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A Normative Approach to Incorporate Affordability Criteria for Industrial Sectors in the Design and Implementation of Environmental Policies: A Case Study Illustration

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Abstract

While we can rely on markets to match producer supply with consumer demand for most goods and services, markets fail to yield the socially optimal outcome in the case of pollution so that government interventions are desirable. However, determining the 'right' level of environmental protection is a question that holds both a social and a political component. Policy makers are not only concerned with the net social benefit of environmental measures, but also with the consequences for those who have to bear the costs. We describe a normative approach to integrate affordability criteria in the implementation of environmental policies. We focus on the affordability of abatement measures for the industrial sector. Subsequently, we illustrate our approach and suggested cut-off points by means of some case studies. The cases show that affordability criteria can support policy makers in their assessment of candidate 'Best Available Techniques' under the European Directive on Integrated Pollution Prevention and Control as well as in the assessment of alternative programmes of measures to achieve good water status under the European Water Framework Directive. The criteria presented are a tool for objectifying the discussion between industry and policymakers about the affordability of environmental measures. xpert judgement and negotiation remain essential in defining and implementing environmental policy.

Keywords: affordability, environmental policies, normative economics, industrial sector

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1. Introduction

For most goods and services, we can rely on market forces to match producer supply with consumer demand so that an efficient equilibrium is reached. Adam Smith's invisible hand ensures that, if all markets are perfectly competitive, resources are allocated efficiently without the need for regulatory control (Smith, 1937). However, one of the conditions that most hold before a market can be considered competitive, is the existence of property rights for all goods and services in that market. In case of pollution, this condition is already violated (Kolstad, 2000). Do polluters have the right to pollute the air or do victims have the right to breath clean air? From an efficiency point of view the distribution of property rights is irrelevant if parties can bargain without transaction costs and to their mutual advantage (Coase, 1960). Unfortunately, in real-world situations polluter and victim face significant transaction costs so that the application of the Coase theorem is limited (Kolstad, 2000). In addition, production and consumption can generate externalities, such as pollution, which are not reflected in market prices. These externalities can be a source of market failure. Consequently, markets do not yield the socially optimal amount of pollution and government interventions are desirable.

In case of government intervention, policy makers have to decide on the right level of environmental protection[1]. Environmental economists in general seek to maximise total surplus (Kolstad, 2000; Żylicz, 2000). They estimate costs and benefits of each policy alternative and select the alternative that maximises the difference between benefits and costs. In literature dissenting views can be found about the kind of costs and benefits that should be taken into account in such a decision-making process. Some authors stress that external costs, imposed on other agents, should always be taken into account. Consequently, policy makers should only focus on those environmental measures for which social benefits, consisting of both private and external benefits, are larger than social costs, consisting of both private and external costs (Pearce et al., 2006). Moreover, they should not move away from this key question by looking at the impact of a certain policy on a particular firm's or sector's economic viability (Bréchet & Tulkens, 2009). Other authors stress that, when deciding on the introduction of environmental measures, one should only consider those measures with both a social benefit - cost ratio and a private benefit - cost ratio larger than one (Georgopoulou et al., 2008). Consequently, only environmental measures that entail economic advantages to

[1] Another concern is how policy makers can induce agents to use the environment in a socially optimal way. Policy makers can rely on a range of instruments such as emission standards, emission charges and transferable emission permits to correct for market failures and to compel firms and individuals to comply with environmental regulations (Cohen, 1998; Rousseau et al., 2005). Although the question about the kind of instrument to use is equally important as the one about the right level of environmental protection, the former lies not within the scope of this paper.

the polluter are selected and polluters do not have to implement measures with net private costs.

Clearly, determining the right level of environmental protection is a normative question that holds both a social and a political component. The decision to exploit or protect the environment affects a large variety of economic agents and within society there is typically no unanimity about the socially desirable level of environmental protection (Kolstad, 2000). Therefore, policy makers are not only concerned with the net social benefit of environmental measures, but also with the socio-economic consequences for those who have to bear the costs of these measures (Oates & Portney, 2003). The question arises whether these environmental measures are affordable and an appropriate methodology to assess their affordability has to be chosen.

In this paper, we describe a normative approach to integrate affordability criteria in the design and implementation of environmental policies. Our approach is based on criteria found in literature. We focus on the affordability of technical abatement measures for the industrial sector[2]. Subsequently, we illustrate by means of some case studies which cut-off points can be used to classify measures as (non) affordable. We particularly look at the implementation of two European directives that incorporate socio-economic issues, namely the Directive on Integrated Pollution Prevention and Control (IPPC Directive) (96/61/EC) and Water Framework Directive (WFD) (2000/60/EG).

The IPPC Directive is the first European directive to address socio-economic aspects explicitly in environmental legislation. The IPPC Directive aims at minimizing pollution from various industrial sources throughout the European Union. Operators of industrial installations are required to obtain an environmental permit from the authorities to operate in the EU countries. As defined in the IPPC Directive the permit conditions, including emission limit values, must be based on the Best Available Techniques (BAT). According to the IPPC Directive the concept of "'available techniques" should be interpreted as *"those techniques developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, …, as long as they are reasonably accessible to the operator".*

Socio-economic considerations are also an integral part of the European WFD. The WFD sets ambitious objectives to ensure that all waters meet good status by 2015. To ensure this good status will be reached, member states are obliged to publish river basin management plans by the end of 2009. These management plans have to include

[2] Affordability considerations for consumers - often related to water, energy and housing services - do not lie within the scope of this paper. For governments affordability is related to cost recovery.

programmes of *cost-effective* pollution reduction measures. Hence, assessing the cost as well as the impact of emission reduction measures is an essential element of a river basin management plan. If reaching the good status in a water body entails *disproportionate costs* for certain agents (e.g. industry, agriculture), exemptions can be granted (Article 4, WFD). In particular, the deadline for reaching the good status can be extended or the objectives can become less stringent.

2. Affordability criteria for an industrial sector

The evaluation of the affordability of abatement measures is discussed in models such as the reference values (Vercaemst, 2002), MIOW+ (Van der Woerd et al., 1995; Dijkmans, 2000; Derden et al., 2002), the DAFFIE model (Vanassche et al., 2008) based on the FiTo® score for prediction of failure (Ooghe & Spaenjers, 2006) and BEAsT decision-support tool (Georgopoulou et al., 2008). Although, all these approaches entail disadvantages and shortcomings they can provide policy makers with useful insights and decision support. In the following paragraphs we discuss the models and criteria at hand and propose a normative approach for their application.

The reference value approach addresses the annual costs of abatement measures relative to turnover, gross profit and added value and the total investment costs of abatement measures relative to the total average investment costs of the past 5 years. Indicative reference values can provide an upper boundary for annual costs or investments that are definitely affordable (acceptable) and a lower boundary for annual costs or investments that are definitely not affordable (unacceptable) (table 1). If measures or techniques are clearly acceptable or unacceptable, no further investigation is needed. However, there is a large interval between the lower and upper bound that needs further discussion in order to be able to draw a conclusion on the affordability of a technique or set of measures. Hence, the main shortcoming of the reference value approach is that it often does not provide conclusive judgment about the affordability of abatement measures. Nevertheless, these reference values are useful to filter out environmental measures with on the one hand yearly costs that are extremely high or on the other hand extremely low in comparison to the financial results of the firms under consideration.

Table 1. Indicative reference values

Annual costs relative to…	***Acceptable***	***To be discussed***	***Unacceptable***
Turnover	< 0,5 %	0,5 – 5 %	> 5 %
Gross profit	< 10 %	10 - 100 %	> 100 %
Added value	< 2 %	2 - 50 %	> 50 %
Investment costs relative to…			
Average total investments of the past 5 years	< 10 %	10 - 100 %	> 100 %

Source: (Vercaemst, 2002)

In the MIOW+ model, a firm's liquidity position, long term solvability and profitability position as well as its competitive position is taken into account. In a first stage this information is used to calculate a score that indicates the firm's resilience. In a second stage the impact of an environmental investment is estimated by recalculating this resilience score by taking into account the effect of the environmental investment on liquidity, solvability and profitability (Van der Woerd et al., 1995). The main disadvantage of this model is that it is designed for assessing the impact of investments made by large individual companies, and therefore the model is less suitable for evaluating the viability of environmental investments for a group of companies (e.g., sector) or small- and medium-sized enterprises. Furthermore, by using a single score for resilience the model presents the financial situation in a rather rudimentary manner which leaves little room for nuances.

The DAFFIE model (Vanassche et al., 2008) relies on the FiTo®-meter developed by (Ooghe & Spaenjers, 2006) and uses 8 key financial ratios to estimate the impact of environmental investments on the financial situation of a firm or sector. DAFFIE has the advantage that the model can be applied on different scale levels: an entire industry as well as an individual company and large as well as small- and medium-sized enterprises. In addition, it provides a more conclusive outcome for all types of environmental investments than the reference value approach. Furthermore, DAFFIE benchmarks each firm or industry against a reference group and uses this relative position, rather than absolute boundaries, to determine the affordability of environmental investments. The main weakness of this model is that it fails to take into account the competitive position of a firm or sector. When considered relevant, the competitive position has to be discussed in a qualitative manner.

We integrated the above-mentioned models in order to arrive at a comprehensive assessment of the affordability of technical abatement measures for an industrial sector. The figure below summarizes the different steps.

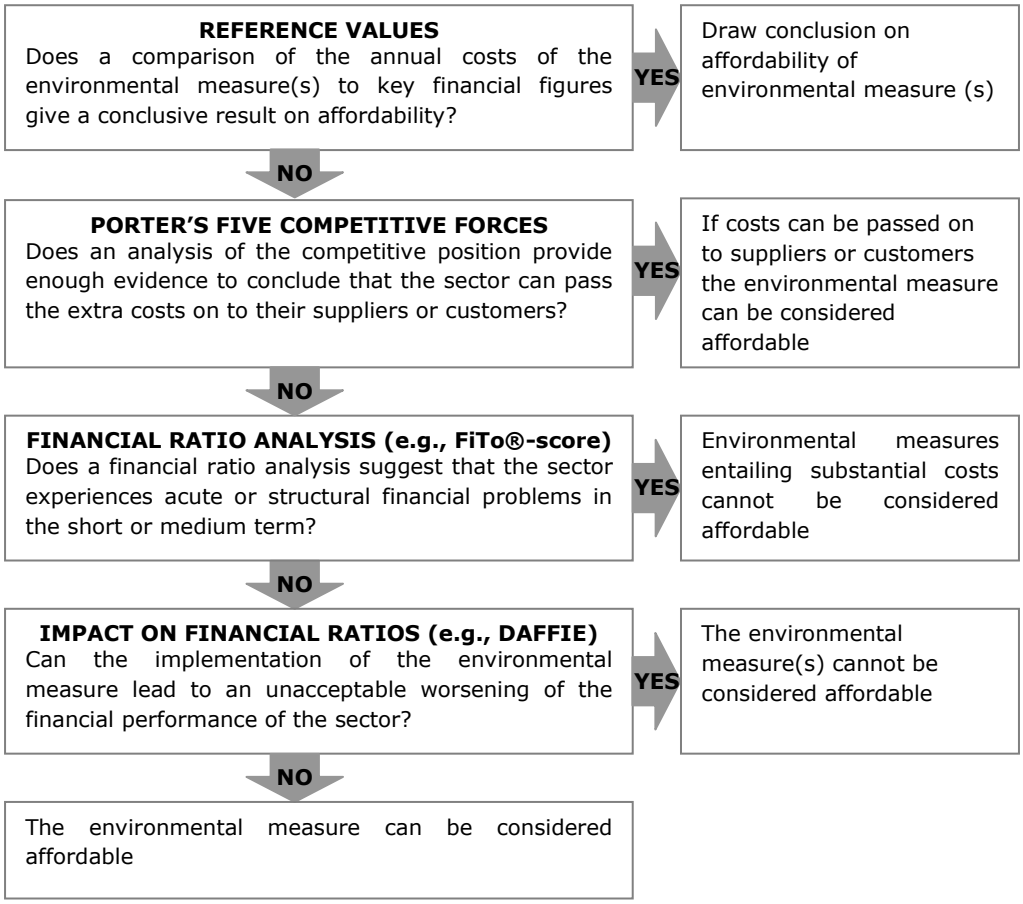

Figure 1. Consecutive steps of an affordability assessment of technical abatement measures for an industrial sector

An important first step to assess the affordability of abatement measures for an industry or sector is comparing the additional costs of the environmental measures to some key financial figures of a representative firm. Often, a (fictional) firm with average size and financial performance is considered representative. In case of a heterogeneous sector, the assessment is balanced by making a distinction between subsectors or size classes. The annual costs of abatement measures are compared to turnover, gross profit and added value of a representative firm. In addition, investment costs of abatement measures are compared to the average total investments over the past 5 years. For this financial ratio analysis, the indicative reference values in table 1 provide an upper boundary for abatement measures that are definitely affordable and a lower boundary for abatement measures that are definitely not affordable. However, between these

boundaries there is a large interval where further assessment is needed in order to be able to draw a conclusion on the affordability of a technique or set of measures.

Therefore, the second step is an extended affordability analysis that looks at the competitiveness of a sector. Porter's five forces framework is used to describe a firm's or sector's competitive position (Porter, 1980, 1985). According to Porter's view, the rules of competition are embodied in five forces that shape the structure and intensity of competition: (i) the entry of new competitors, (ii) the threat of substitutes, (iii) the bargaining power of buyers, (iv) the bargaining power of suppliers, and (v) the rivalry among the existing competitors. The strength of these five forces varies between industries, and can change as an industry evolves. An appraisal of Porter's five forces is done qualitatively, based on literature review or expert interviews. This appraisal gives an indication of an industry's ability to shift additional environmental costs to suppliers or customers.

If competition is high and a sector cannot shift its additional costs to its suppliers or costumers, a more detailed analysis of the eight financial ratios that make up the FiTo®-meter, helps to determine whether the sector would be able to absorb additional environmental costs. The FiTo®-score is the average of the logarithm of the financial ratios. A FiTo®-score above 0.5506 indicates that the sector is financially healthy in the short and medium term. A FiTo®-score below 0.5506 and above 0.5313 means the sector has structural financial problems in the medium run.[3] A FiTo®-score below 0.5313 signals acute financial problems in the short run and structural financial problems in the medium term. Substantial additional costs related to environmental measures are considered not affordable for the sectors with financial distress in the short or medium run, meaning with FiTo®-scores below 0.5506.

[3] These thresholds are valid for the financial year of 2006. The thresholds for Belgian companies are recalculated each year by Graydon N.V. on the basis of annual statements of account submitted to the National Bank of Belgium.

Table 2. Ratios of the FiTo®-meter

#	Ratio	Area
1	Gross value added/personnel costs	Value added; profitability
2	Net return on operating assets before taxes	Profitability
3	Net return on share. funds after taxes	Profitability
4	Self financing quote	Profitability; solvability
5	Financial independence ratio	Solvability
6	Short term debt ratio	Solvability
7	Coverage of external liabilities by cash flow	Profitability; solvability
8	Net treasury ratio	Liquidity

Source: (Ooghe & Spaenjers, 2006)

In the final step, we determine the impact of the technique or set of environmental measures on the financial performance of a sector with FiTo®-score above 0.5506. We rely on the DAFFIE method (Vanassche et al., 2008) to determine whether or not the sector can bear the additional costs.

For that purpose, financial data is extracted from the annual accounts of an average firm in a particular sector. These accounts refer to the four latest years available and are averaged to flatten out yearly fluctuations in the annual accounts. Next, the impact on the annual account of certain environmental investments is simulated based on the costs depicted in table 3. On the one hand we adapt the annual account for related investment, operational, maintenance and avoided costs as well as additional income and depreciation. On the other hand, we take into account the impact of an additional loan on the balance sheet and profit-and-loss account. Based on the simulated annual account, the (fictional) FiTo®-score can be calculated for a sector that has to make environmental investments. The investment is considered to be affordable as long as the projected score lies above the FiTo®-score of 0.5506.

Table 3. Cost components for DAFFIE

Cost component	***Unit***
Investment amount	
Expenditure on pollution control equipment	k€
Installation expenditure	k€
Operating and maintenance cots	
Yearly personnel costs	k€
Other yearly operating and maintenance costs	k€
Additional income and avoided costs	
Yearly income	k€
Yearly avoided costs	k€
Additional parameters	
Economic life span	years
Depreciation Installation Expenditure	yes/ no
Financed with own funds	%
Term of debt	years
Interest rate of debt	%
Other	
Corporate tax rate	%

Source: (Vanassche *et al.*, 2008)

3. Case studies: IPPC and WFD

In the following paragraphs we discuss three cases for different industrial sectors in Flanders. The first two cases illustrate how the affordability criteria supported the BAT selection process (IPPC Directive). The last case illustrates how the affordability criteria were used for justifying time exemptions in river basin management plans (WFD). It is important to note that for each of these case studies stakeholders were consulted in order to guarantee the appropriateness and workability of the approach. In case of the Flemish BAT studies a steering committee, composed of representatives from industry and competent authorities, gathered three to five times during the course of the study. This steering committee was on the one hand responsible for supplying data and information. On the other hand results of the BAT evaluation, including the assessment of the affordability of candidate BAT, were discussed with the steering committee in order to reach a consensus on the conclusions. In the case of the WFD, the draft river basin management plans, including the assessment of the affordability of the programme of measures, were subject to public consultation. The final river management plans were approved by the Flemish Government.

a. BAT evaluation for the beverages industry

Within the framework of selecting the BATs for the Flemish beverages industry (Derden *et al.*, 2008) the affordability of phosphorus removal from the wastewater of malting plants, large breweries and large producers of mineral waters and soft drinks was assessed. This assessment included a description of the sector and its international competitive position as well as a financial ratio analysis and a comparison of the costs of phosphorus removal with the reference values.

The description of the sector illustrated the evolution of turnover, value added and profits in the beverage industry and its sub-sectors between 1999 and 2006. With the exception of a status quo in the large breweries, this evolution was marked by growth. The Flemish beverages industry consisted of a large number of small and medium sized enterprises and a small number of large international firms. The affordability check concentrated on the latter firms as phosphorus removal was only relevant for these larger production plants .

The affordability check was based on the reference values model (Vercaemst, 2002). Table 4 depicts annual costs relative to turnover, gross profit and added value in 2005 and the share of total investment costs of phosphorus removal in the total average

investment costs over the period 2000-2005. The results indicated that the costs of phosphorus removal are clearly affordable for the three sub-sectors under consideration.

Table 4. Comparison of the annual costs of phosphorus removal with turnover, value added and gross profits in 2005 and of the investment costs of phosphorus removal relative to total average investments over the period 2000-2005

	Breweries		*Malting plants*		*Mineral waters and soft drinks*	
	%	**Affordable?**	**%**	**Affordable?**	**%**	**Affordable?**
Turnover	0,16	yes (<0,5%)	0,13	yes (<0,5%)	0,07	yes (<0,5%)
Value added	0,41	yes (<2%)	1,39	yes (<2%)	0,42	yes (<2%)
Gross profits	2,92	yes (<10%)	4,91	yes (<10%)	2,50	yes (<10%)
Investments	1,22	yes (<10%)	0,10	yes (<10%)	2,02	yes (<10%)

Source: (Derden *et al.*, 2008)

Although the application of the reference values leads to a conclusive result, we chose, in consultation with industry and policy makers, to take the analysis a few steps further. Therefore we included an analysis of the competitive position of the firms and financial ratios in order to present a more comprehensive overview of the sector and their ability to invest in environmental measures.

The appraisal of the competitive position of the industry showed that although the larger companies took up a prominent place in the world market, they had little or no ability to transfer additional environmental costs to suppliers or customers. The latter was explained by the price-setting of their raw materials (mainly cereals for malting plants and breweries) on the international markets. Since their product was mainly sold to large supermarket chains within the retail business, the producers of beverages were left with little bargaining power to transfer environmental costs to the customers.

The financial ratio analysis was performed on the basis of the FiTo®-meter (Ooghe & Spaenjers, 2006). Table 4 shows for each sub-sector the median of the ratios on which the FiTo®-scores are based. The ratios were calculated for 2005 since these were the most recent data available. The figures between brackets depict the number of companies in the respective sub-sector. The "Position"- column shows the relative position in percentiles (0: minimum value – 100: maximum value) of the median of each ratio with respect to the entire Flemish industry. The higher the position, the better the sector performs compared to the entire Flemish industry.

Table 5. FiTo®-scores of the large breweries, malting plants and producers of mineral waters and soft drinks

Ratio #	*Breweries (22)*		*Malting plants (9)*		*Mineral waters and soft drinks (29)*	
	Median	**Position**	**Median**	**Position**	**Median**	**Position**
1.Gross value added/personnel costs	224,0	78	158,0	59	142,0	38
2. Net return on operating assets before taxes	237,5	100	228,0	99	56,0	96
3. Net return on share. funds after taxes	6,0	49	10,0	49	7,0	46
4. Self financing quote	28,0	68	62,0	90	14,0	47
5. Financial independence ratio	48,5	74	67,0	84	30,0	46
6. Short term debt ratio	0,0	100	0,0	100	0,0	100
7. Coverage of external liabilities by cash flow	24,0	64	31,0	74	11,0	39
8. Net treasury ratio	10,5	68	45,0	82	27,0	66
FiTo®-score	**0,6280**	**91**	**0,6379**	**93**	**0,5709**	**55**

Source: (Derden *et al.*, 2008)

The table shows that the large breweries and malting plants have a good financial health with respect to the entire Flemish industry. The median FiTo®-score for the large breweries and malting plants was situated respectively in the 91st and 93rd percentile of the Flemish industry. Although the producers of mineral waters and soft drinks had a somewhat lower score, their situation was not considered problematic as none of the ratios was exceptionally low. In addition, the FiTo®-score was still above the threshold value for financial health. In general, the ratio analysis showed that the sub-sectors were able to absorb the additional costs of phosphorous removal.

In summary, the analysis indicated that although the firms under consideration had very limited possibilities for transferring additional costs of phosphorous removal to the suppliers or customers, they were able to absorb these costs themselves. In addition, the costs were considered to be affordable as they were small enough in comparison with the average turnover, value added, gross profits and other investments.

b. BAT evaluation for the ceramic manufacturing industry

The Flemish ceramic manufacturing industry produces bricks, roof tiles, vitrified clay pipes and expanded clay aggregates. The sector is one of the most SO_X-polluting sectors in Belgium. The concentration of SO_X in the flue gas emissions is largely dependent on the amount of sulphur present in the raw clay which is usually exploited locally. Based on the SO_X emissions, the firms within the sector could be classified in three groups:

- Group 1 with SO_X emissions in mg per Nm3 < 500;
- Group 2 with SO_X emissions in mg per Nm3 between 500 and 1800;
- Group 3 with SO_X emissions in mg per Nm3 between 1800 and 3300.

Huybrechts et al (1999) compared the (ex ante) costs of five flue gas cleaning options to reduce not only the emissions of SO_X, but also those of HF, HCl and dust. Based on this comparison the most cost-effective reduction techniques were selected and the impact of the implementation of these techniques on the viability of the sector was evaluated. The five end-of-pipe options under consideration were:

- Cascade counter flow adsorption unit with CaCO3 as the adsorbent;
- Cascade counter flow adsorption unit with Wülfragran (modified $CaCO_3$) as the adsorbent;
- Wet flue gas cleaning with water followed by water treatment with $Ca(OH)_2$;
- Wet flue gas cleaning with $CaCO_3$ as the adsorbent;
- Dry flue gas cleaning with filter and $Ca(OH)_2$ as the adsorbent.

The costs of these five techniques increased with the SO_2-concentration in the untreated flue gas, mainly due to an increase in the cost of adsorbent and waste disposal. Furthermore, there were considerable differences in costs and reduction percentages between the five flue gas cleaning techniques. In case of a 10 year depreciation period and an interest rate of 5%, the first technique, being the cascade counter flow adsorption with $CaCO_3$, was the least expensive and most cost-efficient technique for kilns with a concentration of SO_2-emissions lower than 1000 mg per Nm^3. The wet flue gas cleaning with $CaCO_3$ was the most expensive and the most cost-effective solution for kilns with a high concentration of SO_2 emissions (> 1000 mg per Nm^3).

The impact of the implementation of the techniques on the viability of the sector was evaluated with the $MIOW^+$-model (Van der Woerd et al., 1995; Huybrechts et al., 1999). According to the MIOW+ model, an abatement measure is affordable if the annual cost

on the one hand and the investment cost on the other hand is less than 5% of the total annual turnover. The analysis showed that the firms in group 1 had a good financial health and were able to bear additional investments, while the firms in group 2 and 3, the more polluting firms, had low resilience for absorbing extra costs (table 6).

Table 6. Investment and annual costs of flue gas cleaning techniques for an average company in group 1, 2 and 3 as a percentage of the annual turnover (for 1998).

	Group 1	**Group 2**	**Group 3**
1. Cascade $CaCO_3$			
Investment	4 %	5 %	8 %
Annual cost	2 %	3 %	7 %
2. Cascade Wülfragran			
Investment	12 %	14 %	23 %
Annual cost	3 %	6 %	17 %
3. Wet $Ca(OH)_2$			
Investment	10 %	11 %	19 %
Annual cost	5 %	7 %	13 %
4. Wet $CaCO_3$			
Investment	11 %	13 %	22 %
Annual cost	5 %	8 %	21 %
5. Dry $Ca(OH)_2$			
Investment	16 %	18 %	31 %
Annual cost	5 %	7 %	16 %

Source: (Huybrechts et al., 1999)

Particularly companies in group 3 would face major difficulties if they were required to invest even in the least costly flue gas cleaning technique (cascade $CaCO_3$) Investments in the more expensive technologies would jeopardize the viability of the companies in group 2 and 3, while the companies in group 1 were considered to have sufficient economic strength to invest. For all three groups the cascade counter flow adsorption unit with $CaCO_3$ as the adsorbent was selected as BAT. Based on (Huybrechts et al., 1999), the existing permit legislation for the ceramics manufacturing industry in Flanders was amended in March 2003.

In the framework of the preparationof the BAT Reference document (BREF)[4] Ceramics and the review of the Flemish BAT-report (Huybrechts et al., 2008), more detailed (ex post) cost data were gathered in collaboration with the industry federation in 2007, thus 4 years after the emission limit was set.. A number of surveys at individual plants revealed that since 2003, in order to comply with the emission limit values for SO_X (and HF), firms implemented flue gas cleaning techniques and process integrated measures (e.g., addition of low-sulphur and/or Ca-rich additives to sulphur-rich raw materials). (Huybrechts et al., 2008) confirm that most firms installed the cascade counter flow adsorption unit with $CaCO_3$ as the adsorbent. Only two plants installed a dry flue gas cleaning technique with filter. Wet or semi- wet flue gas cleaning techniques were not installed. Although the review did not permit a comparison of the (ex post) cost data with the financial status of the firms concerned, it was believed that the regulations which emerged as a result of the BAT evaluation were one of the key factors in the subsequent restructuring of the ceramic manufacturing industry in Flanders (Vercaemst et al., 2009).

c. Affordability programme of measures for the industrial sector under the Water Framework Directive

Within the framework of the first generation of river basin management plans the affordability of abatement measures was assessed for the industrial sector (Meynaerts et al., 2009). The abatement measures under consideration were mainly related to sustainable water use and improvement of surface and groundwater quality. On the one hand a package of measures was defined that contributes to reaching good status by 2015 (maximum scenario) as imposed by the WFD. On the other hand, a package of measures was defined that was cost-effective and affordable but not sufficient to reach good status by 2015 (scenario time derogation). Derogation in time - that is achieving good status by 2021 or 2027 – is allowed by the WFD if reaching good status by 2015 is technically infeasible and/or gives rise to disproportionate costs. In Flanders the assessment of disproportionate costs involved the assessment of the costs and benefits as well as the affordability of the proposed package of abatement measures.

In 2005 – 2007 the gross value added of total industry in Flanders (NACE 14 – 36) was on average 33.280 million euro. Total annual costs of the scenario time derogation were estimated to amount 198 – 340 million euro per year, whereas total costs of the maximum scenario were estimated to amount to 239 - 398 million euro per year. Although the share of these costs in the gross value added was less than 2% (and hence

[4] Each BAT reference document generally gives information on a specific industrial/agricultural sector in the EU, techniques and processes used in this sector, current emission and consumption levels, techniques to consider in the determination of BAT, the best available techniques (BAT) and some emerging techniques.

these costs are considered as affordable according to the indicative reference values in table 1), a more detailed analysis was suggested for two reasons. Firstly, the gross added value was not only based on the activities of firms that would have to bear the costs of the proposed package of abatement measures. Secondly, the costs of some of the abatement measures were marked as highly uncertain so that a more detailed analysis seemed appropriate.

A more detailed assessment was done for the textiles industry (NACE 17 and 18) based solely on financial information of the firms that had to bear the costs of the proposed package of measures. Only for two abatement measures the costs could be assigned to specific firms. For these firms financial information was collected about turnover, gross value added, profit and investments. Table 7 compares total annual costs (1,1 million euro) or investments (4,3 million euro) of the two abatement measures with the financial parameters. The resulting ratios are assessed on sector level as well as on firm level, using the reference values of table 1.

Table 7. Ratio analysis textiles industry

	Ratio	Affordable at sector level?	Affordable at firm level (% of firms)		
			Yes	*To be discussed*	*No*
Annual cost relative to					
Turnover	0,09%	Yes (<0,5%)	65%	24%	12%
Gross profit	2,53%	Yes (<10%)	33%	13%	54%
Gross Value Added	0,33%	Yes (<2%)	71%	17%	13%
Investment costs relative to					
Total investments	4,17%	Yes (<10%)	50%	22%	28%

Source: (Meynaerts et al., 2009)

For the entire textiles industry, the abatement measures seemed to be affordable on average. However, for a considerable number of firms this was not the case. Depending on the ratio thatwas taken into account, only one third to two third of the firms could indeed afford to bear the costs of the easures. The ratio of annual cost relative to gross profit illustrated for example that for more than halfof the firms, the abatement measures were not affordable.

5. Concluding remarks

The case studies presented in this paper show that affordability criteria can support policy makers in their assessment of candidate BAT under the IPPC Directive as well as in the assessment of alternative programmes of measures to achieve good water status under the WFD. However, in applying the stepwise approach we identified a number of issues that are subject to further discussion or research.

Firstly, it should be noted that the normative approach presented in this paper concentrates on the *affordability* of technical abatement measures for an *average firm* of an *industrial sector in Flanders*. We found that in many cases it is not obvious how to define the average firm that is subject to the affordability analysis. Therefore, one can rely expert judgement or consultation with the sector under consideration. Furthermore, the results of the affordability assessment for an average firm in a sector should not be generalized as large variations in economic performance may exist between firms within a sector. The latter was illustrated for the textiles industry in Flanders in table 7.

Secondly, since different accounting rules are used for the primary and *secondary sector*, affordability criteria for the agricultural sector should be addressed separately. The difference in accounting rules holds specifically for the European agricultural sector which is largely dominated by family farms. The household is at the same time producer, consumer and worker so that production and consumption decisions are interdependent if market imperfections exist (Sadoulet & Janvry, 1995). Based on some preliminary research to identify affordability criteria for the agricultural sector (Lemmens et al., 2007; Meynaerts et al., 2009), total labour income was put forward as the criterion to evaluate a farmer's capacity to bear additional environmental costs. Total labour income was defined as net farm profits augmented with the compensation for paid (hired) and unpaid (typically family) labour and was expressed per total annual work unit (or AWU). Total labour income per AWU was contrasted with the average gross wage of a full time employed worker in another sector, the so called comparable income. If labour income was smaller than the comparable income, it was assumed that each additional (environmental) cost increased the incentive to search employment outside the sector. If labour income was larger than comparable income, the difference between both incomes was assumed to give an indication of the capacity of the sector to bear additional costs. This rather pragmatic approach has to be extended with criteria to assess the impact of abatement measures on the profitability and competitive position of the agricultural sector.

Thirdly, wide-ranging empirical work on the political economy of environmental regulation supports the view that next to socio-economic criteria, policymakers also take into account political criteria when deciding on governmental interventions. (Oates & Portney, 2003), for example, explore the various political, or collective choice, aspects of environmental policymaking. However, in-depth research needs to be undertaken to obtain a clearer understanding of the relationship between the political process and the use of affordability criteria in the design and implementation of environmental policy.

Finally, the applicability of the normative approach described in this paper is limited in time and space and depends strongly on the availability of cost and financial data. Furthermore, the thresholds have to be recalculated each year and are based on the annual statements of account submitted to the National Bank of Belgium. The financial position of the average firm is determined relative to the industry in Flanders. An EU wide analysis or application in non-EU countries will either require new thresholds for financial health to be set or the replacement of the thresholds by expert judgement.

Despite the above mentioned limitations, the framework and affordability criteria presented in this paper were an important tool for objectifying the discussion between industry and policymakers about the affordability of environmental measures. By combining the various affordability criteria policy makers and industry representatives obtained a clearer understanding of the financial situation of sectors and the possible economic impact of environmental policy. The stepwise approach offered a consistent framework to avoid arbitrary decision making. However, expert judgement and negotiation remained essential in defining and implementing environmental policy. This aspect was confirmed by (Aurora & Donnan, 2006), who also concluded that affordability assessments on itself seldom yield conclusive results but are valuable in complementing other economic tools such as cost-benefit analysis to make informed choices.

The past decades we observed an increasing attention for economic analysis and affordability assessment in environmental legislation such as the IPPC and WFD. Furthermore, to justify the authorisation or restriction of particular uses of chemicals the European REACH regulation (EC 1907/2006) on chemicals allows for a socio-economic analysis of alternatives. This analysis could include an affordability check of the use of alternative substances or adjustments of the production process. We expect that socio-economic aspects will become of importance in future environmental legislation as well, which leaves room for affordability assessment. This calls for addressing the above mentioned limitations and a wider application of affordability criteria in different environmental domains and for different target groups.

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