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PORTFOLIO MANAGEMENT OF EMISSION PERMITS AND PRUDENCE BEHAVIOUR

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HOW DOES UNCERTAINTY AFFECT THE TRADING OF EMISSIONS ?

Demand uncertainty

Production and emissions uncertainty

Technological uncertainty

Abatement costs uncertainty (new technologies)

Regulatory uncertainty

Size of the future emissions limit, future number and types of regulated firms, new trading rules, uncertainty on trade approval

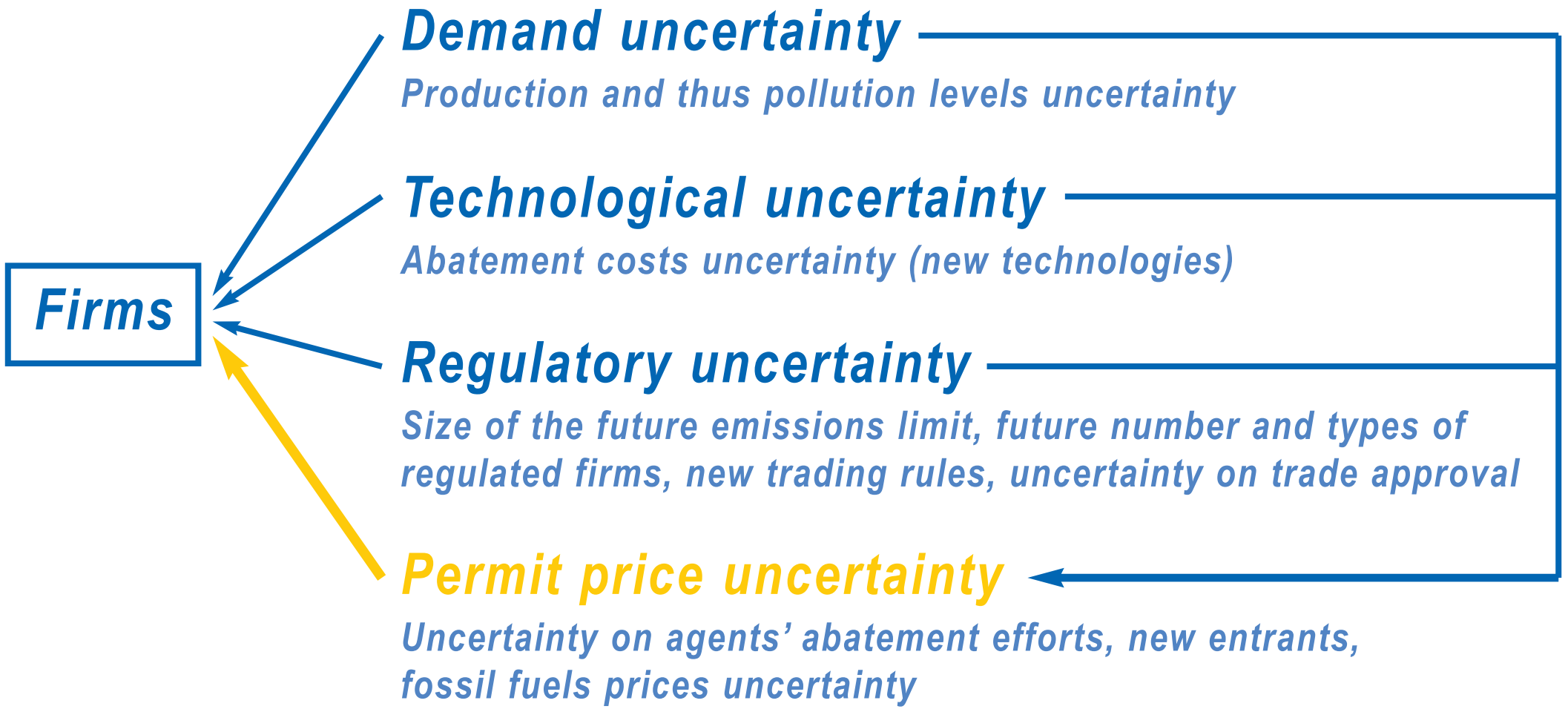
Permit price uncertainty

Uncertainty on agents' abatement efforts, new entrants, fossil fuel prices uncertainty

PREVIOUS LITERATURE

Authors	Approaches	Types of Uncertainties	Main Findings
Carlson & Sholtz (94)	Experimental Economics	Emissions Level Uncertainty	Uncertainty faced by regulated firms about their total emissions creates price instability
Godby & Al. (97)	Experimental Economics	Emissions Level Uncertainty	Idem
Montero (98)	Analytical & numerical Models	Regulatory Uncertainty Uncertainty on Trade Approval	Uncertainty and transaction costs suppress exchanges that otherwise would have been mutually beneficial
Hennessy & Roosen (99)	Analytical Model	Emissions Level Uncertainty Uncertainty on input quality	Uncertainty about the magnitude of pollution tends to reduce production activities relative to the situation of non-stochastic pollution with the same rate of emissions
Ben-David & Al. (2000)	Analytical Model & Experimental Economics	Permit Price Uncertainty	Abatement efforts of risk-averse sellers (buyers) are lower (higher) under uncertainty than under certainty
Baldursson & Fehr (2004)	Analytical Model	Emissions Level Uncertainty	«... when firms are sufficiently risk averse trade will be limited ; in particular, infinitely risk-averse firms would not trade at all.»

THE OVERALL UNCERTAINTY IS INCLUDED IN THE PERMIT PRICE



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MICROECONOMIC MODEL OF A RISK AVERSE FIRM UNDER PERMIT PRICE UNCERTAINTY

- *Portfolio management of emission permits inside a compliance period*
- *Use the concept of prudence developed by Kimball (90, 93) to analyze the precautionary saving of permits*
- *Analytical explanation of the low trade volumes and high prices volatility observed on emission permits markets*

(Acid Rain Program or OTC NOx Budget Program for example)

WHY PORTFOLIO MANAGEMENT ?

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PORTFOLIO MANAGEMENT OF EMISSION PERMITS IS UNJUSTLY FORGOTTEN IN THEORETICAL ANALYSIS

- ***Theoretical analysis assume that production and compliance occur at the same time***

- ***In practice, there is a time-lag between production and compliance***

  Emission permits distinguish from other energy commodities by the fact that these inputs are not immediately needed for production

- ***This time-lag necessitates portfolio management of emission permits even if permits are allocated free of charge***

  In the Acid Rain Program the value of the emission permits portfolio of an electricity producer exceeds in a lot of cases 500 millions $ with a market price volatility in the order of 40 %

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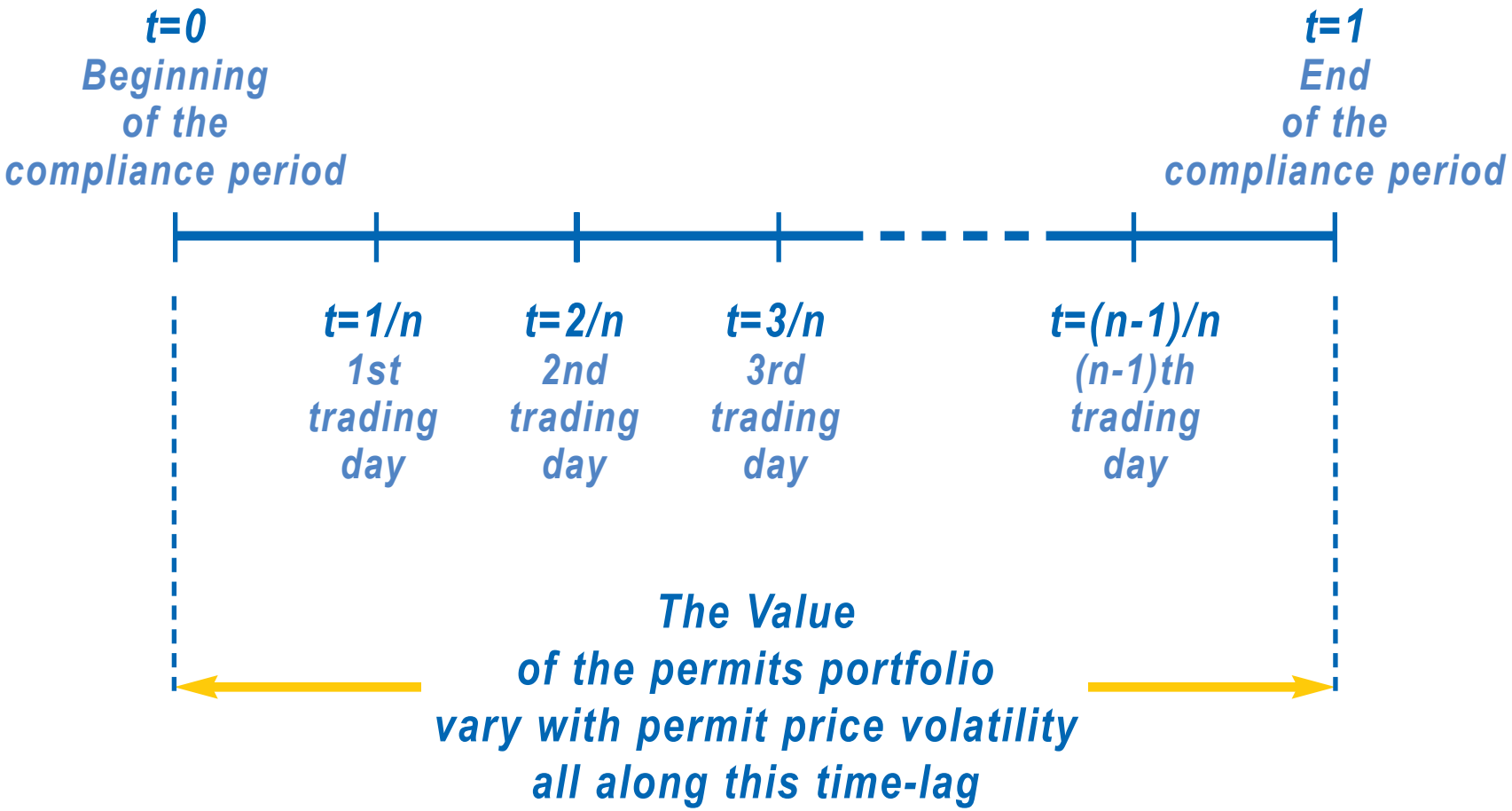
PORTFOLIO MANAGEMENT OF EMISSION PERMITS INSIDE A COMPLIANCE PERIOD



DIFFERENCE WITH BANKING

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BANKING
=
PORTFOLIO MANAGEMENT OF EMISSION PERMITS BETWEEN COMPLIANCE PERIODS

BANKING IS NOT STUDIED IN OUR MODEL

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WHAT IS PRUDENCE ?

- ***In a consumption framework*, it is widely believed that the uncertainty affecting future incomes raises savings**

- **Agents who behave in this way are said to be prudent**

- **Prudence is an old idea without a real explanation**
  First discussions : Keynes and Hicks
  Further analysis : Leland (68), Sandmo (70) and Drèze & Modigliani (72)

- **Risk aversion doesn't allow to explain precautionary saving**

WHAT IS PRUDENCE ?

- *Precautionary saving is really explained by Kimball (90) who definitively introduce the concept of prudence*

- *Kimball establishes the relationship between the characteristics of the utility function and the precautionary saving :*

  An agent is prudent if adding an uninsurable zero-mean risk to his future wealth raises his optimal saving

  An agent is prudent if and only if the marginal utility of future consumption is convex ($u'''>0$)

  An agent can be risk averse but not prudent
  (For example, an agent with a quadratic utility function : $u''<0$, $u'''=0$)

OUR APPROACH

- *Because of the time-lag between production and compliance, the firm has to choose between selling and saving permits*

- *In a production framework, we try to understand the precautionary saving of emission permits with the concept of prudence*

MODEL ASSUMPTIONS

1 - The compliance period is divided in two exchanges periods ($t=0,1$)

2 - The firm knows exactly during the periods :
- its market demand
- its production and pollution levels
- its rates of profit (π_0, π_1)

3 - The firm has already done abatement effort in such a way that :
- it is technological not possible to reduce pollution during these periods
- its initial allocation of permits e matches with its pollution needs for the compliance period

4 - The utility function u is concave for both periods

5 - No transaction costs

6 - Permits price vary from p_0 to p_1 during the periods :
- p_0 is perfectly known in 0
- p_1 is not known in 0

THE PROBLEM OF THE FIRM

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t=0 — **t=1**

Beginning of the compliance period
Initial allocation of permits
1st trading day
Trading price = p_0

End of the compliance period
2nd trading day
Trading price = $\tilde{p}_1$

The firm chooses :
a quantity b of permits to save in its portfolio
to sell $(e-b)$ permits at the known price p_0

The firm :
has to buy $(e-b)$ permits
at the unknown price $\tilde{p}_1$

The problem of the firm is to maximise :

$$H(b) = u_0[\pi_0 + (e-b)p_0] + E\,u_1[\pi_1 - (e-b)\tilde{p}_1]$$

MODEL RESULTS

1 - If the agent is prudent, then his willingness to save permits increases compared to the certainty case

2 - Prudence is a sufficient and necessary condition for a lower amount of trading

MODEL INTERPRETATION

1 - The low trade volumes and high prices volatility observed on several emission permits markets may be explain by prudence behaviours

2 - If agents are prudent, possible welfare gains exist from governmental intervention in the permit market

Baldursson & Fehr (2004) :

« The government may be able to improve the performance of a tradable quota system by judicious choice of distribution and amount of initial quotas and by trading pro-actively in the quota market.»

Although this policy recommendation is not new (Dales, 68), it is however not implemented into practice

CRITICAL ANALYSIS OF THE MODEL

ORIGINAL ASPECTS OF THE MODEL

- **Portfolio Management approach**
  The time-lag between production and compliance is taken into account
- **Study of the precautionary savings behaviour**

LIMITS OF THE MODEL

- **No abatement effort during the periods**
- **The model takes into account only one uncertainty**
- **The firm is neither a net seller nor a net buyer of permits**
  Results may not be very different because being a net seller or a net buyer of permits does not affect the utility function

FURTHER RESEARCHES

- *Study of the precautionary savings of a net seller and a net buyer of permits*
- *Taking into account at least two uncertainties*
- *Banking and prudence behaviour = portfolio management of emission permits between compliance periods*
- *Introduction of forwards trading*

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