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Can the Market Take Care of the Environment? (What the Literature Says about Marketable Permits)

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Abstract

The key objective of this paper is to bring about the notion of "marketable permits" into consideration in Indonesian academic and policy-level discourse on environmental issues. It shows how economics has evolved in its mission to find a way around preserving the environment while ensuring economic activities. As an alternative to the more traditional yet widely adopted, "command-and-control" approach, economists have offered a relatively new approach, namely "tradable marketable permits". It is another alternative from the "market" approach, previously represented by the "tax and/or subsidy" approach. This paper focuses on the marketable permits. In particular, it summarizes the recent development in the field with a hope to provide a fruitful alternative to help solve the problem in Indonesia. Nevertheless, some caveats are discussed.

Keywords: *Marketable permits-Imperfect market-Environmental issue*
JEL Classification: *Q 56-Q 58- Q 59*

In 1975 the US Environmental Protection Agency (EPA) initiated the Emissions Trading Program. This program was designed to allow the maximum cost-reducing trading activity, while maintaining local air quality standards and limiting long-range pollutant deposition. The authority allows trading of emission permits, as long as national ambient standards are satisfied and that aggregate emissions do not increase (Atkinson, 1994).

A number of studies have been conducted to assess the feasibility of such programs, including attempts to recognize economic efficiency, environmental quality impact, as well as possible trade-off between the two, if any. This article discusses this issue by focusing on the case when one of the Coasean assumptions, namely perfect competition is relaxed. Section 1 reviews the emergence of marketable permits as one of the policy instruments for environmental pollution control, as well as the difference between this approach with non-market command-and-control mechanisms and with another market-based approach, namely the Pigouvian taxes. Section 2 describes the case when the market is not competitive. That is, one or more firms may have market power, and therefore can influence the equilibrium price of the permit market. Section 3 provides some empirical studies on the use of the marketable permits and Section 4 expands the discussion into the application of the mechanism. Section 5 discusses major drawbacks of marketable permit system. Section 6 briefly reviews recent development in Indonesian law and regulations with regard to environmental problems. Section 7 concludes the article.

1. INTRODUCTION[1]

Economists like to divide policy instruments for achieving environmental objectives into two categories: "command-and-control" approaches (e.g. technology standards and performance standards) and market-based mechanisms (e.g. taxes and marketable permits). Evidence has shown that conventional regulations fail to achieve environmental objectives in the least costly manner. On the other hand, well-designed market-based approaches provide incentives for firms to equate abatement costs at the margin, and therefore achieve a given level of environmental quality (Hahn and Stavins, 1992).

There are two major approaches to market-based environmental protection policy, namely the Pigouvian and Coasean approach originated in Pigou (1932); and Coase (1960), respectively. Marketable permits, the central interest of this article, has its roots in the Coasean

[1] I thank Madhu Khanna, Maddaremmeng A. Panennungi and the referees/editor.

approach. Taxes and subsidies, on the other hand are policies based on Pigouvian approach.

The Pigouvian approach describes externalities as stemming from differences between the private and the social costs of an activity. These differences are to be corrected by taxes or subsidies that alter the private cost of the activity until it equals the social cost. Therefore, a Pigouvian corrective tax, when added to a private cost, will bring it into line with social cost (Chichilnisky and Heal, 1999).

In contrast, the Coasean approach sees externalities as arising from an absence of property rights. As a consequence, certain economically important goods and services could not be bought or sold in practice, and their provision could not be regulated by the market. That is, the market could not ensure their provision at an efficient level. To fix this, property rights should be assigned. Ownership of a good or service implies property rights in it. Furthermore, the price of the property rights is determined in the market by supply and demand forces (Chichilnisky and Heal, 1999). One implication of the property rights in resource and environmental field is the use of marketable permits.

Conceptually, marketable permit systems have the potential to yield the least-cost solution to achieve ambient standards. However, some argue that these systems should also take equity concerns into account, which in turn become restrictions on the least-cost solution (Atkinson, 1994). Another problem in this market approach is that some agents may have the power to affect prices. The traditional approach stems in large part from the assumption that a market will approximate the competitive ideal. Nevertheless, as Hahn pointed out, the potential of a market to achieve a given objective in a cost-effective manner depends, among other things, on the design of the market and the extent to which individual firms can exert a significant influence on the market (Hahn, 1984). In addition, Rapaczynski warned that property rights in a modern society are very complex to be "put in place" in advance of the development of a market economy (Rapaczynski, 1996). That is, a sound market economy, which is not very common in developing countries, is a necessary condition for the property rights system to be working properly. The good news is then, even a tribal arrangement can act as an effective market mechanism and therefore assure the property rights system (Demsetz, 1967).

In practice, marketable permits have come a long way from its initial abstract conception. Establishing the markets for implementing Coase's idea has turned out to be much harder than it is thought (Tietenberg, 2000). We should not take the effectiveness of any artificial markets for granted. We have mentioned above that one potential problem with a marketable permits system is that one or few firms may be able to manipulate the market and lead to deterioration of its efficiency advantages over standards. However, we will see in this article that it is possible to design a system in such a way as to promote effective markets, despite the failed assumptions. In the case of agent's market power, a central authority could effectively pick the quantity of permits it wants the firm to use through a suitable allocation (Hahn, 1984).

This article focuses on the model of market power developed by Hahn (1984). In the next section we briefly discuss the important contribution of Hahn's model to the continuing discourse upon the efficacy of marketable permits. Empirical analysis follows, based on the study by Hahn and Noll (1982) on SO_x control and Foster and Hahn (1995) on smog control imposed in Los Angeles. We should note, however, that market power is not the only possible caveat of the conventional Coasean approach. Some critics to this approach have pointed out other possible loopholes, such as transaction costs, imperfect information, free riding, etc. However, this article only deals with the case where one firm might affect the market equilibrium.

2. HAHN'S MODEL OF MARKET POWER

In the model developed by Hahn (1984), it is assumed that all firms in the market except one are price takers. There are m firms, and Firm 1 is the one with the market power. There is a single equilibrium price p. Every firm i receives q_{0i} permit, out of total L distributed permits. These permits are traded among firms, and the number of permits that firm *i*-th after trading is q_i . Let $c_i(q_i)$ and p_i be the abatement costs associated with emitting q_i units and the willingness-to-pay, respectively. Marginal abatement costs ($-c'_i$) are assumed to be positive ($c'_i < 0$) and increasing ($c''_i > 0$). Price taker firms solve:

$$\text{Min } c_i(q_i) + p\,(q_i - q_{0i}) \quad i = 2,\dots,m \qquad (1)$$

$$\text{Foc: } c'_i(q_i) + p = 0 \qquad (2)$$

On the other hand, Firm 1 with the market power solves:

$$\text{Min } c_1(q_1) + p\,(q_1 - q_{01})$$

$$\text{s.t. } q_1 = L - \sum_{i=2}^{m} q_i\,(p) \qquad (3)$$

$$\text{Foc: } (-c'_1 - p) \sum_{i=2}^{m} q'_i + (L - \sum_{i=2}^{m} q_i(p) - q_{01}) = 0 \quad \text{.......................... (4)}$$

Equation (2) implies that the number of permits the i-th price-taking firm will use is independent of its initial allocation of permits. Whereas, equation (4) suggests that the only way to achieve a cost-effective solution, where marginal abatement costs are equal across firms, is to pick an initial distribution of permits for Firm 1 that equals to the cost minimization solution. Therefore, in the case that one or more firms have market power, the distribution of permits matter.

To see the effect of Firm 1's initial endowment of permits on the market equilibrium, we can take the partial derivatives of (4) and do comparative statics while holding L constant:

$$\partial p/\partial q_{01} = ((-c'_1 - p) \sum_{i=2}^{m} q''_1 + \sum_{i=2}^{m} q^2_i c''_1 - 2 \sum_{i=2}^{m} q'_i)^{-1} > 0 \text{ .... (5)}$$

Result (5) implies that a transfer of permits from any of the price takers to Firm 1 results in an increase in the equilibrium price. In addition, the number of permits used by Firm 1 will increase as its initial allocation of permits is increased, that is, $(\partial q_1/\partial q_{01}) > 0$ (by chain rule, and assuming a negatively sloped demand curve).

Now that we have found that the distribution of permits could play a critical role, we are left with examining how it affects the degree of efficiency. Hahn measures inefficiency by the extent to which abatement costs exceed the minimum required to reach the target. Efficiency is achieved by solving:

$$\text{Min TC} = c_1(q_1) + \sum_{i=2}^{m} c_i(q_i)$$

$$\text{s.t. } q_1 + \sum_{i=2}^{m} q_i = L \quad \text{.. (6)}$$

First-order conditions give:

$$- c'_i(q_i) = p_i(qi) = pi = 2, ..., m \text{ .... (7)}$$

Differentiating total costs with respect to q_{01} and (7) with respect to q_{01} then substitute them implies the following result:

$$\partial TC/\partial q_{01} > \text{ as } (p + c'_1) > 0 \quad (8)$$

Now (8) and (4) imply that total costs achieve a minimum at q_1^* and will increase as the permits are distributed off q_1^*.

The results can be explained by using graphical analysis (Kolstad, 2000). Suppose that e_1 and e_i is the emission by Firm 1 and every other firm, respectively. Assuming that e is the exact difference between q and q_0, then we can see the costs and the price now as the function of emission. In this light we can modify subjective function (3) as:

$$TC_1(e_1) = c_1(e_1) - p(q_{01} - e_1)\ ;\ p = p(L - e_1) \quad (9)$$

The term $p(q_{01} - e_1)$ is the revenue to Firm 1 from selling its excess permits. The first-order condition of minimizing (9) is:

$$\partial TC_1/\partial e_1 = c'_1(e_1) + p'(q_{01} - e_1) + p = 0$$

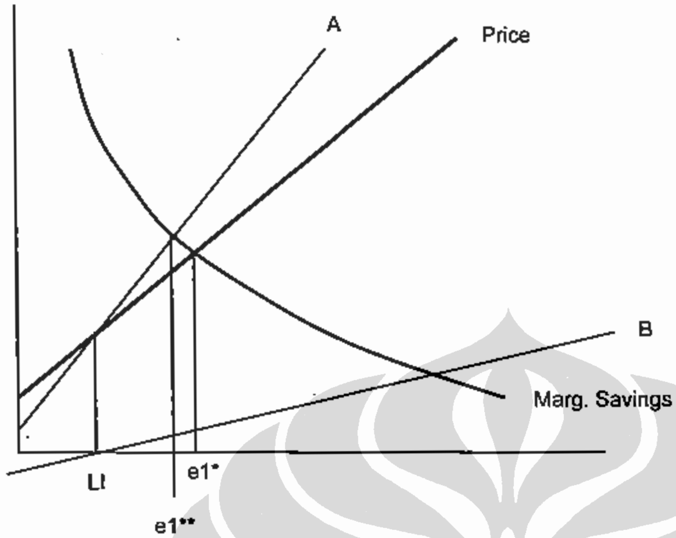
$$- c'_1(e_1) = p'(q_{01} - e_1) + p \quad (10)$$

The term $- c'_1(e_1)$ now can be seen as the marginal savings of emission (ms). We see that $p'(q_{01} - e_1)$ or marginal price term (mp) puts a wedge between marginal savings and price. Suppose that the solution for (10) is e_1^{**}, and the solution for the case without the wedge is e_1^*. We are interested in the relationship between them. Equation (10) suggests that $e_1^* = e_1^{**}$ when $q_{01} = e_1^*$. That is, when Firm 1 uses up all its permit endowments to emit its pollution. If, on the other hand, $q_{01} < e_1^*$ we need to consider:

$$e_1^{**} < e_1^* \Rightarrow ms(e_1^{**}) > p(e_1^{**}) \Rightarrow mp(q_{01} - e_1^{**}) > 0 \Rightarrow q_{01} < e_1^* \quad (11\text{-a})$$

$$e_1^{**} > e_1^* \Rightarrow ms(e_1^{**}) < p(e_1^{**}) \Rightarrow mp(q_{01} - e_1^{**}) < 0 \Rightarrow q_{01} > e_1^* \quad (11\text{-b})$$

Clearly (11-b) contradicts the assumption, so that it must be the case that $q_{01} < e_1^{**} < e_1^*$ when $q_{01} < e_1^*$. Analogously, for $q_{01} > e_1^*$ we have $q_{01} > e_1^{**} > e_1^*$.



The graph shows marginal savings (ms = -mc) and price (p) as functions of emission from Firm 1. They intersect at the point where emission is e_1^*. The more Firm 1 emits, the fewer permits available for other firms, and therefore price increases. Line A and B show deviation from line P if manipulation by market power firm occurs. That is, line A represents $p'(q_{01} - e_1) + p$ and line B represents $p'(q_{01} - e_1)$. The first line intersects with the marginal savings line at the point where emission is e_1^{**}, a lower emission than the efficient e_1^*. The intersection of line B (the marginal price) and the horizontal axis is the point showing initial permit issued to the large firm (point L_1 in the graph).

The result indicates that if Firm 1 is initially allocated too few permits, it will buy from others, but not quite enough, in an effort to keep price down. In this case, its emission will be lower than the efficient level. Likewise, if it gets too many permits to start with, it will sell some, but not quite enough, to keep price high. Therefore, the only way to induce Firm 1 to emit at the efficient level is to give it the correct amount of permits to start with. The total amount of pollution is unaffected, however. It will be just as high as L. Nevertheless, is Firm 1 is emitting too little or too much, the total costs of all firms will be too high. That is, the inefficiency takes place on the cost side. Therefore, Hahn argues that just because a firm may have a large share of the permits, this does not necessarily mean it can influence the outcome. Moreover, if a firm does have a market power, its effect on price varies with its excess demand for permits (Hahn, 1984)[2].

A direct implication of Hahn's model is that, with a full knowledge of demand functions, the government could effectively pick the permits quantity it wants the market power firm to use through a correct initial allocation. In addition, as pointed out by Tietenberg (2000), market power does not seem to have a large effect on control costs in most situations.

3. EMPIRICAL STUDIES

In order to take the discussion into practicality, we now consider some empirical studies of the marketable permits. Our focus now is not whether the market will work perfectly, but whether it can produce a more efficient combination of emissions and abatement strategies. This section is based on the works of Hahn and Noll (1982), and, to a lesser extent, Foster and Hahn (1995). Both studies used simulation in the case of the Los Angeles area. The former focuses on the control of sulfur oxides (SO_x) emissions, and the latter expands it to a more general case, namely smog control.

The simulation conducted by Hahn and Noll can be summarized as follows. A permit is defined as the rights to emit one ton SO_2 equivalent of SO_x per day anywhere in the airshed. Four policy targets are examined, ranging from no further net emissions control to about a 70 percent reduction in emission (**Table 1**).

Table 1
Air Quality Target (Tons SO_x /day)

No.	Target	Allowable Emissions
1.	Achieve CSAQS of 25 micrograms/m3 over a 24 hour averaging time	149
2.	Violate CSAQS 3-5% of the time	238
3.	No additional controls with an above average natural gas supply	335
4.	No additional controls with a low natural gas supply	421

Note: CSAQS: California Sulfate Air Quality Standard.
Source: Hahn and Noll, 1982.

[2] It should be noted, however, that in this case the assumption of no-hoarding becomes crucial. Nevertheless, in reality, high costs may create disincentives to abate, thus it does have an indirect negative impact on the environment.

Table 2 exhibits the market share of the largest permit holder under a competition case and under a market power case, respectively, with their estimated share of total emissions it would produce.

Table 2
Market Share of the Largest Permit Holder (%)

Natural Gas Supply	*Target 1*	*Target 2*	*Target 3*	*Target 4*
Competition Case:				
1. Low	*31*	*43*	*45*	*41*
2. High	*23*	*29*	*40*	*47*
Market Power Case:				
1. Low	*20*	*31*	*37*	*41*
2. High	*23*	*25*	*39*	*32*

Source: Hahn and Noll, 1982

For **Table 2** it is assumed that q01 is fewer than it is expected by Firm 1. Therefore the market power firm acts as a monopsonist (or, monopolistic buyer). Accordingly, as we discussed above, it will buy fewer permits at a lower price than if it is in the competitive-cost minimization solution.

The market power of the firm with the largest market share could be manifested in several ways. Since in our case, the market power firm is a monopsonist, it then follows that, if the firm uses its power, it wants to put a downward pressure to price when it is about to buy. Implicit in this analysis, the market power firm is initially allocated fewer permits than it expected. This assumption is consistent with EPA policies that tend to require utilities (especially electric utility, the source producing the highest rate of emissions) to adopt abatement methods with higher marginal abatement costs than is common for other industries. The next table shows the price comparison under the competitive- and the market power case. As expected, the price in a competitive market is in general higher that that of (monopsony) market power.

Table 3
Price Comparison ($)

Natural Gas Supply	*Target 1*	*Target 2*	*Target 3*	*Target 4*
Competition Case:				
1. Low	*4,590*	*2,720*	*2,000*	*940*
2. High	*1,320*	*650*	*470*	*420*
Market Power Case:				
1. Low	*2,720*	*2,000*	*1,000*	*540*
2. High	*1,000*	*470*	*420*	*210*

Source: Hahn and Noll, 1982

It is important to note, however, that even though the differences between the competitive and monopsonistic case are quite large, it is not certain whether or not they lead to major loss of efficiency. Neither price nor market share is the appropriate measure of inefficiency. The difference in total abatement costs between the two cases, is. Therefore, the shape of demand curves matter[3]. An earlier study by Hahn (1981) using the same set of data indicates that at the competitive equilibrium all firms face a fairly flat marginal abatement costs over a wide range of emissions reduction. Hence a large shift of emissions from the monopsonist to the other firms might create relatively little loss of efficiency. Nevertheless, as the estimated loss in efficiency due to market power is quite sensitive to small changes in the cost function, considerable thought may need to be directed toward solving the problem of monopsonistic power, i.e. through a proper initial allocation of permits, as discussed above.

4. APPLICATIONS[4]

Some former studies (e.g. Hahn (1989) and Foster and Hahn (1995)) divide emissions trading into four distinct elements: netting, offsets, bubbles, and banking. Netting allows a firm that creates a new source of emissions in a plant to avoid the stringent emission limits that would normally apply by reducing emissions from another source in the plant. Thus, net emissions from the plant do not increase significantly. Since a firm using netting is only allowed to obtain emission credits from its own sources, this is also called internal trading. Offsets are used by new emission sources in a region that has not met a specified ambient standard. New sources are allowed to locate in the "non-attainment" areas, only after "offsetting" their new emissions by reducing emissions from existing sources. The offsets could be attained either through internal- or external trading. Bubbles refer to the placing of an imaginary bubble over a plant, with all emissions exiting at a single point from the bubble. A bubble allows a firm to sum the emission limits from individual sources of a pollutant in a plant, and to adjust the levels of control applied to different sources as long as this aggregate limit is not exceeded. This bubble can be attained through internal or external trading. The last element, banking, allows firms to save emission

[3] However, Hahn (1984) finds that the claim that it is the pattern of excess demands that ultimately determines the extent to which any firm can influence the market, does not appear to be widely recognized. Tietenberg (2000) even argues that the anticompetitive effects of marketable permit system are not likely to be very important in general.

[4] A comprehensive assessment on EPA's trading program is beyond the scope of this article. For those who are interested to know about EPA's trading program, please consult e.g. Hahn and Hester (1989).

reductions above and beyond permit requirements for future use in emission trading.

Hahn finds that cost savings have been realized almost entirely from internal trading, and again, environmental quality impact in general is not very significant, as shown in Table 4 below. This is consistent with the claim above that efficiency of the use of marketable permits takes place on the cost side. Moreover, the initial allocation of permits, in the case of market power, tends to affect the cost structures and has less impact to environmental quality.

Table 4

Emissions Trading Activity

Activity	*Est. Number of Internal Transactions*	*Est. Number of External Transactions*	*Est. Cost Savings (millions)*	*Impact on Environmental Quality*
Netting	*5,000 – 12,000*	*None*	*$500 - $12,000*	*Individually insignificant, probably insignificant in aggregate.*
Offsets	*1,800*	*200*	*Probably large, not easily measured*	*Probably insignificant*
Bubbles	*129*	*2*	*$435*	*Insignificant*
Banking	*< 100*	*< 20*	*Small*	*Insignificant*

Source: Hahn, 1989.

The table implies that because marketable permit approaches have been shown to have a demonstrable effect on cost savings without sacrificing environmental quality, the instrument can be expected to receive more widespread use. It is important to note, however, that in general, assuming that the environmental effects of trading are neutral to positive, regardless of the existence of market power, lower pollution abatement costs indicate that emission trading is a more efficient instrument of environmental policy than command-and-control mechanisms. Not only does it lead to economic efficiency, but it also encourages technological innovation: it provides flexibility for plant operators to choose abatement equipment most suitable for their own set of emission points (see for example Burtraw, 1996[5]).

[5] Burtraw finds that the SO2 emissions trading program of Title IV of the 1990 amendments to the Clean Air Act has led to positive impact in the form of i) evolution of input markets, ii) changes in coal markets, iii) innovations in rail transport, iv) innovations in fuel blending, and v) innovations in scrubber market. These achievements are surprisingly obtained with a *low* volume of trade in permits.

5. SOME DRAWBACKS

The above analysis has shown the strength of a marketable permit system in achieving economic efficiency without deteriorating environmental quality. However the system is not free from weaknesses, and therefore cannot be taken as a panacea for environmental problems, especially pollution emission.

The key objection from, say, environmentalists is that this system and market-based approach in general ignores the fact that the environment belongs to the people and it, as a matter of ethics, should not become private property (Kelman, 1981). In addition, while an imperfectly competitive market for permits may not be a common problem, all potential applications of marketable permits involve the selection of an institution for allocating the permits that satisfies equity constraints and still promotes an efficient market (Hahn and Noll, 1982). As a matter of fact, conflicts between efficiency and the political perception of equity have been common.

Another problem that has been encountered is the inconsistency in getting the single largest source of emissions to engage in transactions in order to get the market started quickly and to ensure the provision of stable price signals to firms making abatement decisions. That is, to prevent the market from being manipulated[6]. Without a clear specification of methods for distributing the permits and organizing the trades, the efficiency aimed might be missed.

The model we analyzed above does not take a product market into account. However it is common that redistribution of market shares among firms is controlled by the permits market mechanism. Sartzetakis (1997) points out that the existence of market power in permits market will have a much bigger adverse effect on social welfare than the output redistribution effect. This is possible in the case when the product market is oligopolistic. Permits trading have two effects. First, it achieves cost-minimization by equalizing marginal costs of abatement among firms in a competitive market. This effect is welfare-increasing. The second effect is that it redistributes production among firms due to imperfections in product markets and firm-specific differences in emission control technologies. This second effect can be welfare-decreasing if the inefficient markets are the ones gaining market share.

So far the model ignores the existence of transaction costs. However, these transaction costs in some markets could be quite high.

Therefore, the introduction of emissions trading program motivates the need to achieve efficiency in many aspects.

6 See for example van Egteren and Weber (1994) for the case where cheating occurs in a permit market.

Stavins (1995) shows that it could achieve as high as $25,000 per transaction (on transactions involving millions of dollars)[7]. Failure to include these costs into the model might result in the overestimation of efficiency gained. Other costs that might be significant in some markets are the costs of establishing and maintaining the market, the costs of policing, and the costs of collecting.

6. WHAT DO WE HAVE IN INDONESIA?

This article deserves some words about what Indonesia has done so far in regard to protecting its environment. Alas, not much we can say. An in-depth look on laws and regulations returns yields a very short list of explicit policies for taking care of the environment. In short, Indonesia is still in its infancy in adopting command-and-control policies. This includes an emission standard for motor vehicles (Ministrial Decree or Keputusan Menteri No. 141 Tahun 2003)[8] and CEM (continuous emission monitoring) installment for oil and gas industries (Keputusan Menteri No. 129 Tahun 2003).[9] It seems, however, the compliance may take longer than it should be. The ministerial decree in 2004 on emission valuation (Keputusan Menteri No. 254 Tahun 2004) states that the valuation for new vehicles will start in 2005 and the result will be published in 2006.

There are few indications for a market-based approach – and it is limited to tax instruments. Unfortunately, there seems to be confusion between the central government and the local government in interpreting the law of fiscal balance between the two levels of government (that is, Law or Undang-Undang No. 25 Tahun 1999). Despite the central government's attempt to protect the national environment (for example, by Undang-Undang No. 41 Tahun 1999 on Forestry), some local governments race to exploit their natural resources to increase their own income, an objective that is motivated by the law of fiscal balance.

There is virtually no law or regulation related to a tradable permit mechanism in curbing the environmental problems in Indonesia. A few, however, are related to the exploitation of the natural resources. Undang-

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7 This is the case of SO2 emission permit market at Chicago. Such high figures occurred due to markets had been decentralized and operated via brokers as the intermediaries. As reported by Chilchinisky and Heal (1999), the transaction costs on the Chicago market are currently very much less.

8 The target is to comply with 1988 Euro-1 and 1996 Euro-2 (that is, 50 and 30 percent of emission, respectively). However, the United Nations Economic Commission for Europe has launched Euro-4 mechanism in 2004 (10 percent of emission) following the Euro-3 (20 percent of emission).

9 This decree requires industries to install a CEM instrument in their smokestacks; otherwise they should be inspected every 6 months. In either case, each industry has to comply with the emission standards set up by the government.

Undang No. 41 Tahun 1999, for example, states that disputes in forestry can be settled voluntarily by the involved parties without the need to go to the state court. In fact, such practices have been done in some regions, traditionally with no reference to government official regulations.[10] But they are far from an established mechanism of tradable permits as we discussed above.

One regulation that may have potential to be developed into a tradable permit mechanism is the Hak Pengusahaan Hutan (HPH) or Rights to Forest Extraction. This system, however, has been very controversial. Despite its pro-environment objectives, it has created an area of rent-seeking by the businesses. In addition, the government seems to be lacking a good mechanism to distribute the rights properly, creating room for moral hazard problems.[11]

7. CONCLUSION

This article has discussed the feasibility of using marketable permits in the case when a market is imperfect. It is shown that the existence of a firm that can affect the market equilibrium price may lead to efficiency loss. However, the inefficiency takes place on the cost side. Its impact on the environmental quality is likely to be negligible. That is, market power does not have a large effect on the cost control. The authority could effectively pick the permits quantity it wants the market power firm to use through a correct initial allocation. However this demands a full knowledge of demand functions.

Some problems might be encountered when applying this system. The conflict between efficiency and equity at the decision making level is getting more common. Also, it is not trivial to get a single largest source of emissions to engage in a transaction. In some cases, permits are hoarded. Regarding its impact on welfare, we should be careful when the product market is imperfect. In addition, transaction and other costs might have a significant effect that could reduce the efficiency gained.

Market-based approaches cannot solve all environmental problems with little or no sacrifice. The marked preference that has been shown for incentive-based instruments over command-and-control is largely based on theoretical efficiency advantages in highly stylized situations.

[10] Langko-Lindu, a remote village in Central Sulawesi, for example, has a system called "Tiga Kerbau, Tigapuluh Dulang, Tiga Mbesa": those who violate the traditional convention of forest protection (illegal cutting, etc) should pay three cows, thirty plates, and three dishes – or around Rp 2 million in hard cash (Walhi, 2004).

[11] Currently, there are about 267 firms that have a HPH. In average, each firm is entitled to 105,000 hectares of forest.

However, political and other considerations might make market-based approaches poorly suited in solving environmental problems.

This article has laid out the recent development in the literature on marketable permits for pollution. It is realized, however, that the instrument has yet to be recognized in most of developing countries, such as Indonesia. It seems that the Indonesian government has not considered any marketable permit system. It is in fact still in the early stages of establishing a command-and-control policy. Nonetheless, academics have demonstrated widely that a market-based approach has some advantages over the c-and-c policies. In addition, awareness of policy alternatives many times is a plus rather than a minus for the government. This article can therefore be seen as an effort to bring the issue into discourse among Indonesian academics.

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