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Bankable emission permits under uncertainty and optimal risk-management rules☆

Julien Chevallier[a], Johanna Etner[b,*], Pierre-André Jouvet[c]

[a] CGEMP-LEDa, University Paris Dauphine, France

[b] CERSES, University Paris Descartes, France

[c] EconomiX, University of Paris Ouest and Climate Economics Chair, France

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ABSTRACT

This article proposes a theory of banking of emission permits under conditions of regulatory uncertainty. Based on a two-period partial equilibrium framework, we examine the effects of increasing risk – in the sense of a mean preserving spread – regarding a future permit allocation at the firm level. We also examine the role of an agency to pool risks by re-allocating permits for a group of firms. Our results are twofold. First, an increase in risk may lead to changes in a firm's banking strategy, depending on the third partial derivative of its production function with respect to pollution. Second, we define an optimal risk-sharing rule between agents to respond to political decision changes. Our results overall suggest that the bankability of permits may be used as a risk-management tool.

1. Introduction

Emission permits are now widely considered as efficient instruments for regulating firms' emissions of pollutants. Their numerous advantages have been extensively discussed in the literature (Bohm and Russel, 1985; Pearce and Turner, 1990; Cropper and Oates, 1992; Koutstaal, 1997; Baumol and Oates, 1998). However, emission permits may also convey a high level of uncertainty with respect to political decisions. Indeed, for emission permits, uncertainty depends not only on their price but also on the allocation rules enforced by the regulator.

Hence, the informational efficiency argument[1] in favor of emission permits compared to other classic instruments[2] vanishes given this potential higher level of uncertainty linked to the risk of political decision changes.[3] To cope with these political uncertainties, a number of firms may not participate in the permit market, and express their fear of an environmental regulation system dependent on such shifts in the regulatory environment (Wossink and Gardebroek, 2006).

Hahn (1989) first stressed the potential negative effects of political uncertainties for emission permit systems. He emphasized that the advantages of permit schemes in terms of emission control may be undermined by political uncertainties regarding banking and trading provisions. Leston (1992), Stavins (1995) and Ben-David et al. (1999) have also underlined that the performance of emission permits is critically linked to the clarity of political decisions.

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* Corresponding author.
E-mail addresses: julien.chevallier@dauphine.fr (J. Chevallier), johanna.etner@parisdescartes.fr (J. Etner), pjouvet@u-paris10.fr (P.-A. Jouvet).

1 For instance, less information is needed concerning firms' depolluting costs.

2 For instance, a tax or a lump sum.

3 Be it concerning the global permit allocation, or its repartition between firms.

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In this article, we only examine firms' production decisions subject to the introduction of an emission permit market, and to the possibility to bank permits forward in a partial equilibrium framework. At the beginning of each period, firms receive an initial permit allocation. Without uncertainty on the next period allocation, firms smooth their emissions between trading periods as documented in previous literature (Rubin, 1996; Kling and Rubin, 1997; Leiby and Rubin, 2001). This banking behavior also changes the temporal pattern of emissions by decreasing the concentration of emissions on early periods.[4] Since it overcomes potential negative effects, the authorization of banking therefore appears as a decisive feature for the successful implementation of permit systems as an environmental regulation tool. Departing from this benchmark case, the introduction of uncertainty on future allocation provides further incentives for firms to bank permits, and to consider collusion as a way of insurance (Von der Fehr, 1993; Ehrhart et al., 2008).[5]

This article therefore addresses the following central questions: Will an increase in the level of uncertainty concerning future allocation impact positively or negatively the amount of banking by firms? Following a variation in the level of uncertainty, is it possible to identify an optimal risk-sharing rule between firms? We aim at detailing firms' behavior, that is why we focus our analysis on the banking provisions, and consider that permit trading between firms has already occurred.

Compared to the previous literature, the main theoretical results of this article are twofold. First, we show that when firms face an increase in the level of risk, the variation of the amount of banked permits is linked to the third derivative of their production function with respect to emissions. Second, without uncertainty on the total number of permits allocated during the second period, an agency may introduce a Pareto-optimal permit re-allocation between firms. When the regulatory uncertainty concerns the number of permits available during the second period, an optimal risk-sharing rule needs to take into account the sensitivity of firms' marginal productivity to the number of permits, as well as the elasticity of the marginal productivity with respect to the stock of pollution. These results convey interesting policy implications concerning the use of banking as a risk-management tool linked to political uncertainty on an emission permit market. These results also underline the need to take into account the sensitivity of investors with regard to pollution choices (Etner and Jouvet, 2000).

The remainder of the article is organized as follows. Section 2 provides stylized facts about emission trading. Section 3 details the behavior of firms. Section 4 examines risk-management strategies between firms and proposes an optimal risk-sharing rule. Section 5 discusses the relevance of these theoretical results to the policy debate. Section 6 concludes.

2. Stylized facts about emission trading

Following the development of market-based instruments in environmental regulation (Crocker, 1966; Dales, 1968; Montgomery, 1972), recent experiences with emission trading in the US have been praised for success (in terms of performance, cost-efficiency, etc.) compared to conventional regulatory instruments (Ellerman et al., 2000; Ellerman, 2005). Schmalensee et al. (1998) evaluate the market for sulfur dioxide emissions as a valuable policy tool that proved its superiority over traditional command-and-control methods to deal with acid rain. Joskow et al. (1998) identify among the key reasons for its success the presence of transparent and standardized transaction procedures which, along with the development of third-party intermediaries, contributed to the emergence of an effective, competitive allowance market. They also report falling transaction costs as the market develops, which was also highlighted by Stavins (1995) as critical to increase trading levels and decrease abatement costs.

The same logic of "grand policy experiments" (Stavins, 1998) applies to climate change. Indeed, the development of international emission trading is seen as a decisive first step to curb greenhouse gas emissions (Stern, 2007). However, Kennedy (2002) notes that cap-and-trade programs may also be highly distorting in terms of investment decisions and compliance costs at the national level. This argument leads us to emphasize potential drawbacks in the design of emission trading schemes. Most notably, the choice of allocation rules is characterized by many political uncertainties. Bohringer and Lange (2005) note that granting free permits proportional to past emissions leaves the effective emissions faced by all firms identical and therefore does not affect firms' decisions. While being more difficult to implement in the first place, Jouvet et al. (2005) show that auctioning provides the best results in terms of efficiency when allocating permits.

Uncertainties about the allocation methodology and political decision changes may greatly affect firms' investment decisions. In the US SO_2 Program, Insley (2003) documents that some firms halted the construction of scrubbers in anticipation of state legislation changes and associated low permit prices. As emphasized by Innes (2003), one way to cope with such political uncertainty consists in using banking and borrowing which, absent periodic regulatory intervention, allow to raise or depress future pollution abatement levels at the firm level. In what follows, we consider a model where the exchange of quotas has already occurred between firms, and where banking may be used as a risk-management tool.

3. Behavior of firms

We analyze in this section the behavior of firms with a two-period time-horizon for production decisions. Since we focus on the effects of uncertainty on firms' banking behavior, we thus assume that permit trading between firms has

[4] This behavior applies especially for firms with high abatement costs.

[5] Collusion may have several impacts on the permit market. See the above mentioned articles for a discussion.