

TRANSACTION COSTS OF FIRMS IN THE EU ETS

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Abstract

This paper is a first attempt to measure transaction costs incurred by firms in the European Union's CO₂ Emissions Trading Scheme (EU ETS) during its trial phase (2005-2007). This analysis provides some evidence that such costs were mainly of an administrative nature. We emphasize the existence of remarkable economies of scale, as the costs per tonne of CO₂ were lower for participants with larger allocations. Trading costs were not significant and, hence, not trade prohibitive. Thus, other factors – self-sufficiency in compliance and low allowance prices – played a major role in the decision whether to trade or not during this trading period.

Keywords Climate policy, European Union Emissions Trading Scheme, Transaction costs

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“...we have to take into account the costs involved in operating the various social arrangements (whether it be the working of a market or of a government department), as well as the costs involved in moving to a new system. In devising and choosing between social arrangements we should have regard for the total effect. This, above all, is the change in approach which I am advocating.”

Coase (1960, p. 44)

1. Introduction

The European Union’s Emission Trading Scheme (EU ETS), like any other pollutant-trading system, is expected to produce efficiency gains in reaching the CO₂ emissions target. Firms with the lowest abatement costs should abate most, and sell their surplus of allowances to firms with higher abatement costs. As abatement occurs where costs are lowest, abatement targets should be met at least cost. Montgomery (1972) argues that this efficient equilibrium is independent of the initial allocation, suggesting that regulators can distribute permits as they wish². These key features – cost-effectiveness and irrelevance of initial allocation – of trading schemes are the main arguments why trading schemes are favoured over other alternative environmental instruments to mitigate climate change.

Stavins (1995) uses a simple theoretical framework to show that the potential costs savings from trading systems might be compromised by the presence of trading transaction costs. The nature of transaction costs can determine whether the initial allocation matters for the achievement of the efficient equilibrium. Along similar lines, Tietenberg (2006) argues, that a complete *ex-post* evaluation of the degree of cost-effectiveness of any trading programme needs to address total compliance costs – abatement costs, as well as trading and administrative costs. This comprehensive evaluation approach can be especially useful in the early stages of the trading programmes, as it can provide insights for the development of the existing scheme, or for the design of other new schemes.

These theoretical findings on transaction costs are supported by empirical analyses of the pioneering US trading systems. Kerr and Maré (1998) find that the presence of transaction costs in the lead permits programme caused efficiency losses of 10-20 percent. Gangadharan (2000) shows that the effect of transaction costs on the choice to participate in the Regional Clean Air Incentives Market (RECLAIM) was significant: without such costs the probability of trading would have increased by 12-32 percent.

Based on this evidence, and considering the fact that the scale and complexity of the EU ETS are unprecedented, it is clear that to understanding the transaction costs incurred over its trial phase (2005-2007) is of paramount importance.

This study addresses the transaction costs incurred by firms, but it must be remembered that governments also incur transaction costs. The European Commission (EC) faced transaction costs associated with the creation and maintenance of an EU ETS team in Brussels. Similarly, each member state had to establish complex organisations to facilitate the EU ETS implementation.

As refers to firms, their transaction costs are associated with setting up a monitoring system, reporting emissions, hiring a certified verifier every year and trading allowances if necessary. Some of these costs are incurred only once, in the initial stage of the policy implementation; however, the costs associated with monitoring, reporting and verification (MRV) are continuing costs. The costs related to trading are variable and depend on the number of transactions conducted and/or their volume.

² There is an extensive summarized by Convery (2009) and epitomized by Crampton and Kerr (2002) that an auction is preferred to grandfathering because it reduces tax distortions, provides more flexibility in distribution of costs, provides greater incentives for innovation, and reduces politically contentious arguments over the allocation of rents.

Most of the theoretical and empirical literature addressed to this topic focuses on the trading transaction costs and their implications for market efficiency. The *ex post* empirical analyses focus on the experience with trading schemes in the US. There are no empirical estimates available of the three categories of cost incurred by firms in setting up, implementing (MRV) and trading in the EU ETS. Our study was designed to fill this gap. The objective of this study is to define the sources and nature of transaction costs, and estimate their magnitude. We are also interested to know how these costs were distributed across the preparation, implementation and compliance cycle, and to distinguish between total, fixed and marginal costs.

For this purpose we surveyed all the Irish companies participating in the scheme in the trial period (2005-2007). While Ireland may not be representative of all EU member states in some respects – the share of Ireland’s CO₂ emissions in the EU ETS is low (around 30%) due to the dominance of emissions from agriculture and transport, Ireland has had a rapid growing service economy, and the industrial output is concentrated primarily in non-energy intensive sectors – it is representative in others. First of all, every sector covered by the EU ETS is present in Ireland, with the exception of metal processing; secondly, Irish firms and installations are very heterogeneous in terms of size, and many firms have multiple installations, thus allowing a meaningful overview of how transaction costs differed across installation of different size. Finally, the relative small number of installations involved in the scheme allows for much more detailed investigation than would be the case for a larger country.

The remainder of this article is structured as follows: in Section 2, we review the theoretical and empirical literature on transaction costs. In Section 3 we present a taxonomy of transaction costs in the EU ETS. In section 4 we present our methodology. The survey’s findings are presented and discussed in Section 5. Section 6 contains a summary of our findings, our conclusions, and policy implications for the future development of the EU ETS.

2. Environmental policy and transaction costs: theory and application

OECD (1993) defines transaction costs as “the costs involved in market exchange. These include the costs of discovering market prices and the costs of writing and enforcing contracts.” Another OECD (2001) definition describes transaction costs as “the costs of gathering information, making decisions/contracting, and controlling/policing”. The former characterization encompasses market related transaction costs; while the latter covers both policy and non-policy related transaction costs, a convention which we adopt in what follows.

Few studies attempt to conceptualise the transaction costs created by environmental policies. McCann et al. (2005) provide a comprehensive taxonomy of transaction costs and of the different methodologies for measuring them. In their framework, transaction costs are more agent and time specific rather than transaction specific, and they promote ‘absolute’ transaction costs’ evaluation. In contrast to their arguments, Rao (2003) suggests that it is enough to consider only those components of transaction costs which are not common to alternative policies. We adhere to the latter approach.

Krutilla (1999) argues that in the environmental economics literature, the area of transaction costs is relatively unexplored. Transaction costs are not taken into account in most studies on the governance of the global commons (Ostrom, 1990).

As mentioned above, Stavins (1995) studies the potential impacts of trading transaction costs on pollution trading. Within his theoretical framework, he shows that, in the presence of these costs, the efficient equilibrium of the trading systems might be undermined (decrease in the volume of permits

traded), and, that the market equilibrium depends on the initial allocation³. Nevertheless, discussing the implication for public policy, Stavins points out that even with transaction costs, a trading system is likely to be less costly than mandating a technological standard.

Crals and Vereek (2005), compare the transaction costs of tradable permit systems with those associated with environmental taxes. Their analysis confounds the 'conventional wisdom' that environmental taxation is necessarily less complicated and entails lower transaction costs (especially set-up and negotiation costs) than a cap-and-trade system. Polinsky and Shavell (1981) theoretically show that pollution taxes, like tradable permits, may result in different kinds of administrative costs, and, hence may affect the optimal tax level.

Betz (2005) addresses the differences between pollution trading and project based mechanisms (Joint Implementation (JI) and Clean Development Mechanisms (CDM) allowed by the Kyoto Protocol) in terms of their transaction costs. She notes that in baseline and credit scheme⁴ transaction costs only occur if credits are generated, while in tradable permits programmes some of the firm's costs (e.g. set-up costs and MRV costs) exist even without engaging in any trade. She concludes that baseline and credit schemes might lead to higher one-off administrative costs in setting up the project, but will have less ongoing costs when rules and standardized procedures become established. Woerdman (2001) similarly concludes that transaction costs for JI and CDM project will not necessarily be higher than those for pollution trading. This conclusion is based on the argument that transaction costs for CDM, JI and IET depend considerably on the market's design, and the political elaboration of the relevant documentation.

The *ex-ante* literature on tradable schemes usually neglects or incompletely anticipates the presence of transaction costs (Ellerman et al., 2005, Tietenberg, 2006). One of the early simulation studies (Capros and Mantzos, 2000) on cost savings of the EU-wide emission trading assumes positive administrative costs, while the allowance market is considered as perfect without any transaction costs. Later simulation studies (Klepper and Peterson, 2005, Peterson, 2006, Alexeeva-Talebi and Anger, 2007) only take into account the transaction costs associated with the project based mechanism (CDM and JI), suggesting that the transaction costs for the EU ETS are negligible.

Were transaction costs present in previous trading systems? We look at some empirical evidence of transaction costs in the earlier permit trading programmes.

The Fox River scheme in Wisconsin, under which rights to discharge water pollutants into the Fox River could be traded, is a well cited example of pollution trading failure due to the high transaction costs. Only one trade took place at the initial stages of this scheme. Hahn and Hester (1989) explain that the main reasons of this no-trade situation were the prohibition on trading within a firm, trading barriers from the regulator's side, the limited life of the rights, and the high administrative requirements.

The lead permit trading programme aimed at reducing the amount of lead added to gasoline and experienced high trading levels. The minimal administrative requirements from the regulatory side, the well-established markets, the possibility to conduct intra and inter firm trades, the homogeneity of participants, the previous trading experience of most participants, and the ease in finding trading partners were the major factors explaining its success (Hahn and Hester, 1989, Gangadharan, 2000). Despite the success of this programme, Kerr and Maré (1998) in their empirical investigation find that transaction costs in this programme were significant for first-trade transactions⁵ which account for

³ Cason and Gangadharan (2003) confirm this theoretical finding in an experimental setting.

⁴ In baseline and credit scheme only emissions reductions compared to baseline or target are tradable.

⁵ These costs are defined as the costs of making one trade rather than not trading.

around 10-20 percent of loss in cost effectiveness. These losses were highest for refineries in firms with few refineries and for refineries in small firms.

In stark contrast to the lead trading programme, the RECLAIM, initiated to reduce smog creating pollutant in Los Angeles, encompassed firms with different industrial structure participating in different input and output markets. Gangadharan (2000) empirically measures whether the presence of transaction costs affected trading probabilities within RECLAIM. Her study concludes that, without transaction costs, the probability of trading would increase by 32 percent in 1995 and by 12 percent in 1996 suggesting that these costs are more significant in the early stages of the programme, and then decrease as the market matures and participants learn how to trade (Cason and Gangadharan, 2003).

The US market for trading SO₂ emissions is considered the most successful large scale trading scheme. Transaction costs were mentioned as one of the preconditions that could explain the low trading activity and the low allowance price (relative to what *ex ante* work had expected) in the initial phase of this programme (Burtraw, 1996). However, Conrad and Kohn (1996, p. 1051) conclude that “transaction costs and regulatory uncertainty have not significantly affected the price of allowances”. The brokerage fees – a proxy for trading transaction costs – were estimated to be less than 2 percent of the prevailing spot price (Joskow et al., 1998). The low transaction costs of allowance trading are explained by the anonymity of market participants, the existence of active brokers, and no restrictions from the government on when and how to trade the assigned rights (Ellerman et al., 2005, Joskow et al., 1998, Solomon, 1999). Firms’ homogeneity (only electricity generating units), and the number of participants might be other ingredients explaining the programme’s success.

The UK ETS was the world's first economy-wide greenhouse gas emissions trading scheme. The scheme’s participants noted that monitoring, reporting and verification (MRV) procedures were the most time consuming requirements of the scheme, while brokers had a minimum floor for the volume of a trade, some charging a minimum arrangement fee which could make the transaction costs associated with small trades prohibitive (ENVIROS, 2006).

3. Taxonomy of transaction costs in the EU ETS

We define transaction costs for firms under the EU ETS as the sum of *administrative costs* and *trading costs*. More explicitly, by ‘transactions costs’ we mean those costs the firms incurred in preparing for, and setting up systems to comply with the regulations required by their participation in the EU ETS, and by engaging with the market. The experience of previous emissions trading schemes shows that impediments from regulatory side help to explain frictions in pollution trading markets. Betz (2005) points out that that while trading (market) transaction costs are shifted from seller to other agents like brokers in the economy, administrative costs are a loss to society, since they are real resource losses that do not affect traded volumes.

For our purposes, transaction costs can be grouped into three categories: (1) *early implementation costs*, i.e. costs that were incurred before 1 January 2005; (2) *monitoring, reporting, and verification (MRV) costs*, i.e. costs that were experienced annually; and (3) *trading costs*. The first two categories are relevant for all firms in the scheme, whereas the third category is only incurred by firms that participated in the market. *Early implementation costs* are almost all *fixed costs*, *MRV costs* are *periodic costs*, so the *variable costs* would be *trading costs*⁶.

Early implementation costs are costs incurred by firms before the official start of the scheme. During this time, the familiarisation with the rules and guidelines of the scheme had to be achieved, baseline emissions had to be calculated, an operator holding accounts for each installation had to be established,

⁶ Alternative to this classification, Betz (2005) divides transaction costs as one-time costs (early implementation) and ongoing costs (MRV costs and trading costs).

and any necessary capital equipment had to be purchased. These costs can be considered as *one-time fixed set-up costs* and divided into three categories: (i) *internal costs* incurred by the firms in terms of additional management and staff time and training; (ii) *consultancy costs* incurred in terms of consultancy services taken on; and (iii) *capital costs*, meaning the additional monitoring, recording, and data storage equipment needed to comply.

Costs related to *MRV* activities were incurred annually since *MRV* procedures are mandatory on an annual basis for all installations in the EU ETS. At the end of the year each company had to prepare an annual emissions report which must then be verified. The EU ETS requires all annual emissions reports and monitoring to be verified by an independent accredited verifier. We assume that *MRV* costs are a combination of *internal company costs*, mainly management and staff time, and *consultancy costs*, where a firm buys in the necessary capacity to be *MRV* compliant (e.g. charges for external consultancy services and for accredited verifiers).

Trading costs were incurred only by those firms that chose to trade on the market. These costs depended on: the number of transactions conducted; the volume of allowances traded; and any search or other fee costs incurred (the costs of the allowances themselves are not included). Any installation could trade with any other installations within the same business group (*internal trade*), or with other installations outside the business group and financial institutions (*external trade*). Likewise, companies could trade either directly or indirectly, i.e. via a third-party.

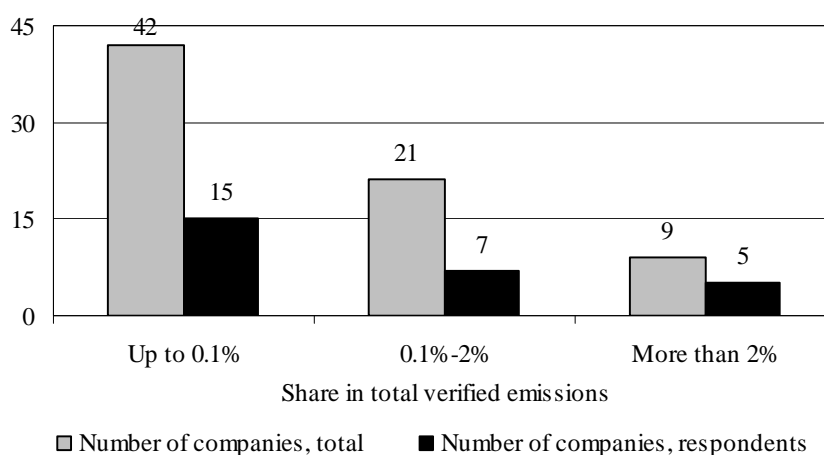
4. Research Methods

Our survey of Irish firms consisted of two stages: (1) a mail survey and (2) face-to-face interviews. In Stage 1, a questionnaire was sent to all 72 firms (106 installations) that were covered in the first phase of the EU ETS⁷. According to the Ireland's national allocation plan (NAP) 2005-2007 (EPA, 2005), Ireland's Environmental Protection Agency (EPA) allocated these installations with 66.96 million tonnes of allowances (see Annex 2). These allowances were distributed to the following sectors: brick and ceramics (0.2%), cement and lime (18.1%), glass (0.1%), paper (0.1%), refining (1.9%) and energy activities (power generation (66.3%) and other combustion (13.4%)). Over 92 percent of allowances were allocated to the 21 larger installations. Consequently, the share of allocations received by the remaining installations is very small.

Twenty seven firms⁸ completed and returned the questionnaire over an eight week period (7 July, 2008–1 September 2008), with an understanding that the responses of individual firms would not be identifiable in the research results (see Annex 3 for a summary of firms contacted). These twenty seven respondents represented around 40 percent of all Irish firms in the EU ETS, and 70 percent of the total Irish allowance allocation, during 2005-2007. According to the level of the respondents' verified emissions, they were grouped into three categories: large (with an allocation share larger than 2% of the Irish total allocation), medium (0.1% - 2%) and small (up to 0.1%) (see Figure 1). In Stage 2, representative responses were identified, by sector and scale, and face-to-face interviews were conducted (see Annex 4 for the interview profiles).

⁷ A questionnaire was sent to all companies that had a greenhouse gas permit before 31/03/2004, i.e. new planned developments were included as their timing of the compliance was the same as for existing installations. For each company, the form was sent to an account holder of the permit. All contact details are provided in the database of the CITL. Four out of the 72 companies contacted had closed down and do not participate in the second phase of the EU ETS. However, since they had to fully comply with the EU ETS procedures during 2005-2007, we contacted them as well.

⁸ Two firms-respondents, each with multiple installations, provided incomplete answers. One firm reported answers only for one of the installations, while the other provided responses for 2 out of 3 installations.



Sources: CITL, EPA and author's calculations.

Figure 1 Distribution of verified emissions across companies in the EU ETS, 2005-2007

Before presenting the results, it is important to understand to what degree these results based on the Irish case study can be generalised and used for providing some insights for further policy implementation in the context of transaction costs. Heterogeneous participants and institutions, differences in scale, and variation in monitoring, reporting and verification requirements across member states are the main reasons suggesting that the findings below may not hold for each member state. One could expect some divergence between the participants in the new member states and those in the EU15. However, Trotignon and Ellerman (2008) find little difference between these participants in their analysis of the monetisation of allowance surpluses in the EU ETS during 2005-2007. As the compliance framework for the EU ETS procedures was the same for all participants and each member state had a similar composition of participants in terms of allocation size⁹, we are confident that the sources of the transaction costs and their distribution, if not their magnitudes, would be comparable across member states.

5. Findings

5.1 Early implementation costs

Twenty five of the respondents (92.6%) experienced some internal costs consisting of time and staff commitment. Twelve firms (44.4%) incurred consulting costs and seven (25.9%) incurred capital equipment costs. Only five firms responded that they experienced all three kinds of costs, while only two firms answered that they incurred none of these costs in implementing the EU ETS rules.

Internal costs

To measure the opportunity costs of time, the firms were asked to report the number of staff members involved and their time spent for the early implementation activities. The firms had two choices: (1) to partially or fully reallocate the existing staff from their regular duties (implicit costs); or/and (2) to hire

⁹ See e.g. EEA (2008) for a classification of installations by their magnitude of emissions across member states. It has been intensively debated whether the EU ETS covers too many small installations with rather low emissions where the administrative costs substantially exceed the advantages of trading (CEC 2008).

additional staff (explicit costs). In most of the firms (23 respondents) only internal staff was involved in the early implementation process (in most of the cases only one person), and only in two companies both existing and newly hired staff were working on the launch of the EU ETS. In the firms with multiple installations, more than one staff member were committed to implementing the EU ETS¹⁰.

In terms of the total time required to engage with the scheme, the firms were asked to provide an estimate of the time commitment for implementing the EU ETS. Three respondents (12.5% of 24 respondents) estimated that the time required was less than one year, but more than nine months. Another five (20.8%) estimated that it took between three and six months. Seven (29.2%) estimated that it required from one to three months; while nine (37.5%) estimated that it only required one working month of effort, or less. It is worth noting here that companies with larger volumes of allowances spent more time on the early implementation procedures, than companies with smaller shares of the total allocation.

Consultancy costs

Twelve respondents incurred some consulting costs for implementing the EU ETS. The costs for such services vary from €3,000 to €50,000 per firm (€17,000 on average). Again, the companies with higher allocations tended to incur higher consultancy costs than the companies with smaller allocations. This was quite surprising as we would have expected an opposite outcome, i.e. that firms with lower allocation would have lower in-house capacity and, hence, would be willing to engage with external consultant.

Capital costs

About one third of respondents incurred some capital costs. These costs vary from €5,000 to €880,000 and, again, reflect the size of the respondents in terms of allocation. Most often meters had been bought for quantification of fuel usage. One firm reported that necessary changes were implemented not only on the tangible capital side, but also on the intangible capital side as necessary updates were made on the information technologies for collating and reporting CO₂ emissions data.

Summary of early implementation costs

The respondents ranked their early implementation activities according to the costs they experienced. The measurement of their baseline emissions and learning about the functioning of the EU ETS were judged by most as the two most costly early implementation procedures, while applying for allowances and delivering a monitoring and reporting plan were the least costly.

Figure 2 and Figure 3 below summarise the early implementation costs faced by respondents expressed as Euros per firm, and per tonne of verified emissions over the three years of the trial period¹¹.

¹⁰ This was especially true if management of the scheme is centralized not at the firm level, but at the installation level.

¹¹ For the derivation of the total early implementation costs see Annex 5 and Annex 6. Alternatively, these costs could be expressed per tonne of CO₂ emissions reduced. However, as early implementation costs, as well as the MRV costs, are seen as a fixed costs component not depending on the extent of the abatement, it is more reasonable to see whether these “inevitable” costs differ across different firms in terms of the size of their allocation.

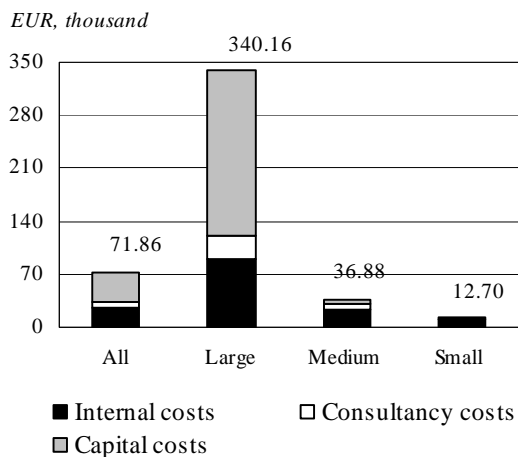


Figure 2 Early implementation costs per respondent across different respondents' categories

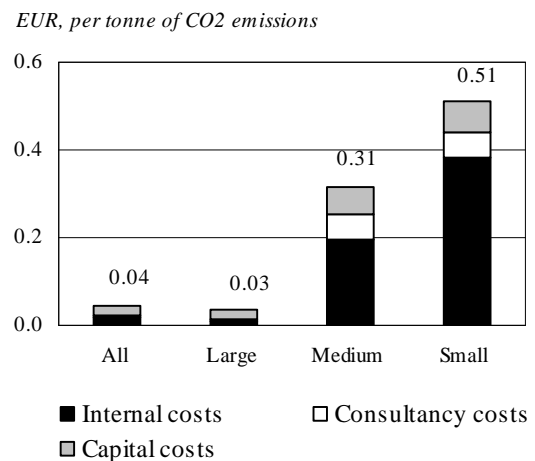


Figure 3 Early implementation costs per tonne of CO₂ emissions emitted across different respondents' categories

Figure 2 shows that the total early implementation costs tended to be higher for large firms than for medium and small firms. On average, large firms faced costs that were 10 times or 30 times higher than those faced by medium and small firms respectively. However, this pattern is reversed when costs are expressed per tonne of CO₂ emissions emitted (see Figure 3): costs per tonne of emissions are significantly higher for small firms. For instance, the early implementation costs were €0.03/tCO₂ on average for large firms, while they were 17 times higher (€0.51/tCO₂) on average for small firms.

These results are not unexpected, and are consistent with other research studies (Schleich and Betz, 2004, Betz, 2005) and with concerns expressed by the European Commission about the unequal distribution of administrative costs across EU ETS participants of different sizes (CEC, 2008).

There is also a difference among firms by size in the composition of the early implementation costs. As described in Figure 4, capital costs were the major component of the total early implementation costs for large firms, while internal costs among small and medium firms were larger than their capital and consultancy costs combined.

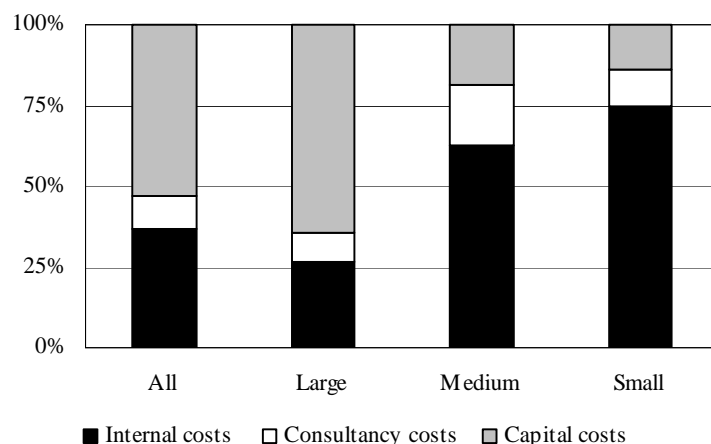


Figure 4 Composition of total early implementation costs across different respondents' categories

The high capital costs among large firms may be explained by the fact that large firms often have multiple and complex points of emission, which may have required the installation of expensive monitoring equipment. Large installations were also subject to more stringent monitoring and reporting requirements than small installations, which may have required the deployment of costly new technology. Small and medium firms, on the other hand, have fewer, less complex emissions points, and may have been able to track emissions from these points using low-cost fuel meters. The relatively low consultancy costs faced by firms in all size categories may imply that sufficient consultation support was acquired at no cost from the governmental bodies responsible for the scheme's implementation¹² or that there was no need to engage with external consultants. However, the former reason is unlikely, as most firms reported that learning about how the EU ETS worked was the most costly process.

5.2 Monitoring, Reporting and Verification (MRV) costs

As monitoring, reporting and verification procedures were mandatory for all operators in the EU ETS, all respondents incurred some MRV costs in the first period of the EU ETS. MRV costs consist of the internal (staff) costs and the consulting costs (e.g. verification and consulting costs), and are generally assumed to accrue annually, as MRV procedures were compulsory on an annual basis.

Internal costs

In twenty four firms, only internal staff members were involved in the MRV procedures (in most cases only one person), while in the remaining three firms both existing and newly hired staff was involved in these procedures.

The annual time commitment for the MRV procedures is not significantly different from the total time commitment for the early implementation procedures. Only one respondent estimated that the time required was less than one year, but more than nine working months. Another three estimated that it took between three and nine months. Four estimated that it required from one to three months, while the remaining fifteen estimated that it only required one working month of effort or less. Companies with higher share of allocation spent more time on the MRV procedures, than companies with a smaller volume of allocation.

Consultancy costs

Over three-quarters of respondents incurred some consulting costs for their MRV procedures, with such costs per annum varying from €1,000 to €100,000 (€1,200 on average). Firms with higher allocations and multiple installations tend to incur higher consultancy costs than companies with smaller allocations. It should be noted here that the definition of consultancy costs encompass verification costs too, which were incurred annually on a mandatory basis by all operators¹³.

Summary of MRV costs

What was the most costly part of the MRV procedure for companies? As evident in Figure 5, large firms with multiple emission points spent relatively more on monitoring. While firms were required to report their emissions only on an annual basis, large and medium firms appear to monitor their emissions more frequently, on a weekly or monthly basis. This may explain why the share of costs for monitoring is higher for large and medium firms. Likewise it reveals that participation in the scheme

¹² If transaction costs were addressed across all agents affected by the scheme (e.g. governmental institutions in each member states), this phenomenon would be considered as a reallocation of transaction costs from private to public organizations. In principle, this burden shifting is welcome if regulators are more efficient than private entities in acquiring and providing information.

¹³ As seven respondents did not provide any information on consultancy costs, for further calculations, we assume that these costs for these respondents were of €3,000 per annum (the modal value of the received answers).

influenced most of the firms' day-to-day operations, since during the interviews most of the firms noted that they had not monitored their emissions before the launch of the EU ETS.

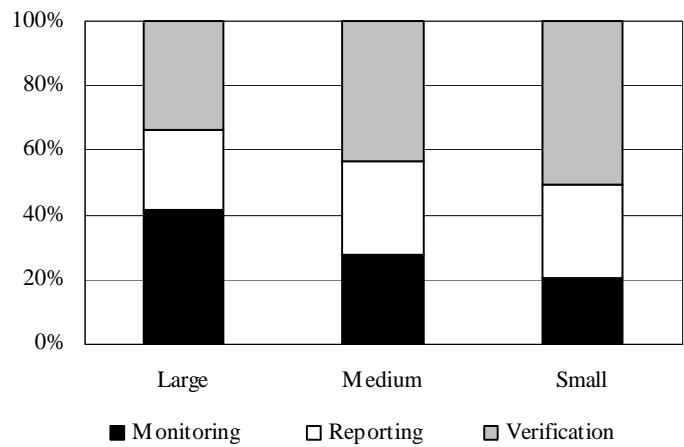


Figure 5 The breakdown of the total MRV costs across different respondents' categories

To understand the magnitude, the distribution and the composition of the MRV costs across the firms of different sizes, the internal and the consultancy costs were calculated per firm and per tonne of CO₂ emitted in the trial phase of the EU ETS¹⁴. These costs are presented in Figure 6 and Figure 7.

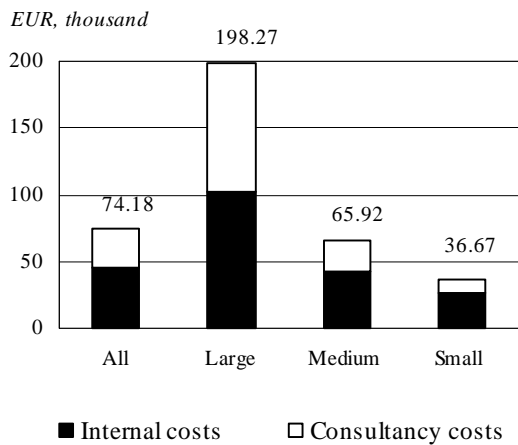


Figure 6 Three-year MRV costs per respondent across different respondents' categories

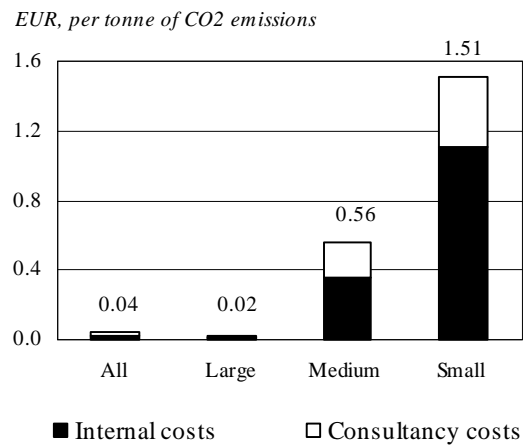


Figure 7 Three-year MRV costs per tonne of CO₂ emissions emitted across different respondents' categories

As in the case of the early implementation costs, the 3-year MRV costs were significantly higher for large firms than for medium and small ones. When costs are expressed per tonne of CO₂ emissions emitted, this pattern reverses: the 3-year MRV costs per tonne of CO₂ were significantly higher for small firms than for large and medium ones. For instance, as shown in Figure 7, MRV costs were €0.02/ tCO₂ for large firms and more than 75 times this level (€1.51/ tCO₂) for small firms.

¹⁴ For the derivation of the total MRV costs see Annex 5 and Annex 6.

The composition of the MRV costs differs from that of the early implementation costs (see Figure 8). The share of consultancy costs in the total MRV costs is much larger than in the early implementation costs. For large companies, the shares of internal and consultancy costs were approximately equal, while internal costs dominated consultancy costs at medium and small firms.

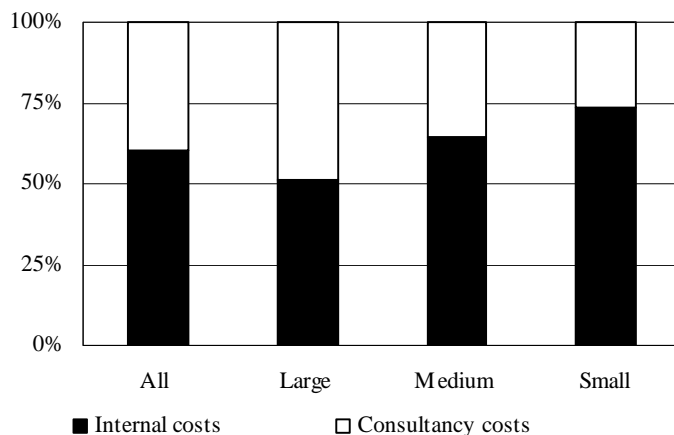


Figure 8 Composition of MRV costs across different respondents' categories

Several insights may be drawn from these observations. First, the small share of consultancy costs in total MRV costs for small firms may imply that these firms incurred consultancy costs only for verification purposes. Small firms may have had little financial capacity to hire consultants for other purposes, or they may have been concerned only about compliance. The larger share of consultancy costs among large firms might suggest that these companies were concerned not only about compliance but also how to reduce compliance costs. For instance, one large company noted during an interview that the same external consultant helped not only to perform the necessary MRV procedures, but also to identify potential abatement opportunities.

5.3 Trading costs

In contrast to early implementation costs or MRV costs, trading costs are variable, as they depend on the volume of allowances traded¹⁵. As pointed out by Stavins (1995), this form of transaction costs can influence firms' trading decisions, and create inefficiencies.

There were some early concerns about the liquidity of the European allowance market. According to a recent survey's results, a lack of understanding of how to trade and the fact that participants with long position did not free-up their allowances in the market were indicated by EU ETS participants as the most important reasons preventing the allowance market from further improving liquidity (European Commission DG Environment et al., 2006). In addition, there were some concerns that brokers fees might have proven overly burdensome for participants with small allocations and no in-house trading capacity, given minimum thresholds on trade volume (Convery and Redmond, 2007).

Out of twenty seven respondents to the Irish survey, eleven firms traded some allowances in the first period of the EU ETS: six sold allowances, and five purchased them. Interestingly, three of the five who bought European Union Allowances (EUA)'s held allowances in excess of their verified emissions

¹⁵ This dependency might not be perfect, as trading transaction costs might have a fixed component as well. For instance, brokerage commissions might consist of a fee per trade (fixed component) and a fee depending on a volume of trade (variable component).

at the end of the first period. The remaining sixteen respondents neither sold nor bought allowances. Seven of these firms held significant surpluses of allowances at the end of the trading period.

These observations raise at least two interesting questions. The first question is why the non-trading firms did not try to sell their surpluses. The second is why the firms that traded some allowances kept surplus allowances in the end. Answering these questions might help understanding whether trading transaction costs were one of the reasons that ‘challenged’ this behaviour.

The sixteen firms that did not trade were asked why they chose not to participate in the market. Fourteen of them responded (7 of which had allowance surpluses), that they had been able to meet their CO₂ obligations without engaging in trading. None of the respondents reported that CO₂ abatement was cheaper than buying allowances or that trading was too expensive. In addition, none of the respondents mentioned transaction costs as a factor discouraging trading.

Non-trading firms also had an opportunity to provide further comments about their non-participation in trade. These comments underline their uncertainty about the first period allocation, and their recognition of the first period allowance price collapse. One firm noted that it maintained an allowance surplus because it was not sure about the extra allocation it would receive from the new entrants’ reserve for an expansion of capacity. Other respondents commented that the allowance price was too low at the end of the period when the surplus was evident to bother with trading. Interestingly, some respondents noted that they had considered transferring allowances to affiliated installations outside Ireland that were under common ownership, but they did not do so because the outside operators also had allowance surpluses.

The eleven respondents that did engage in trading (6 sold and 5 bought) were asked who their trading partners had been. Four firms responded that they had traded only with other Irish installations inside their own business group, and a one firm traded with domestic and foreign installations in the same business group. Another respondent that was over-compliant traded both with installations inside its business group and via financial institutions. The other five (including two over-compliant respondents) traded with financial institutions, mainly commercial banks. Some of the firms that performed allowance trades within their domestic business group regarded this action as a transfer, not as a trade, which might imply that these transfers did not incur any transaction costs.

Seven respondents were involved in direct bilateral trade with counterparty and the other four participated in indirect trade through an intermediary. Respondents were asked what were the main reasons driving their choice to engage in direct or indirect trading¹⁶.

The causes of direct trading were mixed. Two respondents noted that trading volumes had been too small to trade via a third party, while another noted that not only had trading volume been too small, but also it had been cheaper to engage in direct rather than indirect trade. Another respondent noted that it traded directly because it wanted to learn how to trade. Another company noted that there had been no need for it to engage a third party in trading, as it owned a single installation with a small allocation and direct trading was not a complex process. This over-compliant respondent noted that its strategy had been to comply with EU ETS targets on an on-going basis; it had not considered allowances to be financial instruments regardless of its surplus position.

Three companies chose indirect trading because they had no in-house trading capacity and because indirect trading was a quicker process than direct trading. One over-compliant respondent in the power

¹⁶ From the transaction cost perspective, indirect trading is perceived as entailing trading transaction costs. Because of this, brokerage fees are treated as a best proxy of trading transaction costs as one only engages in indirect (direct) trading if his or her transaction costs of direct trading are higher (lower) than brokerage fee.

sector added that indirect trading was chosen as it provided a transparent process for cost pass-through into marginal production cost. In addition, he added that low brokerage fees, which declined along with the allowance price during the first trading period, made indirect trading an attractive option. According to an earlier survey by Convery and Redmond (2007) brokerage fees per tonne of CO₂ traded declined from €0.10 in January 2005 to €0.6 in August 2006.

Based on this analysis regarding traders and non-traders, we conclude that the transaction costs associated with trading were not determining in firms' decisions whether to trade or not. The decision to use allowances for compliance only, and the low allowance prices at the end of the first trading period seem to be the primary reasons why firms did not sell their surplus allowances during the pilot phase. These findings are consistent with those of Trotignon and Ellerman (2008) who analyse the compliance behaviour of direct participants of the EU ETS, who conclude that there was an asymmetry in behaviour in that those who were short were active in the market, while those who were long were much less so.

6. Conclusions and policy implications

This study reveals the importance of a comprehensive approach to assessing transaction costs. The assessment of all sources of transaction costs is especially important in the early stages of any pollution trading programme. As a portion of transaction costs is inevitably of administrative nature which depends on the scheme's design, the total transaction costs assessment should be made well before any corrections on the scheme design are implemented. Nevertheless, this does not suggest that this comprehensive approach should be abandoned in the course of the programme. Tietenberg (2006, p. 205) argues that "since evolution is so common for emissions trading, a strong case can also be made for thinking of mid-course correction as routine".

The fact that the EU ETS comprises heterogeneous participants in terms of core business, initial emission permit allocation size, in-house trading and technical capabilities, etc. raises the question whether companies with small and single installations have the same capability as big multiple installation companies to deal with the scheme requirements. The concern that transaction costs (especially administrative ones) might be excessive for smaller installations has been raised by the European Commission too (e.g. see CEC (2008)). These concerns are supported by the findings of our study.

Figure 9 and Figure 10 below summarize the burden of transaction costs borne by firms with small, medium and large emissions allowance in the pilot phase. The cost distribution reveals that while in absolute terms transaction costs were highest for large firms, the transaction costs per tonne of CO₂ emitted were much higher for the smallest operators. Additionally, the composition of transaction costs shows that while early implementation costs were more significant for large respondents, on-going MRV costs were more considerable for medium and small firms.

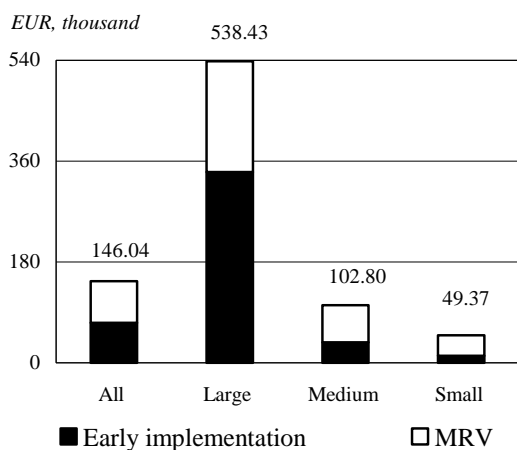


Figure 9 Total transaction costs per respondent across different respondents' categories

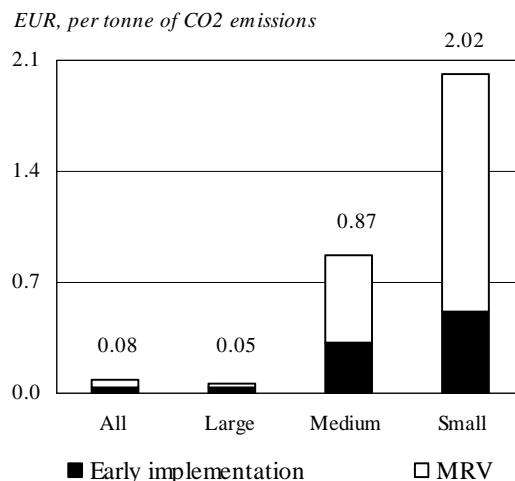


Figure 10 Total transaction costs per tonne of CO₂ emissions emitted across different respondents' categories

Early implementation costs are fixed costs (or sunk costs) that were incurred only once before trading started. If these costs were distributed across the life-span of the programme, they would be significantly lower than other transaction costs components for most of the scheme's participants (however, it remains true that the initial costs are unlikely to be negligible). Hereafter, we refer to the costs incurred before the start of the trading period as 'fixed costs', and MRV and trading costs as 'transactions costs'. Over time, the MRV component of transactions costs should diminish as a result of learning-by-doing and increased competition among verifiers. For instance, one quarter of respondents in the Irish survey claimed that their overall transaction costs decreased over the three years of the EU ETS pilot phase. In the future, when the trading market matures, a special attention should be given to understanding the trading transaction costs, their nature and distribution across different participants.

Although these transaction costs are extra costs that are incurred as a result of implementing the programme, they are more appropriately seen as the costs of implementing a program of limiting emissions to the cap level.

The results, expressed as average costs per tonne of CO₂ emitted, were as follows: the costs of price discovery and trading were negligible - there is no evidence that they inhibited the efficiency of market operation; the average costs per tonne of CO₂ emitted for all firms for set up and MRV amounted to €0.08, which is less than one per cent of the current allowance price of €11.60 on January 23, 2009 (see: <http://www.pointcarbon.com/news/1.1042750>). For the largest firms – accounting for over half the emissions - these costs are still lower, amounting to just €0.05 per tonne. However, for the small firms, while they contribute a very small share of emissions, their costs per tonne – at €2.02 - amount to over 18 per cent of current allowance price. We conclude that the costs overall are so low that they are unlikely to impose a drag on firm or overall performance, but that for small firms, who typically already face major challenges in meeting other input costs, this may not be the case.

The immediate policy implications are that attention to the transaction cost implications of thresholds and scale are important considerations in the design and implementation of trading schemes.

The easiest way to reduce transaction costs for small operators would be to exempt them from the scheme. This 'opt-out' possibility of small operators was considered at the EC level too. However, this goes against the 'polluter pays' principle which is the core of the EU ETS. The European Commission notes that "an exclusion of small emitters from the EU ETS on the grounds of cost-effectiveness cannot

mean, however, that these installations do not need to contribute to the overall emission reduction targets of the EU. It would just mean there would need to be other more cost-effective measures to ensure the same objective” (CEC, 2008, p. 24).

The harmonisation and an increase of efficiency of the MRV activities, and an increase in competition of verification services are other ways to guarantee the reduction and the equalisation of transaction costs in the EU ETS across 27 EU member states and its participants. No doubts, alongside the reforms on bureaucratic side, the learning will be a key in achieving the successful reduction in these costs. This leaning might be considerably facilitated through information provision and training process.

As regards the taxes vs. trading debate, since CO₂ taxes would also require the same level of MRV costs, and some set up costs, our evidence does not support the proposition that carbon taxation would be better than emissions trading from the perspective of transactions costs, although we recognise that there are also other considerations involved.

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Annex 1 A copy of transaction costs' survey

GENERAL DETAILS

Details of the person who led the completion of the questionnaire: PLEASE COMPLETE ACROSS		
Name		
Position		
Telephone number		
Fax number		
E-mail address		
Firm name		
Number of employees		
In which geographic markets did your firm sell goods or services during 2005-2007? TICK ALL THAT APPLY.	Local/regional	
	National	
	Other European Union countries	
	All other countries	
Is your firm a part of a group with multiple installations involved in the EU ETS?	Yes	
	No	

Unless otherwise stated please answer each question by marking **X** in the appropriate box(es).

TRANSACTION COSTS OF THE EU ETS

Transaction costs are the costs your firm incurred in preparing for, setting up systems to implement EU ETS, and then participating in the market during 2005-2007. Transaction costs can be grouped into three categories:

- 1) early implementation costs;
- 2) monitoring, reporting, and verification (MRV) costs; and,
- 3) trading costs.

The first two categories of costs were relevant for all installations in the EU ETS. The third category of costs was significant only for installations that participated in the market and traded European Union CO₂ emissions allowances (EUA) during the first phase of the EU ETS. It should be noted that the costs of the EUA themselves are *not* included in any of the above categories.

'EUA' is the European Union CO₂ emissions allowance.

An allowance, according to the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003, "...means an allowance to emit one *Tonne of Carbon Dioxide Equivalent* during a specified period, which shall be valid only for the purposes of meeting the requirements of this Directive and shall be transferable in accordance with the provisions of this Directive."

Installation, according to the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003, "...means a stationary technical unit where one or more activities listed in Annex I are carried out and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution."

SECTION A Early implementation costs

The early implementation costs are the costs incurred by firms in the EU ETS before the official start of the scheme. These costs should have been incurred prior to January 1, 2005 but some firms may have realized these costs during the early stages of the first phase for a variety of reasons. Please consider your early implementation costs according to their nature, instead of timing.

During this time, familiarisation with scheme rules and guidelines was achieved, baseline emissions were calculated, monitoring equipment was installed, and an operator holding account for each installation was established. All these costs can be considered as *one-time fixed set-up costs* and divided into four categories:

- *internal* costs incurred by your firm in terms of additional management and staff time and training;
- *external* costs incurred in terms of consultancy services taken on;
- *capital* costs, meaning emissions measurement, monitoring, recording, and data storage equipment needed to comply;
- **other costs not included in the above.**

A1 Did your firm incur any internal costs for the early implementation procedures of the EU ETS?

	Yes	CONTINUE
	No	GO TO A4

A2 Who performed the early implementation procedures of the EU ETS in your firm?

	Number of people	Percentage of time spent
Existing internal staff		%
Newly hired staff		%

A3 What is the estimate of overall full-time working days spent by your firm's staff on the early implementation procedures of the EU ETS? **PLEASE WRITE IN NUMBER – RECORD NONE AS '00'.**

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A4 Did your firm incur any external costs for the early implementation procedures of the EU ETS?

	Yes	CONTINUE
	No	GO TO A6

A5 Please provide your firm's estimated overall external costs on the early implementation procedures of the EU ETS **in 000s of Euro.**

--	--	--

A6 Did your firm incur any capital costs necessary to perform monitoring and reporting activities?

	Yes	CONTINUE
	No	GO TO A9

A7 What necessary equipment or technology did your firm purchase to perform monitoring and reporting activities? **Please describe.**

--

A8 Please provide the estimated overall acquisition costs of equipment or technology necessary to perform monitoring and reporting activities **in 000s of Euro.**

--	--	--

A9 What part of the early implementation procedure was the most costly for your firm? **Please rank the following procedures with 1 being least costly and 4 most costly.**

Measurement of baseline emissions	
Bringing Monitoring and Reporting plan to the required standard	
Learning about the functioning of the EU ETS	
Application procedures for allowances (other than measurement of baseline emissions)	
Other (please specify)	

SECTION B Monitoring, reporting and verification (MRV) costs

MRV costs were incurred by all installations in the EU ETS. We assume that these costs are a combination of *internal* firm costs, mainly management and staff time, and *external* consultancy services, where your firm buys the necessary capacity to be MRV compliant. Please, note that the MRV costs do *not* include fixed capital costs. The fixed costs related to the MRV procedures are accounted for as early implementation costs for the purposes of this survey.

All questions refer to the decisions or actions taken during 2005-2007.

B1 Did your firm incur any internal costs for the MRV procedures of the EU ETS?

	Yes	CONTINUE
	No	GO TO B4

B2 Who performed the MRV procedures of the EU ETS in your firm?

	Number of people	Percentage of time spent
Existing internal staff		%
Newly hired staff		%

B3 What is the estimate of the overall full-time working days spent (an annual average during 2005-2007) by your firm's staff on the MRV procedures of the EU ETS? **PLEASE WRITE IN NUMBER – RECORD NONE AS '00'.**

--	--	--	--

B4 Did your firm incur any external costs for the MRV procedures of the EU ETS?

	Yes	CONTINUE
	No	GO TO B6

B5 Please provide your firm's estimated overall external costs (an annual average during 2005-2007) on the MRV procedures **in 000s of Euro.**

--	--	--

B6 Please provide a breakdown of your firm's total MRV costs.

Monitoring	%
Reporting	%
Verification	%
Total MRV	100%

B7 How frequently did you monitor your firm's CO₂ emissions?

Daily	
Weekly	
Monthly	
Quarterly	
Semi-annually	
Annually	
Ad hoc (please specify)	

SECTION C Trading costs

Trading costs are incurred by firms covered by the EU ETS which traded EUAs during 2005-2007. Trading costs are those related to the search of trading partner, price bargaining, enforcement of trade contract, and other legalities. The costs of the EUA themselves are *not* included.

All questions refer to the decisions or actions taken during 2005-2007.

C1 Did your firm trade any EUAs?

	Yes	GO TO C3
	No	GO TO C2 ONLY

C2 What were the main reasons for not trading? **TICK ALL THAT APPLY.**

Met the CO ₂ obligation without buying EUA	
Met the CO ₂ obligation without selling EUA	
CO ₂ abatement was cheaper than buying EUA	
Other (please specify)	

C3 How many EUAs did your firm buy/sell? **PLEASE WRITE IN NUMBER – RECORD NONE AS ‘00’.**

Bought	
Sold	

C4 Who did your firm trade with? **TICK ALL THAT APPLY.**

Domestic installations inside your business group	
Foreign installations inside your business group	
Domestic installations outside your business group	
Foreign installations outside your business group	
With financial institutions (e.g. brokers, exchanges) (please specify)	

C5 How did your firm trade?

<input type="checkbox"/>	Directly, without a third party	CONTINUE
<input type="checkbox"/>	Indirectly, via a third party	GO TO C10

C6 What were the main reasons for trading directly? **TICK ALL THAT APPLY.**

<input type="checkbox"/>	It was cheaper than trading via a third party	
<input type="checkbox"/>	Wanted to learn how to trade	
<input type="checkbox"/>	Trade volume was too small to trade via a third party	
<input type="checkbox"/>	Other (please specify)	

C7 How often did your firm trade?

<input type="checkbox"/>	Daily	
<input type="checkbox"/>	Weekly	
<input type="checkbox"/>	Monthly	
<input type="checkbox"/>	Quarterly	
<input type="checkbox"/>	Semi-annually	
<input type="checkbox"/>	Annually	
<input type="checkbox"/>	Ad hoc (please specify)	

C8 Did your firm trade with the same partner more than once?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

C9 How long did a buy/sell transaction take to complete?

	Buy transaction	Sell transaction
Less than one week		
One week or more, but less than one month		
Other (please specify)		

C10 What were the main reasons for trading via a third party? **TICK ALL THAT APPLY.**

It was cheaper than trading directly	
It was quicker than trading directly	
There was no in-house capacity to trade directly	
Other (please specify)	

C11 What intermediary services did your firm use to facilitate the trade of EUAs? **TICK ALL THAT APPLY.**

Financial institution (such as banks)	
Specialised carbon trading brokerages	
Exchange	
Other (please specify)	

SECTION D Summary of transaction costs

D1 What aspect of EU ETS compliance was the most costly for your firm? **Please rank the following activities with 1 being least costly and 5 most costly.**

Early implementation	
Monitoring	
Reporting	
Verification	
Trading	

D2 How did your firm's total transaction costs (except early implementation costs) evolve over 2005-2007?

They increased	
They decreased	
They remained the same	

D3 Please provide below any additional comments which are important to understand the transaction costs experienced by your firm.

Annex 2 Ireland's Allocation (2005-2007)

Recipient	Allowances	Share of total allocation, %
Installations permitted before 31/03/2004	65 006 999	97.1
allocation to existing installations	57 714 569	86.2
allocation to known planned developments	7 292 430	10.9
New entrant Set Aside	1 004 400	1.5
Auction	502 201	0.8
Combined heat and power Set Aside	446 400	0.7
TOTAL	66 960 000	100

Source: EPA and author's calculations.

Annex 3 Summary of companies contacted

	Contacted companies	Contacted companies (closed companies excluded)	Respondents (% of contacted companies, closed plants excluded)	
Number of companies	72	68	27	39.7
Number of installations	106	101	40	39.6
Initial allocation 2005-2007 ¹⁷	57714569	56788736	39713822	69.9
Verified CO ₂ emissions 2005-2007 ¹⁸	64777597	64514997	45023963	69.8

Source: CITL and author's calculations

¹⁷ Allocation to new developments is excluded.

¹⁸ Allocation to new developments is included.

Annex 4 Interview Profiles

	I	II	III	IV	V	IV
Position	Environmental manager	Strategy division	Environmental chemist	Environmental engineer	Environmental manager	Financial controller
No. of employees	~800	~2000	~400	~450	~50	~50
Sector	Private	Private	Private	Private	Private	Private
Multi installations	Yes	Yes	No	No	No	No
Single installations	No	No	Yes	Yes	Yes	Yes
Market	Local/Foreign	Local	Local/Foreign	Local/Foreign	Local	Local

Source: Survey.

Annex 5 Monetisation of the early implementation costs and the MRV costs

	Total	Per tonne of CO₂ verified
Early implementation	<p>1. Answers to the questions used: -A3, internal costs in fulltime working days; -A5, external costs in 000s of EUR; -A8, capital costs in 000s of EUR.</p> <p>2. Internal costs from total full-time days converted in 000s of EUR assuming: -8 hours of full-time working day; -average hourly labour (wages and salaries) rate of €37.89¹⁹.</p> <p>3. Total costs -Internal costs, external costs and capital costs expressed in 000s of EUR are added together</p>	<p>1. Total early implementation costs converted from 000s of EUR to EUR.</p> <p>2. Total early implementation costs in EUR are divided by total verified emissions for 2005-2007 period emitted by the respondents permitted before 31/03/2004, i.e. new planned developments are included.</p>
MRV costs	<p>1. Answers to the questions used: -B3, internal costs in fulltime working days, annual average during 2005-2007; -B5, external costs in 000s of EUR, annual average during 2005-2007;</p> <p>2. Internal costs from total full-time days converted in 000s of EUR assuming: -8 hours of full-time working day; -average hourly labour (wages and salaries) rate of €37.89 (see footnote 19)</p> <p>3. Total costs: -Internal costs and external costs expressed in 000s of EUR are multiplied by three and added together.</p>	<p>1. Total MRV costs converted from 000s of EUR to EUR.</p> <p>2. Total MRV costs in EUR are divided by total verified emissions for 2005-2007 period emitted by the respondents permitted before 31/03/2004, i.e. new planned developments are included.</p>

¹⁹ The average hourly labour (wages and salaries) rate of €37.89 (4 Q 2007) is applied to estimate hours committed to set-up EU ETS. The rate of €37.89 is an average hourly labour rate for managers, professional and associate professionals working in industry's sectors (mining and quarrying, manufacturing, electricity, gas and water supply). All wages and salaries payments are gross (i.e. before deduction of income tax and employees' PRSI contributions). The statistics are provided by the Central Statistics Office Ireland. The reason for choosing the rate of €37.89 is that most of the returned questionnaires are answered by representatives with managerial and engineering positions within the companies.

Annex 6 Early implementation cost

	No. of respondents	Verified CO2 emissions, 2005-2007	Internal costs	Consultancy costs	Capital costs	Total costs
<i>Total, EUR thousands</i>						
All	25	41903637	655.6	188.0	953.0	1796.59
Large	4	40734240	360.7	120.0	880.0	1360.65
Medium	7	822845	162.2	48.0	48.0	258.17
Small	14	346552	132.8	20.0	25.0	177.77
<i>Per respondent, EUR thousands</i>						
All	25	41903637	26.2	7.5	38.1	71.86
Large	4	40734240	90.2	30.0	220.0	340.16
Medium	7	822845	23.2	6.9	6.9	36.88
Small	14	346552	9.5	1.4	1.8	12.70
<i>Per tonne of CO₂ emissions verified, EUR</i>						
All	25	41903637	0.02	0.00	0.02	0.04
Large	4	40734240	0.01	0.00	0.02	0.03
Medium	7	822845	0.20	0.06	0.06	0.31
Small	14	346552	0.38	0.06	0.07	0.51

Source: Survey.

Annex 7 MRV costs

	No. of respondents	Verified CO₂ emissions, 2005-2007	3-year internal costs	3-year consultancy costs	3-year total costs
<i>Total, EUR thousands</i>					
All	27	45023963	1207.6	795.2	2002.78
Large	5	43835768	508.3	483.0	991.33
Medium	7	822845	296.5	165.0	461.45
Small	15	365350	402.8	147.2	550.00
<i>Per respondent, EUR thousands</i>					
All	27	45023963	44.7	29.5	74.18
Large	5	43835768	101.7	96.6	198.27
Medium	7	822845	42.4	23.6	65.92
Small	15	365350	26.9	9.8	36.67
<i>Per tonne of CO₂ emissions verified, EUR</i>					
All	27	45023963	0.03	0.02	0.04
Large	5	43835768	0.01	0.01	0.02
Medium	7	822845	0.36	0.20	0.56
Small	15	365350	1.10	0.40	1.51

Source: Survey.

Annex 8 Total transaction costs

	Early implementation costs	3-year MRV costs	3-year total transaction costs
<i>Total, EUR thousands</i>			
All	1796.59	2002.78	3799.37
Large	1360.65	991.33	2351.99
Medium	258.17	461.45	719.62
Small	177.77	550.00	727.76
<i>Per respondent, EUR thousands</i>			
All	71.86	74.18	146.04
Large	340.16	198.27	538.43
Medium	36.88	65.92	102.80
Small	12.70	36.67	49.37
<i>Per tonne of CO2 emissions verified, EUR</i>			
All	0.04	0.04	0.08
Large	0.03	0.02	0.05
Medium	0.31	0.56	0.87
Small	0.51	1.51	2.02

Source: Survey.