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The best (and worst) of air Emission Trading Schemes: comparing the EU ETS with its followers

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The best (and worst) of air Emission Trading Schemes: comparing the EU ETS with its followers

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Abstract: The European Emission Trading Scheme (EU ETS) is generally considered as the prototype system for the other Emission Trading Schemes (ETSs) that are rapidly spreading around the world. To get a deeper understanding on the actual capacity of the EU ETS to stand as a model for the other ETSs, the present paper discusses the differences and similarities of the EU ETS with respect to the other main ETSs and the emerging trends that these systems seem to share, comparing the different cap and trade regimes in order to identify the best practices and the desirable features that future ETSs should have. As emerges from the comparative analysis performed in this article, although the followers share some common flaws with the EU ETS, they have also shown the capacity to innovate and possibly devise alternative ways to manage their own ETS regimes, which may in the long term jeopardise the EU leadership in the ETSs context.

Key words: Emission Trading Schemes, EU ETS, California Cap&Trade System, Regional Greenhouse Gas Initiative, Quebec Cap&Trade System, comparative analysis

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1. Introduction

Emission Trading, and in particular, the European Union Emissions Trading System (EU ETS) has received increasing attention in the last few years both amongst scholars and policy-makers. Many contributions have examined the legal, institutional and economic features underlying the functioning of the system (see Grubb and Neuhoff, 2006; Grubb, 2009; Tietenberg, 2006; Ellerman et al., 2007; Krueger et al., 2007; Freestone and Streck, 2009; Tuerk et al., 2009; Convery et al., 2010; Ellerman, 2010; OECD, 2011; Olmstead and Stavins, 2012; Burtraw et al., 2013; Delbeke and Vis, 2015), as well as the environmental effectiveness of its implementation (cf., for example, Anderson and Di Maria, 2011; Rogge et al., 2011; Calel and Dechezlepretre, 2016; Germà and Stephan, 2015). The importance of these analyses goes beyond the EU ETS itself, since cap and trade regimes can be considered one of the most prominent examples of the application of market-based instruments to environmental issues. In fact, the EU ETS represents the tip of the iceberg with regard to the existing cap and trade regimes within the climate change sector, whilst the emission trading regimes can be considered the most relevant application of market-based instruments to environmental problems.

This paper aims at emphasising the main lessons learnt and the emerging trends of the EU ETS as well as of other relevant ETS regimes, comparing the different systems in order to identify the best practices and the desirable features that future ETS should have.

For this purpose, the structure of the paper is the following. Section 3.2 briefly reviews the origin of the Emission Trading Schemes, starting from the early experiences in the United States (US) and focusing on the developments within the EU from a historical perspective. Section 3.3 describes the main features of the EU ETS as it currently stands, emphasising the lessons learnt from its implementation. Section 3.4 presents a focus on the environmental and technological effectiveness of the EU ETS, based on the early experience provided by the first two application periods. Section 3.5 describes the worldwide sprawling of the ETS, looking in particular at some selected "followers" of the EU ETS, which seem to be quite comparable with the European prototype, namely the Regional Greenhouse Gas Initiative (RGGI), the Californian Cap and Trade System and the Quebec Cap and Trade

System. Section 3.6 discusses a few emerging trends that are common to the various ETSs taken into account and the current prospects for ETS cooperation and coordination in the future. The final section contains some concluding remarks on the main findings that emerge from the comparative analysis performed in this paper.

2. Evolution of the Emission Trading Schemes

The introduction of the ETS dates back to the 1970s, when the first cap and trade instrument was applied in the USA to implement the Clean Air Act. The success achieved by such a system in reducing air emissions in several US states subsequently led many other countries to adopt a similar policy tool in their own jurisdictions. In particular, those types of instruments initially proliferated mainly in the USA and other Anglo-Saxon countries, traditionally characterised by a liberal approach and, therefore, generally more prone to the use of market-based instruments. For example, emission trading systems have been implemented in Australia to reduce water pollution and consumption (Borghesi, 2014), as well as in the United Kingdom (UK), where in 2002 the first broad application of a GHG trading scheme was conceived (Smith and Swierzbinski, 2007).

On the contrary, for a long time the European Union (EU) was much more focused on "command and control" environmental regulation and its environmental policies only gradually envisaged the introduction of market-based economic instruments. In fact, the European Commission firstly promoted the adoption of a EU-wide carbon tax in the nineties (Grubb, 2014). This proposal, however, was eventually abandoned, since it failed to obtain broad support from EU member states, mainly due to the negative reaction of the European industrial sector.

Subsequently, the EU, spurred on by the US experience in this field, shifted its attention to the application of the ETS to GHG emissions from the industrial sector. As mentioned in the previous chapters, the EU ETS was first introduced by Directive 2003/87/EC (EC 2003) and initially applied to CO2 and a few sectors only (energy activities – such as oil refineries –, production and processing of ferrous metals, mineral industry, pulp and paper industry).

Later, its scope was extended to include the aviation sector with Directive 2008/101/EC.[1] Subsequently, the whole EU ETS scheme was revised and updated, with the extension to new sectors (petro-chemicals, ammonia, aluminum) and new gases (N2O and PFCs), through the adoption of Directive 2009/29/EC (EC, 2008 and 2009).

Surprisingly enough, the EU and the US seem to have inverted their positions, the EU becoming a forerunner while the US being the follower. The attempt to keep up with the US has led the EU to overtake the US while making use of its own preferred policy tool. While the EU implemented and further upgraded the EU ETS, the US did not manage to establish an overall federal ETS, despite the positive experiences of California and of the RGGI scheme established in some of the Northeast and Mid-Atlantic States of the US.

As Ellerman correctly pointed out, this denotes a change in leadership in terms of environmental policies at a global level. In fact, nowadays, most countries, including the US itself, look at the EU ETS as a prototype to be followed in the ETS field (Ellerman, 2010). However, some criticalities that emerged in the functioning of the EU ETS, together with the rapid evolution of ETSs around the world, cast some doubts on the capacity of the EU to maintain its role in the years to come. To get a deeper understanding on this issue, in the next paragraphs we try to emphasise the main lessons learnt from the application of the EU ETS and compare it with the trends emerging in the other ETSs around the world.

3. The EU ETS: lessons learnt

The experience of the application of the EU ETS Directive in the first two phases[2] (2005-2007 and 2008-2012) shows some remarkable achievements, but also a few important shortcomings.

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[1] According to Directive 2008/101/EC, emissions produced by all flights from, to and within the European Economic Area, that is, the 28 EU Member States, plus Iceland, Liechtenstein and Norway – should have be covered by the EU ETS, as of 2012. However, in order to allow time for International Civil Aviation Organization (ICAO) negotiations on a possible global market-based measure applying to aviation emissions, the EU ETS requirements were provisionally suspended in 2012 for flights to and from non-European countries, by means of the so-called "stop-the-clock-decision". Then, such suspension measures were renewed also for the period 2013-2016, so that, practically, so far only emissions produced by (internal) flights occurring within the European Economic Area fall under the EU ETS.

[2] We will focus here mainly on the first two phases of the EU ETS since few data are currently available on the initial part of the third phase (2013-2020). Indeed, if we exclude the carbon price (which is available on a

The main achievement of the EU ETS is given by the records it established, as it is so far the largest carbon market in the world and the first transboundary cap-and-trade system. In fact, the giant European market includes 31 countries (the 28 EU member states plus Iceland, Liechtenstein, Norway) and covers more than 11,000 installations. The unexpected capacity of the EU to establish such a broad system in a relatively short time is by far the most important feature that distinguishes the EU ETS from previous experiences in this field. The advantage of such a large market size goes far beyond all the other well-known theoretical advantages of an ETS system, such as the induced technological innovation, the concrete application of the "polluter pays" principle as well as the greater flexibility of an ETS regime with respect to more traditional command and control instruments. Not only does the scope of the European market boost competition amongst the economic agents, but it also increases the possibilities of finding buyers for participating installations, thus rewarding innovative firms that manage to reduce emissions. This has the potential to reinforce the incentive to invest in new low-carbon technologies. Moreover, the EU ETS has also a symbolic value, which goes beyond purely economic considerations and demonstrates the will of the EU to stand as a leader in the international environmental policy context. This leading attitude, that the EU showed in the past with regard to command and control tools, now extends to the use of market-based instruments that were once a prerogative of the US.

On the other hand, some shortcomings, that tend to weaken its effectiveness, have emerged in the implementation of the EU ETS. More specifically, it is possible to identify three main problems that have hindered the functioning of the system in the first two phases: (i) price volatility, (ii) governance problems and (iii) monitoring problems.

First, the market price proved to be too volatile during the first two phases (2005-2012, see fig.1).[3] In the initial phase (2005-2007) this was mainly due to an over-allocation of permits

daily-basis), most EU ETS-related indicators are released with a significant lag by the European Commission. For instance, information on transactions in the EU ETS are yet to be released for the year 2013 in the EU Transaction Log, the official EU registry of all transactions taking place in the EU carbon market.

[3] The spot price has shown an ample variance even in Phase III, but such variations have been less pronounced than in Phase II (the price range being €5.84 in Phase III versus €14.36 in Phase II). However, in Phase III the price has been stabilising around a much lower average than in the previous phase, the average annual price in the primary market in Phase III during the years 2013-2015 (€6.03) being about 25% below the lowest average annual price in Phase II (€8.12). As mentioned above, however, we will focus here on the first

coupled with the fact that emission allowances could not be banked. The rationale for not allowing banking was the desire to separate Phase II (which coincided with the first Kyoto compliance period starting in 2008) from the pilot program period, but the consequences of this decision were self-evident: by the final quarter of 2007, spot prices were essentially equal to zero, at €0.06/ton, even while contract futures prices for Phase II allowances hovered above €20/ton.[4] In the second phase (2008-2012), instead, price volatility can be ascribed to a drastic decrease in demand for permits caused by the severe economic crisis.[5] The oversupply observed in the first phases partly reflected an excessively decentralised system with too generic rules for the national caps (see the governance problem described below). On top of that, the difficulty of achieving an international agreement for the post-2012 period lowered the sense of urgency about the necessity of staying on track for the enforcement of the environmental policy goals set by the EU, most notably the reduction of emissions by 20 % (compared to 1990 levels) by 2020. The observed price volatility increases uncertainty for the firms operating on the EU ETS, which may lead to a tendency to postpone costly investments in low-carbon technologies and to keep on using old polluting technologies with detrimental effects on the environment (Gronwald and Ketterer, 2012; Gronwald and Hintermann, 2015).[6]

Secondly, the EU ETS showed a "governance" problem, particularly in phases I and II. In fact, the system was characterised by a too decentralised architecture whereby, for example, Member States retained too much leeway in defining the national allocation plans for allowances. During the first trading phase, in fact, most National Allocation Plans (NAP) allocated an excessive number of emission permits, mainly because of the political pressure on the governments from interest groups who wanted to receive more permits (Gilbert et al.,

two phases since, unlike Phase III, they are already concluded and provide complete information on all transactions details.

[4] See Schleich et al. (2006) for an analysis of the implications of the EU decision to ban banking in Phase I and of the related efficiency losses based on simulation results.

[5] Koch et al. (2014) investigate the drivers of the EUA price drop in Phase II and find that economic recession is a robust explanatory variable for the observed price fall, while renewable policies and the use of international credits (that are also often invoked as carbon price drivers) have had a moderate impact on the EU ETS carbon price.

[6] See Clò et al. (2013) for a discussion of the impact of the EUA price drop on the effectiveness of the trading scheme and on the risk of carbon lock-in that the carbon price fall can generate.

2004; Sijm, 2005). A similar over-allocation occurred also in the second phase, when the European Commission had to intervene on 11 of the 12 original NAPs proposals (with the only exception of the UK), reducing the total number of emission permits that were originally allowed by each state. Moreover, the existence of too generic rules for the national caps caused a lack of adequate tightness of the system. As a consequence, relevant issues, such as the management of the carbon leakage risk, were not properly addressed, leading to EU firms' competitiveness questions.[7] The governance issues was finally addressed with Directive 2009/29, which abolished the national competence to draft allocation plans and centralised all the relevant EU ETS decision-making power in the hands of the European Commission.

Thirdly, the EU ETS evidenced some management problems, particularly in phases I and II. These were related, in particular, to relevant shortcomings in the functioning of the national registries in some Member States, which highly undermined the effectiveness of the overall EU ETS. In particular, the repeated frauds that occurred in the EU ETS market during the first two phases showed a certain difficulty in monitoring the functioning of the scheme and paved the way for the call for more transparency. For instance, as Frunza et al. (2011) have shown, the volume of permits being traded in the Paris stock exchange fell dramatically once the so-called value-added tax (VAT) fraud was discovered.[8] This suggests that the permit exchanges in that market were probably spurred more by the illegal activity that took place in the absence of proper regulation, rather than by the actual need to cover emissions. Beyond the VAT fraud, other scandals have occurred in the second phase, which generated

7 The existence and the entity of a carbon leakage effect induced by the implementation of environmental policies is the subject of a heated debate and of an extensive theoretical and empirical literature. See, among the others, Taylor (2004), Dean et al. (2009), Chung (2014) for analyses of the possible delocalisation effect of environmental regulation in general, Martin et al. (2014a and 2014b), Borghesi et al. (2016) for a discussion of the effect of the EU ETS regulation in particular.

8 By VAT fraud we refer to the practice of some agents of importing permits VAT-free (due to the zero rate of taxation on intra-community cross-border trade) and sell them in the importing country with VAT charged and afterwards disappear instead of paying the VAT to the government. To make an example, the fraudster may buy permits from firm A located in another EU country and then sell them in its own country to firm B charging the VAT. If the fraudster disappears without paying the VAT, when firm B reclaims the VAT from the government the Member State will suffer a loss since it has to reimburse an amount of money that it did not receive from the fraudster. This kind of fraud, that exploits the way VAT is treated within multi-jurisdictional trading, has applied to several other items in the past (e.g. microchips, mobile phones, health products, jewellery etc…) causing relevant losses to the EU budget (cf. Frunza *et al.*, 2011).

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severe criticisms to the effective functioning of the system. In particular, in November 2010 1.6 million carbon permits went missing from the Romanian registry account of the cement-maker Holcim. On January 10, 2011 a hacking attack occurred on the Austrian registry, and nine days later a market participant, Blackstone Global Ventures, declared that 475,000 carbon permits (about 7 million euros) had vanished from its account in the Czech Republic. Following the suspected theft from the Czech Republic's carbon registry, the European Commission decided to suspend spot trades (75% of the ETS market) until January 26, 2011 and several countries (the Czech Republic, Greece, Estonia, Poland and Austria) temporarily closed their carbon trading registries.

These management problems led the European Council's climate change committee to approve new anti-fraud measures on February 17, 2011. Moreover, the EU reacted to these problems by adopting a new Regulation on registry, namely EU Regulation 389/2013, establishing a Union Registry administered at central level by the European Commission, which replaced the more vulnerable national registries, with the aim to prevent the frauds and stop the proliferation of the illegal cyber attacks described above.

On the basis of the pros and cons just shown above, it may be argued, therefore, that Ellerman is right to argue that the EU ETS system is a prototype, but not necessarily a model as it originally stood. In fact, the shortcomings highlighted above had to be properly addressed and resolved in order to increase the effectiveness of the European system.

Some relevant shortcomings were addressed by EU Directive 2009/29, which aimed at strengthening the effectiveness of the EU ETS, in particular with regard to the over-allocation and surplus of EUAs. However, the amendments introduced did not solve all the problems related to the surplus of EUAs in the European carbon market, which continued to negatively affect the system and undermine its effectiveness.

In order to address such persistent problems, the European Commission proposed the back-loading initiative, which was adopted by the Council and the Parliament in 2013, with the aim of postponing auctions for 900 million allowances planned for the period 2014-2016, so as to rebalance supply and demand in the EU ETS market and reduce price volatility.[9]

However, the back-loading initiative was meant to represent just a temporary solution to be used during the EU ETS 3rd phase (up to 2020), and the European Commission made clear from the very beginning that a more structural EU ETS reform was needed to correct the surplus of EUAs and to limit its long term negative impacts on the EU carbon market.[10] To this effect, the European Commission presented a proposal for the establishment of a market stability reserve in the EU ETS.[11] The Proposal on the market stability reserve was presented alongside the EU Communication on "A policy framework for climate and energy in the period from 2020 to 2030", which described the EU 2030 scenario and the proposed main objectives. The market stability reserve has a twofold aim. On the one side, it should address the persistent problem of surplus of emission allowances; on the other side, it should improve the system's resilience to major shocks by adjusting the supply of allowances to be auctioned. Moreover, the mechanism envisaged would operate according to pre-defined conditions, in an "automatic manner" which would leave no discretion to the Commission in its implementation, thus ensuring more transparency and effectiveness to the system. The Proposal on the market stability reserve was approved by the European Parliament on 7 July 2015 and by the Council on 6 October 2015.[12] As a consequence, the market stability reserve shall be established in 2018 and the placing of allowances in the reserve shall operate from 1 January 2019.[13]

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[9] Decision No 1359/2013/EU of the European Parliament and of the Council of 17 December 2013 amending Directive 2003/87/EC clarifying provisions on the timing of auctions of greenhouse gas. OJ L 343 19.12.2013, p. 0001.
See also Commission Regulation (EU) No. 176/2014 of 25 February 2014 amending Regulation (EU) No 1031/2010 in particular to determine the volumes of greenhouse gas emission allowances to be auctioned in 2013-20.

[10] For a critical discussion of the back-loading and of the structural measures proposed by the European Commission to reform the EU ETS see de Perthuis and Trotignon (2014). See also Caton et al. (2015) for an analysis of the implications of back-loading on carbon prices that compares the CO_2 equilibrium price with and without this policy measure.

[11] COM (2014) 20, Proposal for the establishment and operation of a market stability reserve for the EU ETS.

[12] At the moment of writing, the Decision of the European Parliament and of the Council concerning the establishment and operation of a market stability reserve is still awaiting publication on the Official Journal of the European Union.

[13] Source: European Commission, http://ec.europa.eu/clima/policies/ets/reform/index_en.htm

It is still too early to assess whether the approved back-loading initiative (in the EU ETS 3th phase) or the proposed market stability reserve (in the EU ETS 4th phase) will prove suitable tools to solve the shortcomings experienced so far by the European carbon market.[14] It should be noted, however, that the market stability reserve may prove a controversial solution, in particular if compared with another option, the introduction of a price floor, which might have been chosen instead, to reach more or less the same goals. This alternative solution, in fact, which is a common feature of some of the most relevant ETSs currently existing around the world (e.g. the US-based California and RGGI ones), might have proven in the long term a more effective solution also for the EU ETS (see section 5 below).

4. The EU ETS, eco-innovation and environmental effectiveness: early experiences

One of the most important and controversial aspects of ETS regimes concerns their environmental effectiveness. While there seems to be a large consensus in the literature on the efficiency (that is, cost-effectiveness) of the ETS instrument, its capacity to actually reduce emissions is still the object of debate. This seems to apply also to the recent implementation of the EU ETS. During the first two phases, European emissions were substantially reduced. However, one may wonder whether this can be ascribed to the ETS, suggesting a causal relationship, or whether there is simply a spurious correlation between the two events.

According to the data released by the European Environment Agency (EEA 2012b, 2013), EU emissions have steadily declined in the last few years due to warmer weather conditions and more expensive fuels. This has led the EU to achieve and actually "overshoot" the 8 % emissions reduction target required by the Kyoto Protocol. As a matter of fact, the overall EU27 GHG emissions were estimated to be 7.7 % below the 1990 levels in 2006, 11.3 % below that benchmark year in 2008, 18.4 % below in 2011, 19.2% in 2012 and 20.7% in 2013 (EEA 2012a, 2013, 2014a,b,c,d). This suggests that the Kyoto targets have not only been met, but

[14] See Kollenberg and Taschini (2016) for a theoretical model that investigates the consequences of the market stability reserve mechanism in a stochastic partial equilibrium framework.

largely surpassed and that basically the emission reduction target for 2020 (-20%) has already been achieved by the EU, well in advance with respect to the original time schedule. Within the EU, however, there exist large differences in terms of emission reductions between the original EU-15 countries and the new member States that entered the EU after 2004. The overall EU emissions reductions have mainly been driven by the EU enlargement into Central and Eastern European countries that have experienced a dramatic decline in their production with respect to 1990 levels. From closer scrutiny of the data, in fact, it emerges that in the new member States GHG emissions had decreased by 38.5% between 1990 and 2013, whereas in the EU-15 emissions have fallen by 16.4% in the same period (EEA, 2014e).

The estimated emissions reductions, moreover, are likely to depend on the worldwide economic recession that has significantly reduced industrial production (and consequently the resulting GHG emissions). In fact, a look at EU15 emissions trends before the on-going crisis (see Borghesi, 2011; EEA, 2010) shows that, when the crisis began to loom large in 2007, emissions were well above the intermediate target, so that the EU15 was not on track to achieve the final Kyoto target, and that in 2008 they were still only 6.5% below the 1990 level. Therefore, without the economic crisis and enlargement to Central and Eastern European countries, the EU emission reduction would have been much lower and the EU might have experienced serious difficulties in achieving the Kyoto Protocol target.[15]

Another particularly relevant aspect for the assessment of the EU ETS performance concerns its impact on eco-innovation as defined by the "Measuring environmental innovation (MEI)" project funded under the EU 6th Framework programme (Kemp, 2010). According to such definition, eco-innovation refers to "any product, process or organizational innovation that is more environmental friendly than relevant alternatives". While the specific effect of the EU ETS on GHG emissions can be hard to disentangle, its impact on eco-

15 This consideration does not deny the possible role that the EU ETS can play a role in reducing European emissions. Using aggregate data, Ellerman and Buchner (2008) calculate that CO_2 emissions abatement were between 2.4% and 4.7% in Phase I of the EU ETS as compared to a counterfactual Business-As-Usual scenario (without the EU ETS). Similar findings emerge in the study by Anderson and Di Maria (2011) who estimate an emission reduction around 2.8% in Phase I. What we intend to emphasise, here, is that the EU ETS alone (i.e. without the EU enlargement and the unexpected "contribution" of the crisis) might have been insufficient to achieve the Kyoto Protocol target.

innovation (EI) and thus on the firms' capacity to abate pollution can be the object of a more direct investigation, both on the theoretical and on the empirical side. Carbon pricing can persuade the most virtuous firms to invest in new technologies, with a twofold aim: firstly, to avoid purchasing costly tradable permits; secondly, to sell, and thus monetise, the available permits in excess. Furthermore, innovative firms can gain early mover advantages from being at the forefront in the cap and trade market. This can allow them to acquire a dominant position, derived from the capacity to anticipate competitors in the implementation of environmentally friendly innovations (eco-innovations). The incentive to invest in low-carbon technologies, however, is diminished if the carbon price is low or extremely volatile.[16] In the former case, this is because a low carbon price leads firms to keep using the old, polluting technologies and buy pollution permits rather than shift to new environmentally friendly technologies. In the latter case, it is because high price volatility generates uncertainty about the actual profitability of investing in the new technologies, and about the expected advantages of eco-innovations.

As pointed out before (see section 1.11), in the last few years many contributions have tried to empirically evaluate the impact of the EU ETS on EI and the related literature is rapidly increasing along with the evidence on the ETS application experience.[17] Two main approaches can be distinguished within the empirical literature on this issue. On the one hand, several studies have performed analyses based on surveys of managerial interviews (e.g. Hoffman, 2007; Aghion et al., 2009; Rogge et al., 2011; Anderson et al., 2011; Martin et al., 2011; Schmidt et al., 2012); on the other hand, recent contributions have performed estimations of econometric models that account for the EU ETS among their covariates to test for the weak version of the Porter hypothesis (see Abrell et al., 2011; Borghesi et al., 2015; Calel and Dechezlepretre, 2016).[18] Mixed evidence and no unanimous consensus

[16] See, for instance, Popp (2002) for an empirical analysis of the innovation effects induced by energy prices in general.

[17] See Martin et al. (2015) for a review of the literature on this issue.

[18] As it is well known, the so-called Porter hypothesis (Porter, 1991) argues that environmental regulation can have positive effects on firms' competitiveness. Such a hypothesis has been the object of two interpretations: (i) environmental regulation may trigger innovation ("weak" version of the Porter hypothesis) and (ii) induced innovation may enhance firms' productivity ("strong" version). The aforementioned studies,

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emerges from the literature, that is still in its early stages of development, as it generally focuses on the early phases of the EU ETS due to a time lag in the data availability. In the near future it will certainly be possible to derive more precise and robust indications from the empirical analysis as the EU ETS experience goes on and longer time series of data become available for more refined analyses. In general, however, the main conclusion that can be drawn so far is that the EU ETS had at most a very weak impact on EI. This can be mainly ascribed to the uncertainty surrounding the functioning of a totally new market mechanism, as well as to the high price volatility observed in the first phase. The low propensity to perform EI is particularly remarkable in specific sectors and countries, such as the cement and ceramic industries in Italy (Borghesi et al., 2012). A similarly weak effect of the EU ETs on EI emerges also from sector analyses focusing on other countries, such as the German electricity sector (Hoffman, 2007), or on the EU as a whole (cf. Schmidt et al., 2012, for the power sector). These dynamics, which are to be verified for subsequent EU ETS phases, reinforce the necessity of deepening and expanding empirical research, particularly in those energy-consuming sectors (for example, cement and steel) in which EI is below the European average.

5. The other ETSs: differences and similarities

While the European Union was revising and fine tuning its own ETS, on the basis of the lessons learnt in phases one and two, a wide array of other ETSs emerged around the world. Among them, we will focus in particular on three ETS regimes as they seem to be quite comparable with the EU ETS: the Regional Greenhouse Gas Initiative (RGGI), the Californian Cap and Trade System and the Quebec Cap and Trade System.[19]

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therefore, focus on the weak version of the Porter assumption taking the EU ETS as specific example of environmental regulation.

[19] Several other countries and regions started to implement their own ETS or are planning to do so in the near future (e.g. New Zealand, Japan, Mexico, South Korea etc., see Newell et al., 2013). Among them, particular attention should be devoted to China that between 2013 and 2014 started implementing seven pilot projects in selected cities or provinces (Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei, Shenzhen) with the goal of developing a nation-wide ETS in the future. Despite the important role that these Chinese ETS programs may have in the years to come, we deliberately decided to exclude them from the present analysis since they are still in their early stages and due to the limited data availability concerning their recent application which prevents for the moment a proper comparison with the main ETSs examined here.

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The RGGI is a CO2 Budget Trading Program established as a result of a Memorandum of Understanding signed in 2005 by a group of 10 USA States wishing to develop a Cap & Trade Programme covering the power sector. It started in 2009 and, although quite limited in scope, it represents the first carbon emissions Cap & Trade experience in the USA. After the withdraw of New Jersey in 2011, it currently applies to 9 US States (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) and is structured in three-year compliance periods, named "control periods": 2009-2011, 2012-2014 and 2015-2017. It sets an overall multi-State wide cap on the CO2 allowances distributed among the participating States, which allocate them to the covered installations. Currently, it applies to 168 facilities distributed in the territory of the involved States.

The Californian Cap & Trade System, introduced by the Global Warming Solution Act of 2006, started in 2013 and covers almost 600 facilities, corresponding to 85% of the country's GHG emissions. It is structured upon three compliance periods: 1) 2013-2014; 2) 2015-2017; 3) 2018-2020. In particular, in the first period the scheme covered only the large industry and electricity sectors, while from the second period onwards it has been extended also to fuel transport, distribution and generation.

The Quebec Cap and Trade System was established in 2011, by the Regulation Respecting a Cap and Trade System for GHG Emission Allowances, and started in 2013. It initially covered almost 80% of Quebec's GHG emissions, and such percentage has increased up to 85% from 2015. It is structured upon the same three compliance periods as the Californian Cap & Trade System, namely: 2013-2014; 2015-2017; 2018-2020. In the 1st compliance period, the scheme covered industrial and electricity sectors only, while from the 2nd compliance period onwards it has been extended to fossil fuel distribution.

All the ETS regimes described above closely resemble the EU approach to ETS. Table 1 below provides a comparison of the selected ETSs, highlighting the most relevant aspects underlying their design and features. For the purpose of the comparative analysis, the EU ETS will be considered as a benchmark against which the other relevant ETSs will be described and assessed.

Tab. 1 – The EU ETS and the other ETSs: a comparison

	Starting date	Compliance periods (CP)	Target	Benchmark year	GHG	Sectors	Threshold	Deadlines (month-day)	Price ceilings and floor	Allocation method	Exemptions for carbon leakage	Offset programs	Banking / Borrowing	Sanctions
EU	2005	1st CP: 2005-07 2nd CP: 2008-12 3rd CP: 2012-20	20% by 2020	1990	CO_2, N_2O, PFC	Power, heat, energy-intensive industry, aviation	≥ 25 $ktCO_2e/y$ ≥35MW	04/30	Neither ceiling nor floor	Shift from grandfathering to auctioning	yes	yes (CDM/JI)	Banking not borrowing	100 €
California	2013	1st CP: 2013-14 2nd CP: 2015-17 3rd CP: 2018-20	BAU by 2020	1990	CO_2, CH_4, N_2O, SF_6, HFC, PFC, NF_3	Until 2015: first delivery of electricity. After 2015: gas and liquid fuels	≥25 $ktCO_2e/y$	04/10 (non power) 06/01 (power)	Floor not ceiling	auctioning	yes	yes (national)	Banking not borrowing	4*excess emissions
RGGI	2009	1st CP: 2009-11 2nd CP: 2012-14 3rd CP: 2015-18	2009-2014: BAU 10% by 2020	2009	CO_2	Fossil fuels only	≥25 MW	03/01	Floor not ceiling	auctioning	no	yes (national)	Banking not borrowing	3*excess emissions
Québec	2011	1st CP: 2013-14 2nd CP: 2015-17 3rd CP: 2018-20	20% by 2020	1990	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	Until 2015: industrial and electricity sectors After 2015: also fossil fuel distribution	≥25 $ktCO_2e/y$	01/11	Floor not ceiling	auctioning	yes	yes (national)	Banking not borrowing	3*excess emissions

Source: Authors' own elaboration.

Table 1 shows that, as far as their scope is concerned, all ETSs examined - with the exception of RGGI – present several relevant similarities and common features.

For instance, they all cover a wide range of GHG emissions beyond CO2. In addition to that, following the European model, all the regimes analysed establish exemptions for installations below certain similar thresholds. Furthermore, all ETSs have been divided in three compliance periods, although these obviously differ across the various regimes because of their different starting dates (with the exception of California and Quebec that started together and adopted the same compliance periods).

Moreover, all the ETSs analysed foresee the possibilities for linking with other project-based GHG emissions offset programmes. For instance, the EU ETS allows the use of CO2 reduction units generated through the implementation of the project-based mechanisms foreseen under the Kyoto Protocol (Clean Development Mechanism and Joint Implementation).

Following a similar approach, the RGGI, the Californian and the Quebec cap and trade systems allow the use of credits produced from national offset projects carried out in specific sectors.

An additional common feature to most of the ETS analysed refers to the possibility of applying banking and/or borrowing. In this respect, in line with the EU approach, all the three ETSs analysed (California, RGGI and Quebec) allow banking, but not borrowing of the allowances.[20]

Finally, with regard to the preferred allocation method, a common feature shared by all the regimes taken into account is the progressive shift from grandfathering to auctioning, originally envisaged in the EU ETS. Such a shift generated widespread worries within the industrial community of all countries, which led everywhere to the adoption of specific provisions against the risk of delocalisation of productive activities towards "ETS-free countries". In fact, in order to protect the sectors potentially exposed to carbon leakage, all the various ETS, apart from RGGI, include similar exemptions.

Beside the common features and similarities shown above, a closer look at the ETS regimes taken into account reveals that the followers took a different path on some relevant issues with respect to the pattern set by the EU. As to the sanctioning rules, for instance, while all ETS examined foresee the obligation for non-compliant firms to surrender the missing allowances in a subsequent period, some remarkable differences apply. In fact, the EU ETS provides for the application of a fixed monetary sanction of 100€ for each missing ton, whereas the RGGI, Quebec and Californian ETSs opted for a different sanctioning regime, establishing that non-compliant firms installations have to return, respectively, 3 times (for RGGI and Quebec) and 4 times (for California) as many allowances as those not surrendered in each given period. The existence of different sanctioning regimes may imply large differences in the complying costs for the operators being sanctioned. Just to provide an example, consider the current prices of EU-ETS, RGGI and Californian allowances.[21] Given

[20] As pointed out by Newell et al. (2014), banking is widely recognized as "an important tool to avoid short-term supply-demand imbalances and associated price movements". See Chevallier (2012) for a survey of the banking literature.

[21] To perform the numerical calculation we used the €/US$ exchange rate as of 28 January 2016 and the following allowances prices taken by the data sources indicated among brackets on the same day: (i) EU ETS= 6.09€ per allowance (https://www.eex.com/en/market-data/emission-allowances/spot-market/european-emission-allowances#!/2016/01/28); (ii) CARB: $13.23 per allowance

the corresponding sanction systems, a firm that emitted 50 tons in excess of the permits at disposal would have to pay 5304.5€ in the EU-ETS, 2434.32€ in the Californian system while only 1163.34€ in the RGGI.

As far as the target setting is concerned, while Quebec has chosen the same target of the EU, corresponding to a -20% emission reduction by 2020 (as compared to 1990 levels), the US-based regimes have chosen different paths (see Table 1). In fact, California merely aims at returning its emissions to the 1990 levels by 2020, while RGGI has chosen a stabilisation target for 2014 and a 10% reduction target for 2020 (as compared to 2009 levels). In this regard, the Californian target does not appear to be so stringent in absolute terms, while the RGGI choice of taking a different benchmark year for its emissions reductions (2009 instead of 1990) makes the systems not fully comparable to the others.

Another remarkable difference that sets the followers apart from the EU ETS concerns the adoption of price floors and ceilings. While the EU ETS has neither a price floor, nor a price ceiling,[22] a different choice has been made by the three other ETSs analysed, which have all chosen an intermediate path, whereby a price floor, but not a price ceiling is provided. Having a price floor has proved to be crucially important in particular for the US-based regimes, as both the RGGI and the Californian ETS allowance prices have basically hit the floor in their early stages of application. As emerges from figure 2 - that compares the price trends of the EUAs, Californian and RGGI carbon allowances for the period 2008-2015 - the Californian ETS has shown a price volatility that resembles the one characterising the EU ETS, with the Californian price that has fallen down to $12.22 in August 2013 moving on a declining trend towards its floor that was set at US$10/unit in 2012 and increasing 5% plus inflation rate every year. Even in the case of the flatter price trend of the RGGI, it is possible to identify a tendency of the emission price to decline towards the price floor, falling from 2.97 in 2009 to 1.96 in 2010 and tracking the floor price (US$1.86 in 2010 and US$1.89 in 2011) from

(http://calcarbondash.org); (iii) RGGI: $8.43 per allowance (https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=reportsv2.price_rpt&clearfuseattribs=true).

22 The only exception among the countries taking part to the EU ETS is represented by the UK that in August 2013 has unilaterally introduced a price floor equal to £16 per tonne of CO_2, which is expected to rise over time. The government decision has been criticised by many commentators, for the risk that companies pass the cost on to consumer energy bills and for the competition loss that UK firms may suffer as compared to their competitors in the rest of Europe where the price floor does not apply.

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September 2010 onwards. During that period the share of secondary market exchange-based transactions collapsed from 85% in 2009 to 6% in 2011, therefore the existence of a price floor prevented RGGI price from declining even further. In this regard, it may be argued that the followers of the EU ETS might have actually improved the functioning of their ETS with respect to the original EU model and that the introduction of a similar price floor in the EU ETS would have probably prevented the European price from collapsing.[23]

6. A few emerging trends from the comparative analysis

The analysis performed above has shown many common features in the different ETSs, especially with regard to their scope, allocation method and overall climate change goals to be achieved. As a consequence, a first trend that can be identified is that all the ETSs tend to converge to a common structure. Moreover, the ETS is recognised in all the countries analysed as a key tool to tackle climate change (Grubb, 2014). This notwithstanding, ETS is normally conceived as an "additional measure", that is an instrument to be used in parallel with others, so as to achieve GHG emissions reductions objectives. To this respect, in fact, all the countries analysed tend to implement their respective cap and trade schemes along with other renewable energy and energy efficiency instruments, within the broader context of their national climate change policy.

Furthermore, another emerging trend is the provision of special, softer regimes, protecting the national industrial sector from the major risks related to the loss of competitiveness as a consequence of the ETS obligations. All the ETSs analysed (RGGI excluded) endorse this choice, envisaging a direct, free allocation of allowances rather than auctioning, for some exposed sectors, while requiring a rigorous identification of the sectors benefiting from these special regimes (to be determined by the law) and usually providing for these exemption regimes to be temporary.

Finally, all the ETSs analysed foresee some possibilities of "linking" with other project-based GHG emissions offset programmes. For instance, the EU ETS allows installations to use

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23 For a discussion and comparison of the possible mechanisms to implement a price floor and the related implementation pitfalls see Wood and Jotzo (2011).

Clean Development Mechanisms and Joint Implementation credits for compliance purposes. Similarly, the RGGI, the Californian and the Quebec cap and trade systems allow the use of credits produced from national offset projects carried out in specific sectors, although the sectors involved differ across the ETSs. Moreover, all the ETSs allowing for such types of linking solutions, i.e. allowing the use of "external" credits for compliance purposes within the ETS, always set specific limitations in the amount or percentage of credits which can be used for that purpose, and prescribe specific conditions for the eligility of the projects generating the offset credits.

Beyond this "unilateral" kind of linking, with each ETS recognising credits produced from various offset projects, another common feature that is emerging among most ETSs is their effort to establish "bilateral" linking. By this we mean that one ETS can link to another ETS, so that both ETSs involved mutually recognise their allowances as eligible for compliance under either of the two programmes, thus enabling a two-way flow of allowances. So far, the only existing example of bilateral linking in operation is the one between California and Quebec, which has been established by means of an international agreement signed by the Parties in 2013. However, several other jurisdictions are currently considering the conclusion of similar linking agreements. For instance, the European Union had reached a preliminary agreement with Australia for a bilateral linking, to be started in 2018, but this was eventually abandoned due to Australian government's decision to repeal its ETS legislation after the 2013 elections. As a consequence, the European Union is now looking for other partners for the development of bilateral linking agreements that would allow to extend the carbon market and fully exploit the increasing returns to scale that larger markets can generate. The possible emergence of some bilateral linking agreements in the near future has the potential to modify the economic equilibria among the existing ETSs in the years to come and might jeopardise the leadership role played by the EU ETS so far, possibly transforming it from forerunner into follower again.

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7. Conclusions

The ETS is going through a crucial moment in the history of the climate change policy tools. It has become a milestone instrument for tackling climate change and is rapidly spreading in different jurisdictions, as the preferred tool for pricing carbon.

In such a context, the EU ETS represents the prototype regime with respect to all other similar experiences. The analysis conducted above has described the evolution of the EU ETS, from its origins to the present state, as well as its future prospects. As noted above, quite surprisingly, in recent years the EU has changed its role from follower (of the US) to forerunner in the ETS race. However, in this attempt to stand as a model for other countries, the EU ETS shows just a partial success, characterised by some remarkable achievements and a few important shortcomings.

The capacity of the EU to build a broad and encompassing carbon market in a short time is, in our opinion, the most astonishing feature that distinguishes this experience from all other ETS in the world. However, such rapid achievement has had its own drawbacks - i.e. high price volatility, governance issues and administration problems - as highlighted above.

Even the reported success of the EU ETS in reducing carbon emissions and inducing technological innovation is not a clear-cut result. In fact, the bright success of the sharp $CO2$ reduction is obscured by the dark shadow of the on-going crisis. Once the clouds of crisis begin to lift, one might wonder whether the success will stay bright, or $CO2$ emissions will start rising again.

Moreover, the expected technological improvement driven by the EU ETS is itself an object of debate. Further evidence will be needed in the future to disentangle this aspect and fully evaluate the real technological reactivity to the EU ETS.

Keeping these shortcomings in mind, as both lessons and warnings for the future, we have compared the EU ETS with three other relevant ETS regimes, namely the Regional Greenhouse Gas Initiative (RGGI), the Californian Cap and Trade System and the Quebec Cap and Trade System. These regimes have recently emerged as followers of the EU ETS. As argued in this paper, these followers share with the EU ETS some common flaws, especially in terms of price volatility, but they have also shown the capacity to innovate and possibly devise alternative ways to manage their own ETS regimes, which may in the long term jeopardise the EU leadership in the ETS context.

In particular, as far as price volatility is concerned, the decision by all followers to introduce a price floor turned out to be very useful to prevent their prices from decreasing even further during the recent deep recession. In this regard, the European Union should probably learn from the followers and introduce a price floor in the near future. If not, the price of the European allowances may keep falling and end up becoming an application of what could be provocatively defined "the polluter does not pay principle". In other words, without any price floor the price can become so low that polluters have no incentive to abate their pollution levels. If this is the case, the ETS would become nothing but one additional financial instrument, loosing the environmental motivation underlying its origin. A risk that, in our view, all ETSs should try to avoid, in order to preserve their credibility as suitable instruments to fight climate change in the future.

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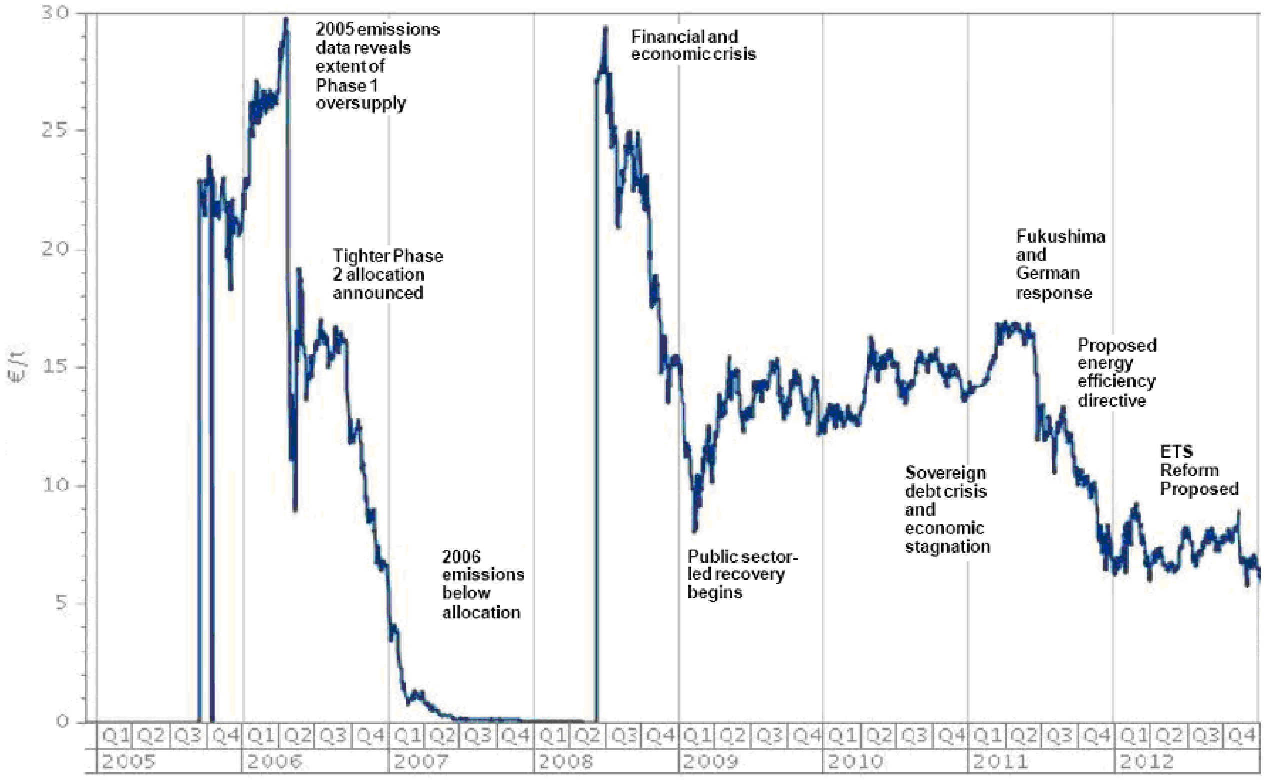
Figure 1: intertemporal evolution of EUA prices and major events in Phases I and II



Source: authors' own elaboration based on Point Carbon (2013) data.

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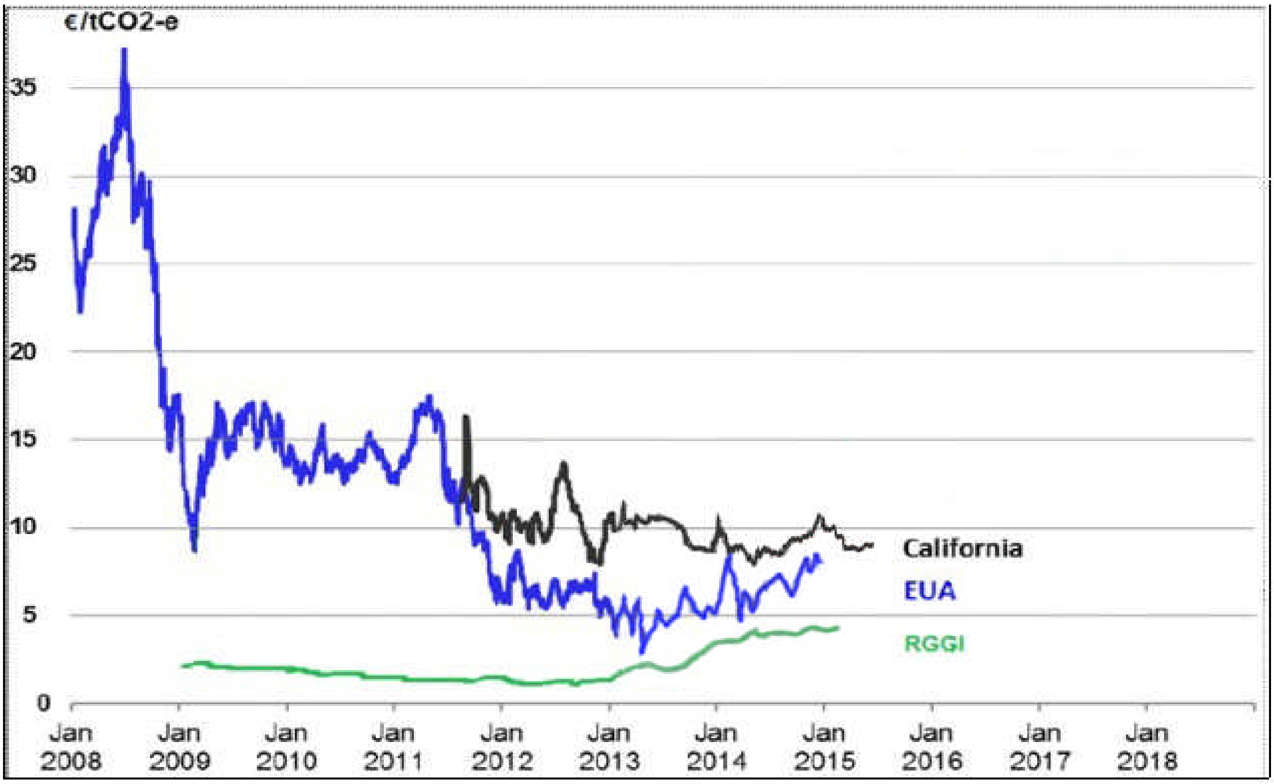
Figure 2: intertemporal evolution of emission allowance prices on different ETS markets



Source: authors' own elaboration based on Point Carbon (2013) extended using EEX data (https://www.eex.com/en#/en), CARB data (http://calcarbondash.org) and RGGI data (https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=reportsv2.price_rpt&clearfuseattribs=true).

Financialisation, Economy, Society and Sustainable Development (FESSUD) is a 10 million euro project largely funded by a near 8 million euro grant from the European Commission under Framework Programme 7 (contract number : 266800). The University of Leeds is the lead co-ordinator for the research project with a budget of over 2 million euros.

THE ABSTRACT OF THE PROJECT IS:

The research programme will integrate diverse levels, methods and disciplinary traditions with the aim of developing a comprehensive policy agenda for changing the role of the financial system to help achieve a future which is sustainable in environmental, social and economic terms. The programme involves an integrated and balanced consortium involving partners from 14 countries that has unsurpassed experience of deploying diverse perspectives both within economics and across disciplines inclusive of economics. The programme is distinctively pluralistic, and aims to forge alliances across the social sciences, so as to understand how finance can better serve economic, social and environmental needs. The central issues addressed are the ways in which the growth and performance of economies in the last 30 years have been dependent on the characteristics of the processes of financialisation; how has financialisation impacted on the achievement of specific economic, social, and environmental objectives?; the nature of the relationship between financialisation and the sustainability of the financial system, economic development and the environment?; the lessons to be drawn from the crisis about the nature and impacts of financialisation? ; what are the requisites of a financial system able to support a process of sustainable development, broadly conceived?'

FESSUD

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