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Transboundary pollution and clean technologies☆

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ABSTRACT

Within a non-cooperative transboundary pollution game, we investigate the impact of the adoption of a cleaner technology (i.e., a decrease in the emission to output ratio). We show that countries may respond by increasing their emissions resulting in an increase in the stock of pollution that may be detrimental to welfare. It is when the damage and/or the initial stock of pollution are relatively large and when the natural rate of decay of pollution is relatively small that this rebound effect of clean technologies is strongest. Moreover, these results are shown to arise for a significant and empirically relevant range of parameters for the case of greenhouse gas emissions. Developing clean technologies make a global agreement over the control of emissions all the more urgent.

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1. Introduction

This paper investigates the impact of clean technologies on levels of emission and welfare in the presence of an accumulative transboundary pollutant.

In recent years, increasing attention is being paid by governments, international organizations and academics to the creation and sharing of clean technologies. In the United States (US), this has taken the form of new legislation. The "Investments for Manufacturing Progress and Clean Technology" (IMPACT) Act of 2009, has been introduced to facilitate the development of domestic clean energy manufacturing and production.[2] International organizations, such as the United Nations (UN), are also actively encouraging countries to fund the development of clean technologies. In 2009, the UN Environmental Program urged countries to allocate one-third of the $2.5 trillion planned stimulus package (spent by the developed world to boost the economy under the financial crisis) for investing on 'greening' the world economy. The G8 summit held in July 2009 included a commitment by the members to double public investment in the research and development of climate-friendly technologies by 2015. The agreement at the COP16 meeting held in Cancun in December 2010 includes a "Green Climate Fund," proposed to be worth $100 billion a year by 2020, to assist poorer countries in mitigating emissions, partially by financing investments in clean technologies (UNFCCC Press Release, 11 December 2010).

We investigate, analytically and through a numerical example using empirical evidence on greenhouse gas (GHG) emissions, the impact of adopting cleaner technologies within a framework that considers transboundary pollution emissions and where pollution emissions accumulate into a stock and therefore have lasting repercussions on the environment,[3] two essential features of the GHG emissions' problem. Considering a world made of n countries or regions, we determine the non-cooperative emissions policies of each region and determine the impact of having all countries simultaneously adopt a cleaner technology (captured by a decrease in their emission to output ratio).

The adoption of a cleaner technology reduces the marginal cost of production (measured in terms of pollution damages), thereby giving an incentive to each country to increase its production. We show that the increase in emissions associated with the increase in production can outweigh the positive environmental impact of adopting a 'cleaner' technology. This is similar to the "rebound effect" found in the literature on energy efficiency whereby energy savings are mitigated when efficiency is improved (see, for example, Greening et al., 2000; Sorrell and Dimitropoulos, 2008). The benefit of the extra consumption from the adoption of the 'clean' technology can be outweighed by the loss in welfare due to the increase in pollution. The positive shock of implementing a cleaner technology results in a more 'aggressive' and 'selfish' behavior of countries that exacerbates the efficiency loss due to the presence of the pollution externality.

We use the seminal transboundary pollution game model in Dockner and Long (1993) and Van der Ploeg and de Zeeuw (1992). In contrast with Van der Ploeg and de Zeeuw (1992) and Jørgensen and Zaccour (2001), we have taken the ratio of emissions to output as exogenously given. This captures situations where a cleaner technology is readily available in the more advanced country. Van der Ploeg and de Zeeuw (1992) (Section 8) and Jørgensen and Zaccour (2001) consider the case where the ratio of emissions to output is endogenous and is a decreasing function of the level of the stock of clean technology. While Van der Ploeg and de Zeeuw (1992) assume that the stock of clean technology is public knowledge, Jørgensen and Zaccour (2001) consider the case where the stock of clean technology, also referred to as the stock of abatement capital, is country specific. Each country can invest in the abatement capital in addition to its control of emissions.[4] We have opted to consider exogenously

[2] The IMPACT Act will set up a two-year, $30 billion manufacturing revolving loan fund for small- and medium-sized manufacturers to expand production of clean energy products. It was integrated into the Waxman–Markey Act (also known as the American Clean Energy and Security Act) passed by the US House of Representatives in June 2009.

[3] See Jørgensen et al. (2010) for a survey of dynamic game models used to analyze environmental problems.

[4] Van der Ploeg and de Zeeuw (1992) compare the outcome under international policy coordination and the open loop equilibrium when there is no coordination. They show that the level of production and the stock of clean technology are both higher under the non-cooperative equilibrium.

Jørgensen and Zaccour (2001) consider an asymmetric game where there exist two regions facing a pure downstream problem. They design a transfer scheme that induces the cooperative levels of abatement and satisfies overall individual rationality for both regions.