[32] This would ensure that compliance costs would be relatively low, as there would be time to reduce pressures to amend or neutralize the regulation when it comes into force.

6.2. *Policies followed: not exactly what the doctor ordered!*

Although the regulatory framework described above was proposed in a timely way, it has taken longer than expected to

[31]After 2010 only recycled substances will be allowed.

[32]Thus reducing the likelihood that it would be profitable for importers to accumulate inventories of these substances in the year prior to the prohibition coming into effect.

be approved. There was a debate about whether ODS could be prohibited using Article 90, considering that it did not necessarily affect local health. It was finally decided to propose a Law that included a schedule of prohibitions based on the proposed regulatory framework, and import quotas following the Montreal Protocol schedule. The proposed law also advocated complementary actions very similar to those set out in Table 8. Unfortunately, as expected, discussions were long and the Law is still pending in Congress.

However, other parts of the proposal were followed. Since 1998, several activities have supported the manufacturing subsectors. The Program of TECFIN, which was implemented in two stages, has been the most relevant producer activity associated with CFCs. The program's total investment has amounted to US$3,026,139 (distributed among 26 firms by means of a "subsidy bid") and resulted in a reduction of 537.54 tons of ODP. The subsectors involved were foams (isolating and flexible) and refrigeration (manufacturing). The Management Plan of Refrigerants, involving technical services of refrigeration and air conditioners, is another on-going initiative. The Fund has also provided finance for the elimination of CFC-12 in hospital sterilization chambers.

As a result, up to 2005 Chile has managed to comply with its obligations in spite of the lack of new regulation. Real CFC consumption is similar to the one projected by the "with subsidy" scenario. However, non-compliance for CFCs will be inevitable in 2007, just as the different scenarios predicted.[33] Unfortunately, the delay will not leave time for gradual adjustments that would have been a benefit of an earlier and timelier law.

7. Conclusions

This paper has explored the development of a Chilean strategy to regulate substances that deplete the ozone layer, based on quantitative and qualitative data, particularly regulatory authority policy attitudes. The most important initial attribute for the authority was compliance costs. The strategy analyzed different development scenarios for the sectors involved and showed their costs to be relatively affordable, varying between US$ 20 million in the most pessimistic case and just US$ 1 million in the optimistic one. Further although the application of a flexible instrument leads to significant reductions in percentage terms—between 23% and 78% depending on the scenario considered—in absolute terms they amount to only US$ 4–5 million. Accordingly, the regulatory authority considered other instrument features that were relevant, among which are that the proposed instrument should be easy to apply; avoid the need for legislation, where possible; not be difficult to inspect and monitor; have a potential for meeting commitments under reasonable scenarios; and be consistent with regulatory practice, that is trying to make the instruments as simple as possible and as close as possible to those in use.

The exercise of assessing each instrument, by quantitative and qualitative methods, showed that no one instrument has outstanding technical advantages over the others. Consequently, with the technical information provided for each instrument, the regulator can give a policy weight consistent with the appropriate strategy. In this case, it was concluded that the most appropriate policy was to ban CFC imports, starting with the most cost-effective (CFC-11), and then advance the final deadline for CFC-12 phase-out to 2007. The different phase-out deadlines for CFC-11 and CFC-12 allowed cost differences between both to be manipulated and so made this strategy relatively cost-effective.

Based on this, the Chilean Environmental Agency decided to propose a "stick and carrot" strategy to encourage compliance with the Protocol. First, this would give a strong signal of commitment to the Protocol and national compliance by banning substances and announcing concrete phase-out dates for the rest. The original idea was to use an existing regulatory instrument (Article 90 of the Sanitary Code) so as to not require passing a new law. Second, the authorities would support complementary measures—which would help to bring about the moderate or optimistic scenario—with state resources for the most affected sectors. The regulatory authority made clear that it prefers to invest resources in this way rather than try to rely on more flexible instruments.

However, the implementation of the proposal has been slow. Up to now just the carrot has been applied. After long discussions it was decided that a law was required, rather than using the Sanitary code. This resulted in significant delays so only the complementary actions aimed at producers have been implemented. To achieve the reductions required in 2007, a law, based on the proposal, is expected to be approved by the end of this year. The proposal made in 1999 would have enabled firms to plan reduction schedules with greater anticipation and incur lower costs.

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[33] As all developing countries, in 2007 Chile must reduce in 85% its consumption relative to the 1995–97 average.

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