CARBON PRICES AND INCENTIVES FOR TECHNOLOGICAL DEVELOPMENT[1]

Per-Olov Marklund, Umeå University, Umeå, Sweden, +46 90 7866661, pelle.marklund@umu.se
Tommy Lundgren, SLU and Umeå university, Umeå, Sweden, +46 90 7866910, tommy.lundgren@usbe.umu.se
Eva Samakovlis, National Institute of Economic Research, Stockholm, Sweden, +468 4535917, eva.samakovlis@konj.se
Wenchao Zhou, Umeå University, Umeå, Sweden, +46 90 7865685, Wenchao.zhou@umu.se

Overview

According to the UN Intergovernmental Panel on Climate Change (IPCC), the mean temperature of the earth has risen by 0.7°C since 1850, most likely due to greenhouse gas emissions related to human activity. In order to stabilize the level of greenhouse gases in the atmosphere, and to prevent the mean global temperature from rising more than 2°C, anthropogenic emissions will have to decrease more than 50 percent by 2050 and approach zero by 2100. Further increases in temperature would have far-reaching consequences for much of the earth's population. It is therefore of utmost importance to limit emissions of greenhouse gases from human activity. Crucial for succeeding is to create incentives that induce productivity growth in terms of rapid technological development and more efficient use of resources, e.g., the use of energy as input in production.

The major aim of this paper is to empirically analyze price setting climate policy measures and their potential to create incentives for technological development and efficiency improvements. This is accomplished through analyzing how carbon- and energy taxes, as well as the European Union Emission Trading System (EU-ETS), affect productivity development in the Swedish pulp and paper sector. However, because of the generous allocation of emission allowances, the financial crisis of 2008 and its concequences, and the availability of cheap reductions abroad through Kyoto flexible mechanisms (such as the Clean Development Mechanism, CDM), the price on the emission allowances within the EU-ETS has been low. There is a concern that the price is too low to create incentives for technological development.

Empirical studies on the effects of economic (or market based) policy instruments on firm productivity are scarce, but examples are Anger and Oberndorfer (2008), Martin et al. (2009), Lundgren and Marklund (2014, 2010), Brännlund and Lundgren (2010), and Commins et al. (2011). This paper is a useful contribution to this strand of the literature.

Methods

In this paper we empirically assess the effects of carbon and energy taxes actually paid by firms and the effect of the EU ETS. The empirical analysis concerns firm level data on Swedish pulp and paper firms during 1998 to 2008, and is based on a two-step approach. In the first step a Luenberger total factor productivity (TFP) indicator, with its two components technical efficiency change and technological development, is computed based on directional output distance functions using data envelopment analysis (DEA) (see, e.g., Färe and Grosskopf, 2003). In the second step, following Levine et al. (2000) and Zhengfei and Oude Lansink (2006), the impact of climate policy on TFP is estimated using a system Generalized Method of Moment (GMM) estimator based on original work of Arellano and Bond (1991).

Productivity is computed both excluding and including emissions. Previous literature find that productivity growth will be interpreted differently depending on whether emissions are included or not (e.g., Färe et al., 2001; Weber and Domazlicky, 2001; Färe et., al., 2012). In this paper we take the analysis a step further by investigating whether the impact of climate and energy policies on productivity will be interpreted differently when excluding and including emissions. Given that policy leads to reduced emissions, the hypothesis is that the policy will be interpreted to have larger impact on productivity when including emissions and crediting reduction of these emissions.

Results

Our results indicate that climate policy has had a modest impact on technological development during the period in study, and if significant it has been negative. This confirms the concern of too low carbon prices. That high energy

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prices can affect technological development is apparent from the fossil fuel price which has had a positive effect on technological development.

Whether excluding or including emissions in the analysis results in different policy recommendations are not obvious. The results show that the impact of climate policies on productivity, technological, and efficiency change works in the same direction regardless of whether emissions are included or not. However, there is a tendency that climate policies can be interpreted to have less impact when emissions are included and reduction is credited in the productivity measurement. This result goes against our hypothesis, given that policy should induce reduction in emissions. However, we point out that comparisons between two different approaches of modeling are not straightforward and that there are issues of methodological nature to take into account.

Conclusions

An overall policy conclusion is that price-setting policy measures can stimulate development of low-carbon technologies. However, prices set by climate policy measures have been too low.

Since the analysis only include the experimental phase of the EU-ETS, further analyses are needed. The European Commission is planning a structural reform of the carbon market in order to counter low prices and stimulate development of low carbon technologies. Back-loading, i.e., postponing the auctioning of emission allowances, will be done in phase 3 (2013-2020) as a short-term measure and creating a market stability reserve has been suggested. These types of measures will, however, increase market insecurity for the investors. A more straight forward way to create incentives for technological development would be to subsidize R&D.

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