Emission permits: financial intermediation and environmental policy

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- The European market for carbon dioxide emission permits (EU ETS) –launched in January 2005– as well as other national or regional initiatives, are paving the way towards a global market.
- These two events confirmed the emergence of **carbon finance** based on a new financial asset class: CO_2 asset

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  - At the end of each year, operators are required to **hold enough permits** to account for their installations' actual emissions.
  - Regulated firms can **buy** additional permits to meet their obligation or **sell** any surplus allowance generated from reducing their emissions below the initial allocation on the EU-wide market.

Carbon finance and the EU ETS

The EU ETS for carbon dioxide emission permits is currently the leading market for **allowance-based transactions** (roughly 99%)

Table 3.1: Reported volumes and value 2005, 2006, forecast 2007

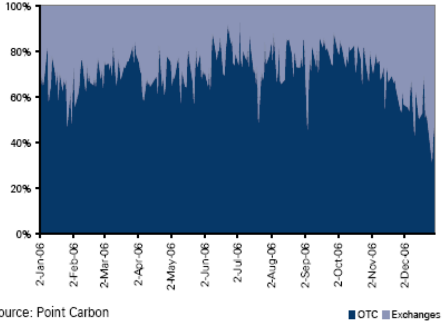
Reported and estimated volumes 2005 and 2006, together with forecasted volumes for 2007, in Mt CO2e and million €. 7 % discount rate employed for CDM and JI where price is at point of delivery. Prevailing carbon prices at time of writing for 2007 forecast.

	2005		2006		2007	
	Final figures		*Final figures*		*Forecast*	
	[Mt]	[€ million]	[Mt]	[€ million]	[Mt]	[€ million]
EU ETS total	362	7,218	1,017	18,143	1,750	18,503
- OTC + exch.	*262*	*5,400*	*817*	*14,575*	*1,550*	*15,903*
- Bilateral	*100*	*1,818*	*200*	*3,568*	*200*	*2600*
Other ETSs	7.8	52	31	300	50	500
CDM	397	1,985	523	3,349	456	3,260
CDM 2nd	4	50	40	571	96	1,061
JI	28	96	21	95	45	277
Sum	**799**	**9,401**	**1,632**	**22,458**	**2,397**	**23,601**

Exchanges vs. OTC

Most of the trades are currently OTC, but exchanges are becoming more and more important (from 25% up to 40% between 2005 and 2006)

Figure 3.4: Change towards exchanges?
The relative shares of daily volumes for the brokered and exchanged market in the EU ETS in 2006. Pure bilateral trades not included



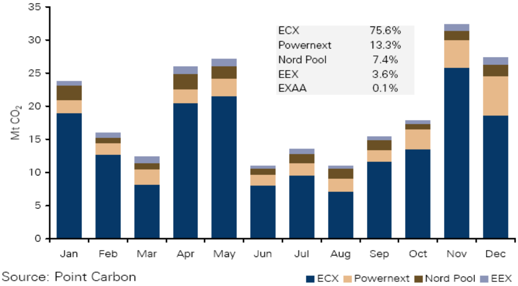
Source: Point Carbon

Trading exchanges

Among exchanges, the European Climate Exchange (ECX) currently dominates the market:

Figure 3.5: Still dominated by ECX

Monthly volumes of EUA trades in 2006 at the different carbon exchanges, in Mt CO_2.



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In the near future, trades are expected to take place in a **single centralized market**.

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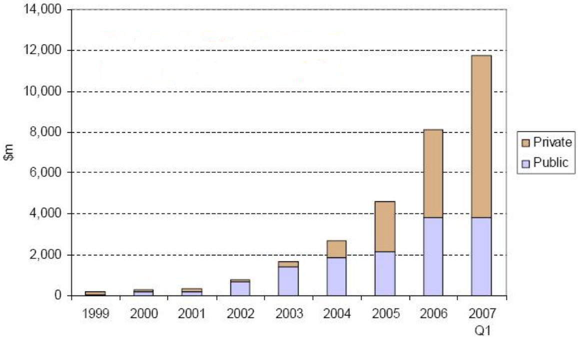
- **Non-compliance agents**: financial institutions (banks and insurance companies) and hedge funds purchasing allowances seeking to realise a capital gain on the sale of permits.

Carbon funds

Investment vehicle: carbon funds (58 funds at the end Q1 2007)

- **private-sector** investors: industrial companies (compliance) as well as speculators (non-compliance)
- **public-sector** investors: governmental funds (compliance)



Source: New Carbon Finance research

- **European Carbon Fund**: launched by Caisse des Dépôts and Fortis, it includes 11 investors among which Dexia, Société Générale, Caixa de Depositos, AGF and CNP Assurances.
- **Trading Emissions**: launched by a group of financial institutions including Crédit Suisse, HSBC, Société Générale and JP Morgan

	Type of fund	Programme name	Current investors	Year of launch	Investment objective or funds raised	CDM	JI	EUAs	Green AAUs
Private-sector funds	Investors : participants subject to emissions constraints	Japan GHG Reduction Fund	JBIC, DBJ, Japanese industry	2004	$140 million	√	√		√
		ICECAP	Seeking investors	2004	20 million tCO2	√	√		
		Greenhouse Gas Credit Aggregation Pool	26 companies (energy production)	2005	€455 million	√	√		
	Investors : financial institutions	European Carbon Fund	11 private-sector financial investors	2004	€130 million	√	√	√	
		Trading emissions	Financial institutions	2005	€258 million	√	√	√	
		Climate Change Capital	Not disclosed	2005	€80 million	√	√	√	
		RNK Capital	RNK Capital	2005	$25 million	√			

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  - what's the impact of **non-compliance agents** on emission markets (prices, expected return and volatility)?
  - what's the response of the **environmental agency** to the presence of non-compliance agents?

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- ... and before market opens...
  - Date 0: the **environmental agency** decides the total amount of permits to distribute to firms. It balances the social gains from reducing the total amount of emissions with the losses in production due to the constraint on emissions.

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- From the point of view of **aggregate welfare**, speculators improve/damage welfare depending on the model parameters.

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$$\underbrace{-p_1 \overbrace{(s_{i1} - s_{i0})}^{\text{date 1 net demand}} - p_2 \overbrace{(s_{i2} - s_{i1})}^{\text{date 1 net demand}}}_{\text{gains/losses from trading}}$$

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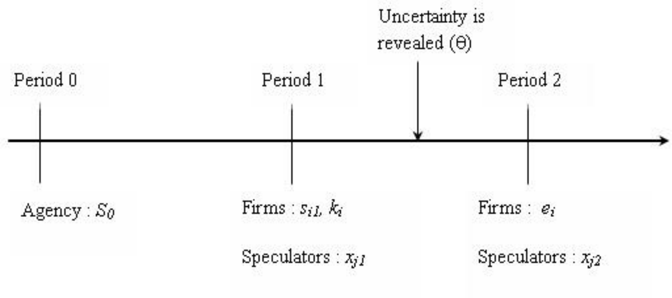
Uncertainty is revealed (Θ)
Period 0
Period 1
Period 2
Agency : S_0
Firms : s_{i1}, k_i
Speculators : x_{j1}
Firms : e_i
Speculators : x_{j2}

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  - market clearing:

$$S_2 - S_1 - X_1 = 0$$

$$p_2 = \left(1-\alpha\right)\left(\frac{K}{S_0}\right)^{\alpha}\theta$$

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  - market clearing:

$$S_1 + X_1 = S_0$$

$$S_0 = \frac{\tau}{\sigma^2} \left[\frac{\left(1-\alpha\right) r}{\alpha p_1}\right]^{\alpha} \left[\mu - \left(\frac{r}{\alpha}\right)^{\alpha} \left(\frac{p_1}{1-\alpha}\right)^{1-\alpha}\right] \quad \text{(nonlinear...)}$$

where τ is market risk-bearing capacity

$$\tau = \tau_F + \tau_S$$

Equilibrium properties

Proposition (eqm uniqueness and risk-hedging)

There exists a unique equilibrium price $p_1 > 0$*. In eqm, speculators buy permits at the first trading round, i.e.* $X_1 > 0$*, and expected returns are strictly positive,* $E(R) > 0$

- **Intuition**: Due to prod. shock, holding permits between the two rounds is risky. Speculators are ready to bear part of the risk firms face by holding the risky asset ($X_1 > 0$) provided that they are compensated for that. The compensation takes place through the (strictly positive) difference between $E(p_2)$ and p_1, i.e. through positive expected returns.

- Besides the traditional source of emission trading, i.e. differences across firms in their marginal cost of pollution control, this identifies risk-hedging due to uncertain future permits price as a second motive to trade permits.

The agency problem

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- green revenue (social welfare) is

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which means that it balances the social gains from reducing the total amount of emissions with the losses in production due to the constraint on emissions.

Proposition (uniqueness and damage costs)

The agency optimization problem admits a unique positive maximum $\hat{S}_0 > 0$ for which $W\left(\hat{S}_0\right) > 0$ if and only if δ is small enough, i.e. $\delta < \hat{\delta}$. Further, both the optimal amount of permits, $\hat{S}_0$, and the social welfare, $W(\hat{S}_0)$, decrease with δ.

- **Intuition**: if marginal damage costs are large, i.e. $\delta \geq \hat{\delta}$, the agency chooses to issue and allocate no emission permits at all, so that production –and therefore pollution– will not take place. Consistently, the higher the marginal damage (δ), the lower the amount of permits issued and the lower the social welfare.

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- ...it turns out that what matters is the relationship between τ_A and τ

Proposition (speculation and welfare)

$$\begin{aligned} \frac{d\hat{S}_0}{d\tau} &\geq 0 \quad and \quad \frac{dW\left(\hat{S}_0\right)}{d\tau} \geq 0 \quad if \quad \tau_A \geq \tau. \\ \frac{d\hat{S}_0}{d\tau} &< 0 \quad and \quad \frac{dW\left(\hat{S}_0\right)}{d\tau} < 0 \quad if \quad \tau_A < \tau. \end{aligned}$$

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  - If $\tau < \tau_A$, firms are too conservative from the agency standpoint: aggregate capital, production and a fortiori the risk-adjusted social utility of production are too low.
  - On the contrary, when $\tau > \tau_A$ the agency is more risk-averse than the market. In such a case firms are 'too liberal' from the agency's point of view: both K and Y are too large and output volatility $V(Y)$ negatively affects the social utility of production

- It is of particular interest to understand how speculators affect the equilibrium price p_1. We have

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  which shows that the impact of speculation on p_1 can be disentagled in two components.
- First, a **direct effect** (measured by $\partial p_1/\partial \tau$) that is for a given amount of initial permits S_0. Speculators' demand for emission allowances has an impact on the equilibrium price p_1. Changes in permit prices affect the optimal allocation of firms' resources between capital and energy and changes in firms' production plans will in turn have an effect on the aggregate welfare.

- The direct effect therefore brings in a second component measured by the second term $\frac{\partial p_1}{\partial S_0}\frac{dS_0}{d\tau}$. This second **indirect effect** takes into account the reaction of the agency to the entry (or exit) of speculators that modifies τ. Such reaction translates in a variation of the optimal amount of permits (measured by $dS_0/d\tau$) which in turn induces a further change in p_1 (measured by $\partial p_1/\partial S_0$).

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- To summarize, speculation exerts a direct effect on the permits equilibrium price when speculators submit their demand, and an indirect effect through the amount of permits optimally chosen by the agency.

- The overall effect on p_1 is a-priori non trivial, however we have

Proposition

The equilibrium price $p_1 = p_1(\hat{S}_0)$ increases with τ and expected returns and volatility decrease with τ.

- **Intuition**: when the market risk-bearing capacity increases, holding permit inventories becomes less risky and the compensation for holding them, i.e. $E(R)$, necessarily decreases. Moreover, as the market risk-aversion lowers, we have that p_1 increases (direct effect dominates). Therefore, the combined effect of higher date 1 prices and lower expected returns is a decrease in permits volatility $V(R)$.

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  - Speculators reduce expected returns as well as volatility
  - Social welfare depends on the risk-bearing capacity of the market (which in turn depends on the risk attitude of the market participants', i.e. firms and speculators) as well as on the regulator's attitude towards risk.