Environmental Rights on the Futures Markets
*An Application to the Dutch Manure Market**

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Abstract. A study was carried out to analyze futures markets for tradable rights after a cash market was initiated. Furthermore, some indication was given on the size of such a futures market to provide insight into its viability. Futures markets can play a role in solving environmental problems, by making the market for pollution rights (i.e. P_2O_5 rights) and agro rights (milk rights, sugar rights and P_2O_5 rights) more effective and transparent. Moreover, the market for tradable rights would be able to meet the users' need for hedging. This paper investigated the possibility of introducing a futures markets for tradable P_2O_5 rights and the commodity manure. Because there is already a cash market for manure, although not well developed yet, and there will be a cash market for P_2O_5 rights, a futures market is a logical sequel. The futures market can play a role in implementing agricultural policy efficiently and with respect to manure and P_2O_5 rights can be an economically efficient solution to environmental problems.

Key words: Environmental rights, tradable permits, manure, futures markets

1. Introduction

The market for tradable rights, such as SO_2 permits, is expanding. In the Netherlands, for example, problems with P_2O_5 emissions on account of intensive livestock production are tackled by the allocation of P_2O_5 rights.

In the U.S., a first start in developing a spot and futures market for permits (rights) was made by initiating the Acid Rain Program. The overall goal of the Acid Rain Program (ARP, established by Title IV of the Clean Air Act Amendments of 1990) was to obtain significant environmental benefits through reductions in emissions of sulfur dioxide and nitrogen oxides, which are the primary causes of acid rain. To achieve this goal at the lowest possible cost to society, the program employs market-based approaches for controlling air pollution. In addition, it encourages energy efficiency and pollution prevention. The Program introduced a permit (not a property right) trading system that harnesses the incentives of the free market to reduce pollution (EPA, 1993; Tietenberg, 1989; Sandor, 1991; Walsh, 1992).

Despite the fact that the U.S. has taken the first steps in developing a spot market and a futures market, a centralized spot market for rights (i.e. milk rights) has run in Ontario since 1980, followed by Quebec that started in 1985.

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Since 1984 there has been a decentralized spot market for rights (i.e. milk rights) in the Netherlands and the United-Kingdom.

The possessor of (environmental) rights bears the risks. Price fluctuations cause changing values of the right. Futures markets are an effective tool to deal with these price risks and hence will result in more efficient decisions. In this article, the possibilities and limitations of futures markets for environmental rights are discussed and an application to Dutch phosphorus rights, issued by the Dutch government is presented.

In Section 2, some government policy options for abatement are discussed, which show that the introduction of a rights system is an efficient way for handling pollution problems. Sections 3 and 4 deal with the cash market for rights and the risk involved for users in general and for the Dutch P_2O_5 rights in particular. In Sections 5 and 6, some basics of futures markets and some models for futures markets for environmental rights are presented and applied to the Dutch P_2O_5 market. The viability of this futures market is discussed in Sections 7, 8 and 9. This paper ends with an evaluation.

2. Policy Options for Abatement in the Presence of Rights

In practice, many conditions of the model for perfect competition have not been satisfied. One broad class of violations are those occurring when an agent making a decision does not bear all economic consequences of his or her action, the so-called externality. An externality is caused by the fact that the property rights structure is not exclusive. Externalities cause the market price to diverge from social costs and benefits. In general this brings about an inefficient allocation of resources and enhances government intervention in the market. The government has different tools to internalize externalities such as regulation, levies and the introduction of environmental rights (Bressers, 1988; Huppes, 1992).

A tool often suggested nowadays to internalize externalities efficiently is the introduction of rights. A right is a permit from the government or public authority to perform actions which are legally forbidden without approval from the government or public authority. In the case of pollution rights we can make a distinction between a geographic transfer and a temporal transfer. A geographic transfer means a transfer of the right to another location. A temporal transfer means that the right can be used not only upon maturity but also during another time. In other words the right can be banked. As to a temporal transfer we can distinguish between a permanent transfer or a temporary (lease) transfer (Peeters, 1992; Tietenberg, 1992).

Trading systems of rights can be characterized in terms of a number of important attributes, including scope of coverage, degree of government intervention, the technical basis for the trading, and its geographic limits. The geographic area in which trades are permitted is largely determined by the type of pollutant. If the pollutant spreads widely and has adverse effects even if the concentration is low, the geographic area is likely to be large. In other cases many pollutants have adverse effects primarily on a small local or regional area. An example is the manure problem in the Netherlands (Hahn, 1984; Oskam, 1991).

Usually, when the efficiency of a system of tradable rights is involved, costs of the emission reduction are minimised under the constraint of the minimum required reduction in the emission (Tietenberg, 1985). However, in this case, the system of tradable manure rights is considered efficient if it ensures maximum profit w of a region's livestock farming sector as a whole and for each individual farm under the given constraints of a maximum allowed amount of manure M in the region.[1] Manure is in this context embedded to minerals.

It is assumed that there are n farms in the region considered. Total costs c_i of farm i including the cost of manure transportation and the costs of levies, excluding the costs to be paid for the manure right consisting of the price p_m times the number of right m_i, are assumed to be a rising function of production q_i, while the production manure ratio μ_i is assumed to be fixed for each farm i^2. So:

From this it follows:

$$c_i = c_i(q_i), \quad \frac{dc_i}{dq_i} > 0, \tag{1}$$

$$q_i = \mu_i m_i. \tag{2}$$

From this it follows:

$$c_i = c_i(\mu_i m_i) = \mu_i c_i(m_i), \quad \frac{dc_i}{dm_i} > 0. \tag{3}$$

With a fixed price p of the final product and the market price p_m for the price of the manure rights m_i, total revenue r_i and profit w_i of farm i equal respectively:

$$r_i = pq_i = p\mu_i m_i, \tag{4}$$

$$\text{wi} = r_i - c_i = p\mu_i m_i - \mu_i c_i(m_i) - p_m m_i. \tag{5}$$

It is assumed that farms strive for profit maximisation. From the last equation it follows that farm i's is maximised if:

$$\frac{dw_i}{dm_i} = \mu_i p - \mu_i \frac{dc_i}{dm_i} - p_m = 0, \quad \text{or:} \quad \mu_i \left(p - \frac{dc_i}{dm_i} \right) = p_m.$$

Profit maximisation problem for the sector as a whole may be formulated as follows:

$$\text{Max } W = \sum_{i=1}^{n} w_i = p \sum_{i=1}^{n} \mu_i m_i - \sum_{i=1}^{n} \mu_i c_i(m_i) - p_m \sum_{i=1}^{n} m_i, \tag{6}$$

subject to: $\sum_{i=1}^{n} m_i = M$.

Because it is assumed that the constraint of the maximum amount of manure allowed is restrictive, the "lesser than or equal to" sign can be replaced by an "equal" sign, hence we can apply the Lagrange procedure.[3] Thus:

$$\text{Max } L = p \sum_{i=1}^{n} \mu_i m_i - \sum_{i=1}^{n} \mu_i c_i(m_i) - p_m \sum_{i=1}^{n} m_i - \lambda \left(\sum_{i=1}^{n} m_i - M \right), \tag{7}$$

subject to: $\sum_{i=1}^{n} m_i = M$.

The first order conditions for a maximum are:

$$\frac{\partial L}{\partial m_i} = p\mu_i - \mu_i \frac{\mathrm{d}c_i}{\mathrm{d}m_i} - p_m - \lambda = 0, \quad (1 \leq i \leq n).$$

It follows, that in the maximum:

$$p_m = \mu_i \left(p - \frac{\mathrm{d}c_1}{\mathrm{d}m_1} \right) = \mu_2 \left(p - \frac{\mathrm{d}c_2}{\mathrm{d}m_2} \right) = \mu_3 \left(p - \frac{\mathrm{d}c_3}{\mathrm{d}m_3} \right) = \ldots = \mu_i \left(p - \frac{\mathrm{d}c_i}{\mathrm{d}m_i} \right) = \ldots = \mu_n \left(p - \frac{\mathrm{d}c_n}{\mathrm{d}m_n} \right). \tag{8}$$

This means that, in equilibrium, the marginal revenue of the manure right equals the marginal costs for all farms in the region. This result implies that, under the given constraint of the maximum amount of manure M and given price p, profits are maximised when all rights are sold at the equilibrium price p_m.

The equilibrium price may be found by way of an auction.[4] The auctioneer announces a price and considers how many permits are sold at this specific price. He continues doing so in a systematic way till he has reached a price at which all permits have virtually been sold. In this way, the equilibrium price is set and every farmer can buy the manure rights he wants at the equilibrium price. Of course, this can only work properly with perfect competition at the demand side of the market.

A system that is based only on administrative regulations might not be as efficient, because, in practice, it is impossible to estimate the marginal productivity function of each farm. Besides, marginal productivity functions tend to change over time. The conclusion is that a system of tradable manure rights may be more efficient than a system that consists only of administrative regulations.

Once the firm understands how the rights market functions and knows the price per right, it can start to formulate and evaluate alternative courses of action. The various actions to choose from (inexhaustive list) are:

- Purchase the necessary right each year for a specific period.
- Purchase in year x all the necessary rights to cover the period of operation.
- Install reduction methods, for example increase μ in our presented model by using different feed concentrate.
- Purchase the necessary rights in year x, install reduction methods at a future date and sell the rights previously purchased.
- Continue emissions without purchasing any rights and be penalized for violations.

In practice it is impossible to estimate the future price per right, which causes uncertainty and by that means inefficient decisions. The future market is a tool to solve the above-mentioned problem. By making use of the futures markets of rights the firm can lock in the price and will be able to hedge against (adverse) price fluctuations. The futures market of rights is an economically efficient tool in planning ahead for users of rights.

3. Cash Markets of Rights: The Dutch P_2O_5 Rights Market

The cash market for rights shows some characteristic features. The amount of environmental rights is in general predetermined by the government. This implies that the total (aggregate) supply of rights is fixed, although there can be some fine tuning regulations with respect to the trade of rights. For example, trade may only be allowed in particular areas. Another type of fine tuning regulation is the fixed percentage of reduction in the amount of rights by the government when rights are traded. The demand for rights is a derived demand as are means of production. The demand for rights will be an outcome of many factors like final product price, interest rate, levies, etc. A right is a perfect homogeneous 'commodity', which implicates that the right is a very fungible 'commodity' on the cash market.

In the Netherlands livestock production has been expanding enormously in the past twenty years. Consequently, there is an over production of manure from the environmental point of view. Overload causes problems of minerals in the soil like eutrophic, nitrate loading of groundwater and acidification. These environmental problems made it necessary for the Dutch government to introduce a manure policy. Since 1987 the Netherlands has had legislation on manure. The Dutch government has introduced a manure production right. By this policy instrument it tries to solve the problem. Another related instrument is the manure accountancy. Every producer of manure has to record how many minerals enter the production unit and how many are removed from the production unit. In this way every mineral can be traced (Baltussen, 1992, 1993; Nentjes, 1990).

In the 'Manure' Act it is arranged that a farm is in principle not allowed to produce more manure than an equivalent of 125 kilograms of phosphorus per hectare of land. This land has to be the property of a farmer or in use on the basis of a tenancy. Farmers who recorded their livestock on 31 December 1986 have been allocated P_2O_5 rights by the government. This amount can be smaller or bigger than the 125 kilogram phosphorus limit.

If a farmer has been granted in 1986 an average P_2O_5 rights of more than 125 kilograms per hectare, he is allowed to produce phosphorus up to his P_2O_5 rights. The phosphorus surplus, i.e. the amount of phosphorus exceeding the legal limits (this amount depends on which crop is grown on the land), has to be removed from the farm. The farmer has to pay a levy because he produces more than 125 kilograms of phosphorus per hectare. Moreover he should have a manure record system. A farmer with a production of 125 kilograms of phosphorus per hectare or less does not have to pay a levy, does not need to have a manure record system and may increase his production up to 125 kilograms per hectare.

Since January 1994 it has been possible to buy P_2O_5 rights (the free transferrable part of the rights, which was defined in the Act). Purchased rights will be added to existing P_2O_5 rights. A farmer who intends to produce more than 125 kilograms of phosphorus, needs to buy P_2O_5 rights. If a farmer under the conditions of the new Act purchases more than 125 kilograms per hectare he must be able to remove the phosphorus surplus from his farm and prove that to the government.

A farmer with a high production of phosphorus production per hectare who wants to increase his production has three possibilities under the new 'Removing manure production' Act.

(1) To buy P_2O_5 rights; through this transaction his average production of phosphorus per hectare will exceed the 125 kilogram limit and he has to pay a levy and will bear the cost of removing the surplus phosphorus from his farm.
(2) To buy land in order to produce manure up to 125 kilograms of phosphorus per hectare without paying a levy.
(3) Combination of possibilities 1 and 2.

4. Risk Involved for Users of Rights (i.e. P_2O_5 rights)

When the spot market for P_2O_5 (phosphorus) rights is established after the 'Removing manure production' Act has come into operation, there is a possibility for a futures market. With the creation of tradable rights, phosphorus rights markets involve a price risk for the users (i.e. intensive livestock farmer). In order to comply with the new legislation, an intensive livestock farmer (a farmer who produces more than 125 kilograms of phosphorus per hectare) who wants to increase his production may either purchase phosphorus rights or reduce phosphorus production. Phosphorus production methods can be achieved by a reduction of phosphorus output per animal or a reduction of the livestock. Reduction of phosphorus per animal involves making use of feed with a low concentrate of minerals and breeding animals with a better feed conversion. The intensive livestock farmer will make this decision on the basis of the net profit involved in the above-mentioned possibilities. A farmer with relatively low marginal abatement costs (i.e. reduction in phosphorus production) will invest in phosphorus reduction measures. If his measures to reduce the phosphorus production are successful, he may be able to sell some P_2O_5 rights. A farmer with relatively high marginal abatement costs but with a relatively high processing margin (exclusive abatement measures) may decide to purchase P_2O_5 rights. Because prices of P_2O_5 rights, manure, abatement, meat etc. fluctuate, he runs a price risk (adverse price fluctuations in the cash market) the so-called processing margin risk. The intensive livestock farmer may make use of three markets to manage a part of his processing margin risk, namely 1) the market of phosphorus rights, 2) the market of hogs and 3) the market of manure, where the market of manure is the market where the livestock farmer has to sell the surplus manure he produces on his farm.

Whether farmers are inclined to hedge rights depends on their risk attitude. We will illustrate this for a farmer being risk averse, with a constant average risk attitude measure λ. We assume that this farmer is hedging only his rights by buying those rights in the future market (i.e. long hedging). Furthermore it is assumed that production does not vary as a result of variation in weather conditions or unexpected diseases. The latter assumption seems reasonable for the production considered, pig raising and dairy farming. Following Robison and Barry (1987) we will demonstrate that the variance in price of rights in the spot market has a positive impact on hedging. It is assumed that the price of the right is the only factor of uncertainty in the profit maximisation problem. The objective of profit maximisation for a farmer, who is constantly absolute risk averse with a constant average risk attitude measure λ, can be expressed, on the basis of the certainty equivalent model as:

$$\Omega = E(\pi) - (\lambda/2)\text{Var}(\pi), \tag{9}$$

where π is the profit and λ is the risk parameter which is positive, assuming the individual is risk averse. If the only price uncertainty, in determining the profit, is the input price of the right then the profit can be expressed as:

$$\pi = R - [(P + \varepsilon)(q - h) + P_f h] - C(q) - F, \tag{10}$$

where R is the turnover (output times output price); $P + \varepsilon$ is the current spot price of the right with expected value P and variance σ_ε^2; q is the total input of rights; h is the hedged input; P_f is the future price of rights minus the transaction costs, it is assumed that there is no basis risk; $C(q)$ are variable costs and F are fixed costs.

The expected profit is:

$$E(\pi) = R - [P(q - h) + P_f h] - C(q) - F. \tag{11}$$

Similarly, the variance of profits is

$$\sigma^2_{(\pi)} = (q - h)^2\sigma^2_\varepsilon. \tag{12}$$

The certainty equivalent model can now be formulated as

$$\pi_{ce} = E(\pi) - (\lambda/2)\sigma^2_{(\pi)}, \tag{13}$$

where $\lambda/2$ is the trade-off at equilibrium between the expected profit and the variance of profit. By substituting (11) and (12) into (13), the objective function can be written in terms of the level of risk,

$$\text{Max } \pi_{ce} = R - [P(q - h) + P_f h] - C(q) - F - \lambda/2(q - h)^2\sigma^2_\varepsilon. \tag{14}$$

To determine the optimal holdings of futures contracts, the objective function is differentiated with respect to h. After setting the first order condition equal to zero one obtains:

$$h = q - \left[\frac{-P + P_f}{\lambda\sigma^2_\varepsilon}\right]. \tag{15}$$

This relationship indicates the condition required for a complete hedge. If the expected spot price P equals P_f, the total cash position will be hedged because a risk aversive farmer will always exchange an uncertain price for a certain one if the latter equals the expected value of the uncertain one. But the expected spot price P and the futures price P_f may not be equal. Very important to note is the fact that the expected spot price P of the right and the futures price of the right P_f are costs in respect to the objective function (i.e. are negative prices). The more risk-averse the farmer and/or the more price fluctuations in the spot market of the right, the greater the level of hedging for a constant positive difference between P_f and P. Only if P, the expected spot input price of the right, exceeds the certain future price the risk-averse firm will speculate because the expected value of the difference between buying and subsequently selling (i.e. long liftings value) is positive.

Differentiating h in equation (15) with respect to σ^2_ε yields the farmer's level of hedging response to an increase in the variance of the expected spot input price of the right,

$$\frac{\delta h}{\delta\sigma^2_\varepsilon} = \frac{(-P + P_f)}{\lambda(\sigma^2_\varepsilon)^2}. \tag{16}$$

The response to an increase in the variance of the spot input price of the right is unambiguously positive as long as $P_f > P$.

5. Basics of Futures Markets

If the cash prices of rights in the future are known with certainty, there is no reason to establish a futures market. Uncertainty introduces two motives for futures trading. First, as Keynes and Hicks originally noted, uncertainty may produce a desire to transfer risk. Those with large endowments will want to hedge by selling future contracts on the futures market (i.e. going short), while those with future requirements will tend to buy future contracts (i.e. going long). Under uncertainty, differential information provides the second motive for futures trading. As long as the market price does not aggregate all information perfectly, different beliefs will lead to futures trading. Both motives account for the volume of trading that can be observed on the market at any point in time.

To establish a futures market there has to be a lively spot market. The establishment and operation of a cash market for rights by an electronic data interchange system could accelerate this evolution, although it is not necessary for establishing a futures market. Although there is no evidence yet of a successful futures market for pollution rights, there are reasons to believe that these rights lend themselves for trading in futures.

The role of a futures market is to provide a mechanism for price discovery as well as for hedging. In order to capture these benefits, a set of conditions for a successful market has to be fulfilled: homogeneity of the product; existence of a spot market; competitive markets; price variability; inefficient hedging alternative and well defined contract specification. It is not necessary that the contract specification on the futures markets equals the spot market specification exactly. Cross-hedging is a commonly used method in futures markets, where cross hedging can be defined as hedging a commodity in the future market which is closely related to the underlying commodity of the futures contract (Black, 1986; Working, 1953).

The first prerequisite for a successful futures market is that it is used for hedging. Substantial hedging interest draws speculators to the market. Both speculation and hedging are necessary for continued contract use. Speculators are crucial to a contract's success because they provide the liquidity that permits hedgers to put on and take off their hedges at relatively low cost. The lack of sufficient liquidity in most newly initiated futures markets results in the relatively high cost of hedging, which inhibits contract growth.

6. A Proposal for Implementation of P_2O_5 Futures Contracts

On a futures market transactions are standardised with respect to commodity characteristics, time of delivery, delivery location, and unit of trading (Sandor, 1973). On futures market for commodities, this standardisation process is very complicated, especially with respect to location of delivery and commodity characteristics (such as sort and form), this being in contrast with the futures markets for rights. A right is a perfect homogeneous 'commodity', which implicates that there are no problems with respect to delivery, also the location of delivery is of no importance because delivery takes place by book entry transfer between accounts in the rights book entry system (no transport costs are involved as is the case with commodities).

The contract specification for manure futures is more difficult than for P_2O_5 rights futures where a manure future is a legally binding agreement to make or accept delivery of a standardized quantity and quality of manure at a standardized time and place for a price agreed upon today. This is because manure is not a homogeneous product. First, four kinds of manure are distinguished: from hogs, cows, calves and poultry. Second, the manure can be distinguished into their contents of phosphorus and other minerals. Probably the best solution in this complex matter is to specify two manure contracts: hogs manure futures and poultry manure futures. The manure surplus problem in the Netherlands is mainly caused by hogs and poultry farming. It is expected that most trade will occur with these kinds of manure. The two contracts should also specify the phosphorus and moist contents. Although manure from farms will seldom be exactly the same as specified in the two futures contracts, hedging by the participants is possible by cross-hedging. In Table I the salient features of the proposed future contracts are summarized.

Table I. Salient features of P_2O_5 future contract and hogs/poultry future contract.

	P_2O_5 futures	Hogs/poultry manure futures
Unit of trading	The contact unit shall specify the right to produce a certain number of kg phosphorus	The contact unit shall specify a certain number of kg of hogs/ poultry manure with specified moist and phosphorus content
Standards	Phosphorus rights are those issued by the Dutch government and administered by 'Bureau Heffingen'; deliverable phosphorus rights must be applicable against phosphorus production in the year of the delivery month	The contact is specified as to origin, delivery place and time, contents of moist and phosphorus
Months and years	Every month of every year traded in	Every month of every year
Price basis	All prices of phosphorus rights futures shall be multiples of one NLG per contract	All prices of hogs/poultry manure futures shall be multiples of one NLG per contract
Delivery	Delivery shall be done by book entry transfer between accounts in the book entry system of the government or shall be done by cash settlement	Delivery shall be done in corporation with and by the rules of the clearing house or done by cash settlement

7. Participants and Hedging Systems

Participants (hedgers and speculators) involved in the already existing hogs futures market could be interested in the P_2O_5 rights and manure futures. Other possible participants in the futures trading of manure futures are the manure processing industries. They could use the futures market to hedge against adverse price fluctuations of manure. By making use of the futures market they can plan ahead and by this being able to use their capacity optimally. Also the government may be a participant in the rights futures market. Through the futures market the government is able to plan ahead and when starting programs they can hedge against adverse program costs. Environmental organizations can buy futures contracts on the futures market, by this achieving their goals in the same way as happened on the SO_2 rights market in the U.S.A. In the Netherlands participation of farmers on the futures market is not as common as it is in the United States. In the case of intensive livestock farmers it will be the (cooperative) meat processing industries and the (cooperative) mixed feed industries that will participate. In the Netherlands, the feed concentrate industries and meat processing industries have already worked closely together in the chain to establish high quality meat.

If the intensive livestock farmer purchases the P_2O_5 futures, he is obligated to remove the manure surplus, which means that he needs to hedge himself against adverse cost price fluctuations with the help of manure futures. In this way he can use both futures markets to hedge against adverse price fluctuations of both commodities. The intensive livestock farmer may also use the already existing hogs futures markets for his output to hedge against adverse price fluctuations.

The intensive livestock farmer can make a futures contract combination of the above-mentioned possibilities, he buys the P_2O_5 rights futures and sells the hogs and manure futures. The farmer can use this hedge to protect his processing margin against adverse price fluctuations. This so called spread (the simultaneous purchase of one futures contract and the sale of a different futures contract) can be considered analogous to the soybean crush at the Chicago Board of Trade and is known as "the Meat Product Spread" (MPS). The only factor with uncertainty in the processing margin after making use of the MPS is the feed price, nevertheless he can also buy on the futures markets of feed components a future such as corn.

A co-ordinated marketing operation through the marketing channel is often needed in order to achieve competitive advantages over rivals. The chain marketing established by the agribusiness industries can be extended by their offering the intensive livestock farmer a MPS package. By the introduction of the MPS package, the chain marketing can be strengthened. The farmer can establish a known processing margin without worrying about the knowledge involved in future trading (Table II).

The MPS can be executed by trading each single futures contract or by

Table II. Meat product spread model.

Mixed feed industries (MFI)
- Buys feed concentrate components futures contracts. For example corn and soybean meal at the CBOT.

Intensive livestock farmer
- Makes use of MPS package
  MPS: buys P_2O_5 futures contracts, sells manure futures contracts,[a] sells hogs futures contracts

Meat processing industries (MPI)
- Buys hogs futures contracts.

[a] The value of manure is negative, so the price will be negative. To avoid a negative price quotation in the futures market we can define a dual manure futures contract. This contract could be defined as the service to remove a certain number of kilograms of manure with specified moist and phosphorus contents.

trading the spread as a combined future contract. If the spread is traded as one future contract then in fact the processing margin from hogs is traded. A MPS contract specification is a combination of the three contracts involved.

8. Viability of Futures Markets of Rights

At the moment the cash market of rights has not been well structured and developed yet. This primitive structure of the cash market will have an impact on the futures markets of rights. The purpose of futures markets is to provide hedging possibilities for participants, since actual delivery seldom occurs in a liquid futures markets. On average only 3% of the trade that is conducted is actually delivered. In the case of a futures market of rights, the actual delivery will be higher in the beginning of such a market, because the cash market is not that liquid yet. Hedgers who do not succeed in making a deal on the cash market will not offset their futures markets position. As mentioned in Section 6, this higher frequency of delivery will not pose a problem in the case of a rights futures market because of the homogeneity of rights.

In this section the viability of a futures market for manure futures contracts and P_2O_5 rights is evaluated by using data on the cash market in manure, contract success criteria and data on existing futures markets. The following assumptions were made: (1) a manure futures contract is defined as 125 kilograms of P_2O_5 embedded in hogs with respect to poultry manure. The 125 kilograms of P_2O_5 criterion was chosen because of the 125 kilograms of P_2O_5 per hectare criterion of the Dutch manure legislation. (2) 90% of the amount of phosphorus that was processed and traded in 1991 is hedged on the futures market. This figure is expected to fluctuate because farmers, agri-distributors and processors can make contracts with each other on the cash market which have their impact upon this figure. (3) The turnover on the futures market is two and a half. The argumentation with respect to the turnover is the following: a contract may be traded on the spot market between farmers *A* and *C*, the turnover of one contract being one. A contract may also be traded between farmer *A* and middleman *B* and between middleman *B* and farmer *C*, the turnover of one contract being twice. On the futures market speculators can trade with a farmer, a scalper or another speculator (in reality the clearing house will take the opposite position in those transactions). The above-mentioned ways of turnover makes an average turnover of two and a half acceptable.

In 1991, the supply of phosphorus was 88 million kilograms, 3 million kilograms P_2O_5 of which were processed, 3 million kilograms were exported and the rest was distributed to phosphorus shortage areas within the Netherlands. From the distributed part of the P_2O_5 14 million kilograms were traded (*source:* National Manure Office, 1993). In total 17 million kilograms were traded consisting of 3 million kilograms of the processing industry and 14 million kilograms of distribution industries. The volume of this futures market would be 306,000 futures contracts per year (17 million kilograms times 90% divided by 125 times 2.5). This volume is more than three times the actual volume of the potato futures contract in Amsterdam and indicates a successful future contract according to Silber, Sandor and the Wall Street Journal.

In 1992, the supply of manure in the Netherlands was 16 million tons; 616 thousand tons of which were processed; 378 thousand tons exported and the rest was distributed to shortage areas within the Netherlands. From the distributed part of the manure 2.8 million tons were traded (*source:* National Manure Office, 1993). A hogs manure futures could be defined as 25 tons of hogs manure with 5 kilograms of P_2O_5 per ton. A poultry future contract could be defined as 25 tons of poultry manure with 15 kilograms of P_2O_5 per ton. The 25-ton criterion was chosen because that was the average manure capacity per truck. The phosphorus criterion was based on the P_2O_5 content in manure of hogs with respect to poultry. The price risk involved on the manure cash market could be hedged on the hogs and/or poultry manure futures market. If 90% of the cash market was hedged and the turnover was two and half, the volume would be 252,000 contracts per year. Again the percentage of 90% is disputable. If the manure processing industries and the producers of manure make contracts on the spot market in advance, this percentage of 90% will be lower.

The statistics on the manure that was traded are not complete yet in the Netherlands. What we did know was the manure removed from intensive livestock farms to farms with a shortage. This manure shift is recorded by the so-called delivery proofs. The participants in this manure trade are likely to want to hedge against adverse price fluctuations. In Table III, an estimation is presented for this hypothetical future market, where a contract is specified as 25 tons of manure (hogs or poultry).

Table III. Estimated volume (number) of manure futures contracts (not specified as to type of manure).

	(1) Amount of manure traded with delivery proofs in tons	Corresponding contracts (90% of column 2 divided by 25)	Turnover	Volume of contracts trade at hypothetical future market
1990	2,792,000	100,512	2.5	251,280
1991	3,241,000	116,676	2.5	291,690

Source: LEI-DLO (1), own calculation, 1993.

The volume of contracts traded on the hypothetical futures market is high compared with the existing futures market in hogs and potatoes in Amsterdam. Important in the calculations made above is the supposition that on the cash market for manure there is a cash market between every participant in the marketing channel of manure. Integration of manure producers with agri-distributors and processors could reduce the turnover.

Table IV shows an estimate of the future Dutch manure problem. The manure surplus will be traded on the cash manure market. If there is a high price variability on that cash market, a future market will be a logical consequence so that participants can hedge against adverse price fluctuations. The amount of surplus manure indicated in the above-mentioned contract specifications is huge.

Table IV. Manure production in millions of tons and the equivalent in P_2O_5 in millions of kilograms of phosphorus.

	Production		Surplus	
	Manure	P_2O_5	Manure	P_2O_5
1994	83.3	223	17.2	84.3
1995	75.4	196	17.3	74.1
2000	64–71	172–184	22–26	86–93

Source: National Manure Office, 1993.

If it is assumed that 90% of the manure to be distributed is hedged on the manure future market by the participants and the turnover is two and a half, the volume of future contracts will be one million in 1995 and 576,000 contracts in 2000, provided that one contract consists of 125 kilograms of phosphorus. It is important to note, however, that this number is partly influenced by the magnitude of the contract. In the calculation the 125-kilogram P_2O_5 criterion was used because of the 125 kilograms of P_2O_5 per hectare criterion of the Dutch manure legislation. This criterion is disputable. Another and perhaps better criterion would be the value of the underlying commodity.

Table V. Proposed solution for the Dutch manure surplus in millions of kilograms of phosphorus.

	1995	2000
Distribution	59	32
Process/export	12	54

Source: TNO-Heidemij and National Manure Office

The value of the manure futures contract must not be too high because it will have a negative impact on the attractiveness of the contract. On the other hand, the value of the underlying commodity (i.e. manure) must not be too low relative to the transaction costs involved in trading on the futures market. The 125-kilogram criterion might give the contract too low a contract value. Nevertheless, Tables III, IV and V show that the manure surplus in the Netherlands is of such a volume that a futures market will be successful according to the volume traded (under the assumptions made).

9. Evaluation

Introducing environmental rights is an economically efficient tool for implementing environmental policy. The users (i.e. polluters) of rights have to put up with adverse price fluctuations of the right, which cause different valuations of the right. This uncertainty of cash prices of rights at a future period causes problems for farmers to make efficient economic decisions. The futures markets of rights would be an efficient tool to solve the above-mentioned problem. With the help of such a market, users of rights can lock in the price of rights at a future period. A future market for those rights is not available yet. An important barrier for developing a futures market is the legislation involved with the rights. Cooperation with the government in implementing a rights spot and futures market is required.

Notes

1 Of course, the amount of manure can be measured in several ways, for example in weights units P_2O_5 in M^3 sludge or otherwise.

2 A manure right is the right to produce a certain amount of manure during one period, and can be divided into standard contracts of specified amounts of manure.

3 If the "lesser than or equal to" sign should be maintained, the Kuhn Tucker conditions apply.

4 There may be different systems of selling the manure contracts. For example, it may be decided that each farmer has a certain amount of manure rights for free depending on the amount of land he owns in the region (grandfathering). Then only these manure rights that are not exploited by the owners (e.g. arable farmer) can be bought and sold at the auction.

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