Chapter 6

How helpful are economic incentives to steer consumer behavior towards sustainability?

6.1 Introduction

Earlier stages of the HOMES project have left little doubt about the degree of sustainability of current household consumption patterns. As shown in Chapter 2, the energy and water consumption are still increasing or increasing again. Even under favorable scenarios regarding the employability of renewable energy sources and currently known technological improvements, a reduction of the use of energy and materials per household is required in order to arrive at a consumption pattern that is more sustainable.

One of the challenges of environmental policy is to find an optimal mix of policy instruments to achieve these goals. The purpose of this Chapter is to investigate this problem, in the light of some insights from (behavioral) economics and other social sciences, and the results from previous Chapters.

Section 6.2 discusses some theories – with elements from economics, psychology and sociology – which we think are particularly relevant in understanding consumer behavior regarding sustainability. The section includes discussions of interdependent preferences, non-sustainable behavior as a prisoner's dilemma, information and uncertainty, and bounded consumer rationality. While the HOMES project – as well as the empirical parts of this thesis –

have focussed exclusively on the Dutch society, the results of the project have implications that go beyond the borders of The Netherlands. Section 6.2 also presents a brief outlook to other countries from the HOMES viewpoint. Section 6.3 reviews types of instruments that can be used to affect consumer behavior. Our discussion will include public awareness campaigns and education, prohibition and regulation by law, (tradeable) quantity rations, and financial incentives. We focus on effectiveness and efficiency conditional on implementation. Political feasibility and public acceptability, which are other crucial determinants of the success or failure of an instrument, receive ample attention in Ligteringen (1999). In section 6.4 we make a side step comparing the outcomes of the implementation of two policy instruments: a budget neutral energy tax and tradeable quantity rations. Section 6.5 reviews financial incentives in the sustainability context and finally section 6.6 concludes.

6.2 Some social science views on sustainable consumer behavior

Understanding behavior is a prerequisite for designing a consistent and effective policy aimed at influencing human behavior. Our knowledge of human behavior within a society is based on cumulated insights that have been obtained gradually during many decades of research in various disciplines.

There is no such thing as consensus about which theories are appropriate, and our insights in human social behavior are still at best partial. In the case of environmental and energy policy in particular there is a lot of controversy about appropriate policies. One obvious reason is that people have different (political and ideological) views regarding society and social order. But controversy may also be a consequence of a lack of 'objective' knowledge and insights in physical and/or social aspects of environmental problems. When perception about the nature and seriousness of environmental problems differ, so will the accruing policy recommendations, even when there would be no ideological disagreement. Despite these qualifications we believe that social sciences provide insights which are sufficiently coherent to base policy recommendations on.

In the basic neoclassical model of human (economic) behavior, the individual maximizes utility subject to constraints (income constraint, time constraints, technological constraints), taking individual preferences as given. Mainly because preferences are taken as given, the model is too limited to use for policy

design. Therefore we will attempt to also use insights from social psychology and sociology. Below we subsequently discuss some extensions that are particularly relevant in the present context: interdependent preferences, non-sustainable behavior as a prisoner's dilemma, information and uncertainty, and bounded consumer rationality. We conclude with a discussion of changing norms and values from an international perspective.

Interdependent preferences

A central issue in understanding consumer behavior concerns the interdependence of the behavior of individuals in society. Although in economics the notion of interdependent preferences was already described half a century ago by Duesenberry (1949) and Leibenstein (1950), the important issue of preference and behavioral interdependence has been largely neglected in economic research. One of the reasons is that economists traditionally take preferences as given and leave the explanation of preferences to other social sciences. Another reason is that the effect of the behavior of others is not easily distinguished from the role of other variables; see Manski (1993). Yet, there is little doubt – in economics as well as in other social sciences – about the existence and importance of interdependent preferences.

Preference interdependence may have far-reaching consequences for understanding and predicting consumer behavior at the aggregate level (cf. Blomquist, 1993). Consider for example the case of car use. Analyses at the individual level show that a decreasing (real) fuel price induces additional car use. As this applies to all consumers in society, car owners will not only experience an incentive to drive more because of the lower fuel price, but they will also observe that other car owners drive more. As preferences are usually strongly influenced by the observed behavior of other people, driving a car gets more weight in the preference scheme of consumers, which is likely to induce another upward effect on the number of kilometers driven. As a result, the sum of the predicted individual effects will underestimate the effect on the aggregate level when preference interdependence is ignored.

Non-sustainable consumption as a prisoner's dilemma

Preference interdependence means that a consumer's utility does not only depend on his own consumption but also on the consumption of others. As a consequence, subjective well-being is largely determined by a consumer's rel-

atively position in society, rather than by the absolute level of consumption, at least in the more a- uent societies; see for empirical evidence Kapteyn and Van Herwaarden (1980) and Oswald (1998). As a result, consumers may keep each other captive in a prisoner's dilemma regarding their consumption pattern. To explain the issue let us reconsider the car example. The utility one derives from a car does not only depend on the car characteristics but also on the characteristics of the cars of neighbors. When a neighbor purchases a more expensive car, this will generally have a positive effect on the first person's expenditures on his next car, and *vice versa*. As a result, consumers end up in a Pareto inefficient pattern of expenditures: all would be better off if they would cooperate and jointly decide to spend less on cars and more on goods which are less conspicuous, such as cultural and recreational activities.

It is important to note that these consumption externalities occur in addition to the 'ordinary' externalities related to pollution, noise, resource exhaustion, etc. The externality due to the conspicuousness of certain consumption goods and services provides an additional motivation for taxing conspicuous goods and subsidizing non-conspicuous goods; see Frank (1997) and Kooreman and Schoonbeek (1998) for further discussion. Such a tax system can support a more fundamental change in norms and values regarding consumption, which seems to be necessary to achieve sustainability.

Information and uncertainty

Even when consumers and households are committed to behave in a way that is best from the viewpoint of sustainability, making the best choice is not always easy. This may be due to either a lack of information or to bounded rationality (i.e. limited capacity for information processing and decision making from the part of the consumer, or simply: making mistakes). A lack of information is not necessarily related to bounded rationality. To quote Linder (1970): '*Only unintelligent buyers acquire complete information*'. In many cases acquiring information is too costly for an individual consumer compared to the expected benefit of additional information search. Even professional organizations may be unable to provide decisive information about which alternatives are optimal from a sustainability point of view. An example is the choice between cartons or glass bottles for packaging liquid dairy products. Initially glass bottles were thought to be preferable because they are easier to recycle. However, the outcome of the comparison reversed once it was taken into account that glass packaging takes

more fuel in transportation since it is heavier than carton packaging.

In Chapter 3 we have analyzed the seemingly simple choice between two versions of a durable good (e.g. light bulbs or refrigerators) which only differ in purchase price, energy use, and (fixed) life times, and are identical otherwise. We showed that a rational choice on the basis of a mere comparison of expected discounted costs made by fully informed consumers may yield complicated and counterintuitive behavioral patterns; see also Kooreman and Steerneman (1998). The latter example shows that it is often not only difficult for a consumer to make the right choice, but also that it may be difficult for a researcher to determine whether a choice made by a consumer was optimal or not. For example, in earlier research several authors conclude that consumer behavior regarding durable goods is irrational, for example, because they implied extremely high subjective discount rates (see, e.g. Gately, 1980; and Loewenstein and Thaler, 1989). Further scrutiny showed that these results can be explained by taking into account aspects such as liquidity constraints (choosing a high-efficiency durable would be profitable for the consumer; still, he purchases the low-efficiency version because he is unable to borrow the money necessary for the initial investment), uncertainty regarding the life time of durables, and the costs of acquiring information on the durables.

Bounded consumer rationality

The cases discussed above are not examples of bounded rationality in the pure sense. The latter occurs if consumers do have all the necessary information at their disposal but yet do not make the optimal choice. One could distinguish two types of bounded rationality. The first type are errors in calculations, not paying sufficient attention, etc. Such mistakes are inherent to human decision making in general and do not apply specifically to sustainability related choices. In other cases non-optimality of choices is the result of a lack of self-control; see e.g. Laibson and Benjamin (1999) and Warneryd (1999) for examples and discussion.

Changes in consumption values and norms

Although policy instruments can surely contribute to sustainability objectives (cf. section 6.3), behavior will always be largely determined by powerful social and cultural forces which are not easily affected by policies. These forces exhibit slowly evolving trends.

Table 6.1: *Summary statistics of several countries*

Country	Income[a]	Energy[b]	Subjective well-being index[c]	Pop.[d]	Share of services	PM index[e]	Education index[f]	Average household size
Argentina	23	1,994	59	12	66.2	19	22	3.9
Austria	80	4,171	59	94	63.3	22	33	2.7
Belgium	79	6,872	77	328	62.3	27	37	2.7
Brazil	24	810	55	18	55.4	19	12	4.4
Canada	87	10,965	69	3	66.2	25	70	2.7
Chili	32	1,305	53	18	55.4	19	19	4.1
China	13	833	42	123	21.4	7	2	4.4
Czech Republic	30	5,610	32	131	50.5	16	18	2.8
Denmark	81	4,655	85	121	69.0	23	32	2.2
Germany	89	5,890	64	226	63.7	22	31	2.3
Finland	73	6,566	76	15	58.2	33	47	2.5
France	83	5,434	67	105	67.5	27	40	2.6
Hungary	28	3,339	28	111	66.0	12	15	2.7
India	5	350	16	274	40.9	13	6	5.5
Ireland	52	3,997	80	51	54.0	22	26	3.6
Italy	77	4,019	66	192	65.4	27	20	2.8
Japan	88	4,735	54	331	61.1	25	31	3.0
Mexico	32	1,891	51	44	59.8	21	14	5.0
Netherlands	76	7,122	85	403	66.0	32	34	2.5
Nigeria	6	207	33	114	43.8	13	3	n.a.
Norway	78	6,713	81	13	64.5	20	43	2.4
Poland	20	3,484	58	124	41.9	13	22	3.1
Portugal	43	2,111	51	107	56.2	17	18	2.9
Romania	16	2,702	20	99	31.9	12	9	3.1
Russia	31	7,357	-1	9	26.8	11	20	2.9
South Africa	18	2,488	30	33	48.8	18	3	n.a.
South Korea	38	3,188	51	448	44.2	18	39	3.8
Spain	57	3,109	65	78	63.4	25	34	3.5
Sweden	79	6,937	86	19	67.2	25	33	2.2
Switzerland	98	4,877	86	170	62.2	30	26	2.5
Turkey	22	1,045	47	76	49.9	22	14	5.2
United Kingdom	74	5,400	75	238	66.5	24	25	2.8
United States	100	10,737	77	27	74.9	22	75	2.6

Source: Inglehart (1997) and The Economist Pocket World in Figures (1996)

[a] income per capita in purchasing power parity (US=100)

[b] energy consumption per capita in kilogram coal equivalent

[c] see Inglehart (1997)

[d] population per square kilometer

[e] Post-materialist values index; see Inglehart (1997)

[f] percentage in higher education

Table 6.2: *Correlation matrix*

	Income	Energy	Subj. well-being index	Pop.	Share of services	PM values index	Eduation index
Income per capita							
Energy consumption per capita	0.76						
Subjective well-being	0.77	0.45					
Population per square kilometer	0.16	-0.02	0.07				
Share of services in GDP	0.73	0.46	0.73	-0.01			
Post-materialist values index	0.78	0.48	0.78	0.17	0.73		
Education index	0.77	0.85	0.61	-0.02	0.60	0.57	
Average household size	-0.73	-0.73	-0.46	-0.04	-0.46	-0.41	-0.45

Remark: for correlations involving average household size: n=31, for other correlations: n=33.

In a comprehensive survey on norms in 43 different countries, Inglehart (1997) has found convincing evidence of a trend towards postmaterialism. This is to say that people attach more importance to issues like religion, culture, ecology and natural environment as compared to items like income, housing, and status. It might be conjectured that such a development is associated with a tempering demand for energy and natural resources. Table 6.1 shows summary statistics on income, energy use, postmaterialist values, and related variables for 43 different countries.

Table 6.2 shows a positive correlation between energy use and the postmaterialist value score (almost 0.5), and an even higher positive correlation between income and the postmaterialist value score (almost 0.8). This suggests that a relatively high level of consumption and energy use is a prerequisite for the emergence of postmaterialist values. To put it differently: postmaterialist values appear to be a 'luxury' good rather than a substitute for materialist consumption. This interpretation is highly tentative, however, given the nature of the data.

6.3 Instruments for affecting consumer behavior

The results of the HOMES project and the discussion above provide motivations for government intervention related to household consumption behavior and sustainability. The first and least controversial motivation is that many consumption activities, in particular those related to natural resources and energy, have negative 'ordinary' externalities such as pollution, noise, and natu-

ral degradation. A second motivation has been alluded to above: as individual consumers seem to be unable to escape from the conspicuousness prisoner's dilemma described above, governments should interfere. Finally, the various manifestations of bounded rationality of irrationality described above provides a motivation for interference.[1]

Below we discuss a number of instruments that can be used. The list is neither exhaustive, nor original. Moreover, financial incentives are extensively discussed in section 6.5.

Providing information, public awareness campaigns, and education

Producers and the government should provide minimum information to consumers regarding energy use, lifetime, etc. of various models to help them making informed choices. To exploit scale economies, collecting such information is often best done by professional consumer organizations. Public awareness campaigns have been used extensively in past Dutch environmental policies regarding consumer behavior. The effects, however, have almost never been measured and are difficult to measure conceptually. There are indications that the effects are small and quickly fade away after the conclusion of the campaign.

Information that can improve consumers' awareness is direct feedback on the energy or water use. An example is measuring and monitoring input uses of individual household appliances (such as a shower), or measuring and monitoring daily electricity use in terms of both kilowatt-hours and guilders. In another example, households weekly register their natural gas and electricity consumption during Winter months. Energy-supplying companies weekly provide bench-mark consumption levels based on weather and household circumstances and the annual expected energy consumption. In the Netherlands, the reduction in household energy consumption realized with direct feedback in 1995 was estimated at 2.0 PJ, which is equivalent to about 63.2 million m^3 of natural gas; see EnergieNed (1996).[2] By participating in the campaign, households realize a 3 percent reduction in their energy consumption.

[1] In the latter case in particular, interference might be considered as 'patronizing'. Whether it is appropriate for governments to play a role in such cases is, at least to some extent, a matter of ideological and political views.

[2] In 1995 1.2 million Dutch household participated voluntarily in this campaign. The costs of these activities are paid by the households with the Environmental Action Plan tax; see Chapter 2.

Prohibition and regulation by law

An example of these instruments is the 'Wet Energiebesparing Toestellen (WET)', (Law Energy Conservation for Equipment), which sets standards regarding maximum energy or water input per unit of output. Another example is traffic speed limits. A third example, discussed by Palmer and Walls (1997), is the 'recycled contents standards', which requires that a predetermined fraction of inputs of a consumption good has to consist of recyclable materials. Effectiveness of regulation by law requires that the regulations are combined with credible enforcement, i.e. a sufficiently high probability of detection of violation and a sufficiently high fine. The municipality of Oostzaan, for instance, employs a monitoring and fining system in order to prevent illegal dumping; see Chapter 5.

(Tradeable) quantity rations

In public debates about energy policies the implementation of quantity rations is sometimes advocated; see e.g. Lyklema (1997). One can make a distinction between rations that cannot be traded (at least not legally) and those for which trade is permitted. These (tradeable) quantity rations are largely similar to tradeable pollution permits; see for instance Hanley *et al.* (1997).

In the first case, each household is assigned a certain quantity of energy in each period, which may depend on family composition and other circumstances. Households are unable to exceed the limit of energy use in a particular period. Rationing policies are sometimes used in case of extreme shortages of basic necessities such as food, water and clothing, for example in case of natural calamities or in times of war. The motivation in these cases is that free market distribution would result in extremely high prices, which would prohibit poorer households to satisfy their basic needs. However, as long as this argument is not relevant – as seems to be the case for energy in current Western societies – there are few solid arguments in favor of its implementation. One advantage might be that it increases household's energy awareness. Another advantage – from an environmental point of view – is that the total amount of energy supplied can be determined beforehand, so that the total amount of energy consumption can be regulated. The main disadvantage is its arbitrary nature. Beyond the limit quantity the price of energy suddenly goes to infinity. The household is confronted with an additional constraint and the utility level it can reach is at best as high as the level without the constraint.

The situation improves when households are allowed to trade their rations with other households. However, it can be shown that (under certain conditions) this leads to the same allocation as when aggregate energy use is reduced by means of a price increase; see the next section.

The physical system that is used to charge households for energy may affect energy use, and hence act as an indirect quantity ration mechanism. For example, Baker *et al.* (1989) find that households who pay for gas or electricity by throwing coins in a home-installed meter use significantly less, *ceteris paribus*, than other households. This is likely to be associated with a loss in comfort (utility).

In principle, physical systems can also be used to help people coping with self-control problems related to non-sustainable behavior. As an example, consider people who sincerely commit themselves to obey a speed limit of 120 kph, but sometimes violate the limit due to a lack of self-control. In such a case, a device can be installed which prevents the car from exceeding the speed limit. Another example is a shower which automatically shuts down hot water supply after a preset number of minutes.

6.4 Allocative equivalence of energy taxation and tradeable rations; an example

In practice, the tradeable quantity rations for energy have – to our knowledge – never been introduced yet. Quantity rations have the advantage that they can determine the total energy supply beforehand. This predetermined energy supply would be beneficial from an environmental perspective because the total energy consumption can be regulated. In the case of energy taxes the total energy supply is determined by the total amount of energy demand given the predetermined energy prices including the energy tax. This section compares the effects of both policy instruments: an energy tax and tradeable energy quantity rations. For expositional purposes we use a model which is simple, but which captures all the essential features.

Consider a society with a continuum of consumers whose preferences are represented by

$$U(x_1, x_2) = \alpha \ln x_1 + (1 - \alpha) \ln x_2, \qquad 0 < \alpha < 1. \tag{6.1}$$

Here x_1 is the quantity of energy and x_2 is the quantity of other consumption. The corresponding prices are denoted by p_1 and p_2; y is income. Maximization

of the utility function subject to the budget constraint $p_1\ x_1 + p_2\ x_2 = y$ yields the individual demand equations:

$$x_1 = \alpha\frac{y}{p_1}; \qquad x_2 = (1-\alpha)\frac{y}{p_2}. \tag{6.2}$$

Consumers differ in two respects. First, they have different values for α. The α's follow a probability distribution f_α defined on the unit interval with expected value $\bar{\alpha}$. (Without preference heterogeneity no trade would occur in the case of tradeable quantity rations). Second, the incomes differ as well. The y's follow a probability distribution f_y with expected value $\bar{y}$. The distributions of α and y are independent.

Total energy use X_1 and total other consumption X_2 (both per capita) in society are given by

$$X_1 = \int\int \frac{\alpha y}{p_1} f_\alpha(\alpha) f_y(y) \partial\alpha \partial y = \frac{\bar{\alpha}\bar{y}}{p_1}; \qquad \text{and} \tag{6.3}$$

$$X_2 = \int\int \frac{(1-\alpha) y}{p_2} f_\alpha(\alpha) f_y(y) \partial\alpha \partial y = \frac{(1-\bar{\alpha})\bar{y}}{p_2}. \tag{6.4}$$

Suppose that the government wants to reduce total energy consumption to λX_1, with $0 < \lambda < 1$. We consider two policies: a budget neutral energy tax and tradeable quantity rations.

Energy taxation

The government imposes an energy tax by increasing the price of energy from p_1 to $p_1 + \tau_1$. We assume that the tax is budget neutral, which is achieved by giving each household a lump-sum tax reimbursement Δy. The tax rate τ_1 and Δy are therefore implicitly defined by

$$\frac{\lambda\bar{\alpha}\bar{y}}{p_1} = \frac{\bar{\alpha}(\bar{y} + \Delta y)}{p_1 + \tau_1} \tag{6.5}$$

and

$$\frac{\tau_1 \lambda\bar{\alpha}\bar{y}}{p_1} = \Delta y. \tag{6.6}$$

The solutions for τ_1 and Δy are given by

$$\tau_1 = p_1 \frac{1-\lambda}{\lambda(1-\bar{\alpha})}. \tag{6.7}$$

and

$$\Delta y = \frac{(1-\lambda)\bar{\alpha}\bar{y}}{(1-\bar{\alpha})}. \tag{6.8}$$

with an after-tax energy price of

$$p_1 + \tau_1 = p_1 \frac{1 - \bar{\alpha}\lambda}{\lambda(1 - \bar{\alpha})}. \tag{6.9}$$

The individual demand for energy after tax is given by

$$x_1^{\text{after tax}} = \frac{\alpha(y + \Delta y)}{p_1 + \tau_1} = \frac{\alpha\lambda(1 - \bar{\alpha})y}{(1 - \bar{\alpha}\lambda)p_1} + \frac{\alpha\bar{\alpha}(1 - \lambda)\bar{y}}{(1 - \bar{\alpha}\lambda)p_1}. \tag{6.10}$$

Tradeable ration

The same policy objective can be achieved by introducing tradeable quantity rations. Each household receives a ration $\bar{x}_1 = \frac{\lambda\bar{\alpha}\bar{y}}{p_1}$ for which it has to pay an amount $\lambda\bar{\alpha}\bar{y}$. A household can choose to consume more or less than $\bar{x}_1$ by buying or selling an amount m on the ration market (m is positive when the household buys and negative when it sells). The ration market is perfectly competitive. So, the law of one price holds, and the market price, r, is given for the individual household.

A household now maximizes

$$U(x_1, x_2) = \alpha \ln(x_1 + m) + (1 - \alpha) \ln x_2, \qquad 0 < \alpha < 1. \tag{6.11}$$

subject to

$$r \cdot m + p_2 x_2 = y - \lambda\bar{\alpha}\bar{y}. \tag{6.12}$$

The solution for m is given by

$$m = -\bar{x}_1 + \frac{\alpha}{r}(y - \lambda\bar{\alpha}\bar{y} + r\bar{x}_1). \tag{6.13}$$

The ration market clears when

$$-\bar{x}_1 + \frac{\alpha}{r}(y - \lambda\bar{\alpha}\bar{y} + r\bar{x}_1) = 0, \tag{6.14}$$

from which we can solve the equilibrium price as

$$r = \frac{\bar{\alpha}\bar{y}(1 - \lambda\bar{\alpha})}{(1 - \bar{\alpha})\bar{x}_1} = \frac{p_1(1 - \bar{\alpha}\lambda)}{\lambda(1 - \bar{\alpha})}. \tag{6.15}$$

Note that the equilibrium price is equal to the after tax price in the energy tax case (eq. (6.9)).

Using (6.13) and (6.15) we find that individual energy consumption is equal to

$$\begin{aligned} x_1^{\text{ration}} &= \bar{x}_1 + m \\ &= \frac{\alpha\lambda(1-\bar{\alpha})}{(1-\bar{\alpha}\lambda)p_1}(y - \lambda\bar{\alpha}\bar{y} + r\bar{x}_1) \\ &= \frac{\alpha\lambda(1-\bar{\alpha})y}{(1-\bar{\alpha}\lambda)p_1} + \frac{\alpha\bar{\alpha}(1-\lambda)\bar{y}}{(1-\bar{\alpha}\lambda)p_1}, \end{aligned}$$

which is identical to the expression in (6.10).

Thus the outcomes of an energy tax and tradeable rations are identical.[3] Given the identical outcomes of this simple model, the choice between the energy tax and tradeable quantity rations cannot be based on the effectiveness of the instruments. The choice between the alternatives could be based on political feasibility, public acceptance, and the implementation costs. We expect the implementation costs of quantity rations to be larger, partly because the trade involves transaction costs.

6.5 Financial incentives

This Chapter has described some aspects of the design and motivation of policies aimed at achieving more sustainable household consumption patterns. In this thesis, we provided compelling empirical evidence that financial incentives are effective instruments to affect behavior, provided that they are sufficiently large and properly implemented. The tables 4.1 to 4.3 in Chapter 4 and table 5.2 in Chapter 5 summarize the results of various empirical investigations into the price sensitivity of household energy, water and waste collection demand. The results are given in terms of elasticities, which is defined as the percentage change in consumption as a result of a one percent increase in its price.

In public debates it is sometimes claimed that consumption is insensitive to price changes. For example, in 1993, the Dutch Unie van Waterschappen (Union of Water Control Boards) claimed that increasing the marginal price of water would not affect household water consumption. Other examples are opinions expressed by RAI (Dutch Association for Car Retailers). According to RAI increases in the price of car fuel are only meant to raise government revenues and will not reduce the number of kilometers driven. Similarly RAI

[3] Note that we used a rather simple utility function. Using more complicated utlity functions might yield different results.

claims that road pricing ('Rekeningrijden') will be ineffective. The numbers in the tables 4.1 to 4.3 and 5.2 show that such claims are false; these claims can often be explained from the organizations' own interest in not raising marginal prices.

Some confusion in the public debate is caused by confounding price elasticities and price effects. The price effect is determined by the elasticity *and* the size of the price increase. If the price elasticity is small, a large decrease in consumption requires a sizeable price increase. For example, the price elasticity of household water consumption is approximately -0.07; see Chapter 4. This implies that doubling the price will decrease consumption by only 7 percent. However, our findings in Chapter 4 as well as the numbers in the tables 4.1 to 4.3 show unambiguously that price increases will work, provided that they are sufficiently large and properly implemented.

Proper implementation requires that a tax or subsidy should affect the *marginal* price and that the possibilities for evasion are absent or small. An example of a financial incentive which does not affect the marginal price is the tax increase for households that use company cars for private purposes. Although these households pay for private use, it does not affect the marginal price of using the company car for private purposes. Hence, it is completely ineffective as a means for reducing car use.[4] The condition of affecting marginal price also requires that the use is measured at the household level. There are still a lot of situations in which this is not the case. Examples are households without a water meter (see Chapter 2), or household waste collection without weighing. Given the decreasing costs of the technology required for individual measuring and the increasing costs of the environmental damage resulting from zero marginal prices, future policies should strongly discourage charging systems implying zero marginal prices.

An example of a large possibility of evasion is the implementation of weight-based pricing in the collection of household waste. As mentioned in Chapter 5, weight-based pricing for household waste collection in Oostzaan has been successful partly because there is strict enforcement and illegal dumping is fined.

In the case of subsidies, proper implementation includes three aspects. First, the amount of subsidy should be sufficiently large. The relative price differences between high-efficiency and low-efficiency versions are of primary interest. Purchase prices of high-efficiency light bulbs, for instance, are at least ten times

[4] An alternative which is effective has been proposed by De Kam and Kooreman (1996).

as high as those of ordinary light bulbs, while the expected lifetime for high-efficiency light bulbs is much larger than for ordinary light bulbs. Large purchase price differences will require relatively larger subsidies (cf. example 3 in Chapter 3).

Secondly, if many consumers are already purchasing energy-efficient versions (i.e. the penetration rate of high-efficiency versions is already high), it is not useful to implement a subsidy. Moreover, if the subsidy has been successful and the penetration rate increased to a high (predetermined) level, the subsidy supplier should reconsider the subsidy suppliance. An example is the subsidy on high-efficiency central heating systems in the Netherlands. In 1996, this subsidy, supplied by the national government, has been abolished because the predetermined government's objective was exceeded in 1995, see ECN (1998).

Thirdly, subsidies should not encourage consumers to sharply increase the usage of the particular appliance, i.e. the take back effect should be small or absent, see section 3.3.5. If the take-back effect is large, the increase of energy consumption due to the increase of appliance usage might off-set the initial reduction in energy consumption – from choosing a more energy-efficient technology. In the case of high-efficiency light bulbs, for instance, consumers may well be tempted to use the high-efficiency light bulb more often than ordinary light bulbs. Another example is indicated by the effects of multiple insulation types in Chapter 4. We found evidence that the consumer choice of multiple insulation types in a dwelling could even lead to an increase in the natural gas consumption. From an environmental perspective, the effectiveness of subsidies could then be heavily argued.

So far, we focussed on taxes and subsidies, but there are two other financial instruments that should be mentioned. First, loans could be provided to allow liquidity constrained consumers to purchase high efficiency versions of durable goods. Alternatively, one could give consumers the opportunity to rent rather than purchase the high efficiency version. Second, warranty arrangements should be provided to insure (risk averse) consumers against early failure of the durables. Both instruments are cost effective.

Furthermore, to reduce the household energy consumption effectively, it is important that the time span between consumption and the associated charge (including energy taxes) is as short as possible. This requirement is definitely not satisfied for current Dutch charging systems for energy and water. Households usually pay monthly advance payments (based on the consumption in the

previous year), which are adjusted only once a year. As a result, it may take a year before the financial incentives from increased or reduced consumptions are felt. In the case of subsidies, however, consumers will directly associate the energy-efficiency version of an appliance to the subsidy. The subsidy is not automatically supplied; consumers have to request for it explicitly. A consumer will be aware of the possible subsidy when purchasing a consumer durable. As a consequence, the subsidies are not only a financial instrument but may also contribute to increment of the environmental awareness of consumers.

When implementing financial instruments in order to reduce the household demand for energy, and household waste collection, governments – or energy suppliers – should constantly evaluate and reconsider whether or not the financial instruments are still effective. We think that financial incentives are inevitable when reducing consumption, but they are not objectives per se.

6.6 Concluding remarks

This Chapter has described some aspects of the design and motivation of policies aimed at achieving more sustainable household consumption patterns.

Our empirical findings, which in most cases are supported by results of other studies, showed that financial incentives are effective in the sense that higher energy and water prices will result in reductions of household energy and water consumption. From an environmental perspective, the real price levels of energy and water should be set and then maintained at higher levels with energy taxes for instance. Financial incentives will only be successful if they are properly implemented; see the discussion in the previous section.

One complicating factor is the current trend of market liberalization in which market forces increasingly determine the prices. At present, the supply side of the markets for energy, water and waste collection are still predominantly ruled by the (local) governments. However, large developments are at hand; due to the creation of one large European Union market, the markets for energy and water are becoming more privatized and international.[5] In the future, consumers themselves can choose their own supplying company even if it is located abroad. The consequence of this market liberalization is that the prices are increasingly determined by market forces rather than by government regulation. Insofar prices will decline due to this process, higher off-setting taxes will be required

[5] Another example of a market formerly ruled by the government and which is now open up for competition is the (mobile) telephony market.

from a sustainability perspective.

As the analyses in Noorman and Schoot Uiterkamp (1998) and elsewhere have shown, household behavior regarding sustainability at the aggregate level is subject to slowly evolving trends. At the macro level rapid changes on a national scale are rare, and if they occur, usually transitory. Yet, a balanced mix of instruments characterized by a strong emphasis on various kinds of financial incentives, combined with government initiated consumer information, proper education, and monitoring and fining systems will contribute to long-run sustainability objectives.