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Energy-tax changes and competitiveness: The role of adaptive capacity

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ABSTRACT

This paper estimates the effect of energy tax (and price) changes on Total Factor Productivity (TFP) and net trade at the industry level, using a panel of industries from European countries covering the period 1990–2003. We investigate the hypothesis that industries with high adaptive capacity (measured by their relative level of labour compensation) are able to mitigate the adverse effects of energy tax rises better than others. We identify the pro-adaptation effect by interacting wage levels (a proxy for human capital) with energy taxes. We find that the negative marginal effect of higher energy taxes on TFP and net trade is significantly reduced for industries with stronger human capital and even turns to an overall positive effect in at least two cases. Up to three low-wage sectors display an overall negative effect. This suggests that human capital is key to adaptation to higher energy costs and climate policy, in some cases making it a win-win.

1. Introduction

Whereas opponents to the regulation of CO_2 emissions often cite scientific uncertainty about the magnitude of climate-change risks, there is as much if not more uncertainty about the cost of cutting emissions. Technical change is at the heart of that uncertainty. As Jaffe et al. (2003, p.463) note, "[i]n global climate change modeling […] different assumptions about autonomous improvements in energy efficiency are often the single largest source of difference among predictions of the cost of achieving given policy objectives." The uncertainty is not only about the magnitude of the cost of environmental regulation; there is also controversy about its *sign*. In influential articles, Porter (1991) and Porter and van der Linde (1995) argued that well-designed environmental regulation could be a spur to innovation, ultimately making regulated firms more competitive. Ambec et al. (2013) provide a recent review of theoretical and empirical insight on the Porter Hypothesis (PH). They distinguish between behavioural arguments, market failures (market power, asymmetric information, research and development (R&D) spillovers) and organizational failure (see for example Ambec and Barla, 2002).

Arguments similar to the Porter Hypothesis were made by DeCanio (1993) and Lovins (1996). Building on the "evolutionary" tradition of the economics of R&D (Nelson and Winters, 1982) which views firms as boundedly rational, Gabel and Sinclair-Desgagné (1993, 2001) proposed a model in the same vein, in which the enforcement of environmental regulation overcomes organizational failures within firms, leading them to become more efficient overall. Later attempts at formalizing the Porter Hypothesis (e.g. Ambec and Barla, 2002; Mohr, 2002) based the argument on market failures other than environmental externalities (barriers to innovation – network externalities, lock-in effects, or imperfect information – or external economies of scale in production), behavioural or organizational failures. Attributing a strategic role to technology adoption Mohr (2002) introduces external economies of scale in production. The productivity of any given agent depends on the cumulative production experience of all agents using the same technology. In this setting external economies of scale can explain why firms might rationally avoid the short-term cost of experimenting with new technologies. Environmental policy could therefore indeed

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offset a coordination failure. Ambec and Barla (2002) argue that environmental regulation allows firms to overcome organizational inertia (e.g. private information of managers about real costs of new technologies that might be used to extract rents from the firm).

While theoretical arguments are sound, the evidence, reviewed in Section 2 of this paper, is largely ambiguous. One of its key insights, which came out in an important recent paper (Commins et al., 2011), is that the effect of energy-tax shocks varies substantially across sectors. These results suggest that aggregate effects of environmental policy changes are likely to hide substantial cross-sectoral heterogeneity.

We build on this literature and extend it by looking for factors driving adaptability at the industry level, more precisely focusing on the role of human capital. The intuition is that if adaptation requires technical innovation or the reorganization of production processes, the availability of human capital is likely to help. Suppose e.g. that firms face costs to implement energy-efficiency programs helping them to reduce energy costs. Sectors with skilled workforces will have less difficulty implementing such programs and will see their performance deteriorating less as a result of higher energy prices. In addition to facilitating direct adaptation at the firm level, human capital may also facilitate the diffusion of best practices (e.g. Battisti et al., 2009).

Specifically, our approach analyses the response of industry TFP to changes in energy taxes and prices (net of taxation). Our dependent variable is TFP constructed either as an index or through estimation via a production-function approach. Results are similar under the two approaches.[4] In robustness runs, we also use net trade as a measure of competitiveness at the industry level. Our unit of observation is a country-sector-year combination where sectors are defined by the OECD's STAN database.

Our central hypothesis is that the effect of high energy prices on industry TFP is affected by the industry's capacity to adapt. Like Commins et al. (2011), our identification strategy relies on the cross-industry variation in how energy taxes and prices affect performance. In order to identify the effect of human capital, we interact energy taxes and prices with industry-level relative wages.

Our sample used is a panel of industry × country pairs tracked over the period 1990–2003 from the OECD's STAN database, comparable to the data used by Enervoldsen et al. (2009). Working at the industry level has advantages and drawbacks. On the one hand, identification is obviously not as sharp as in Commins et al. (2011) who perform their analysis at the firm level. On the other hand, TFP improvements at the firm level can be obtained by "passing the buck" of adjustment to either customers or suppliers. For instance, energy-intensive operations could be outsourced, producing TFP gains at the firm level that have no counterpart at the aggregate level and whose offsets would be difficult to track. Working at the industry level allows us to "internalize" at least some of these spillovers, although not those with an international dimension.

Our main regressors of interest, energy taxes and prices, are country × year specific. This might lead to overestimate the energy taxes faced by certain industries, mostly energy-intensive ones, given the possibility of exemptions which can be attributed. Data limitations do not allow us to dig deeper into this issue. Some recent papers on the response of gasoline consumption to a change in taxes also suggest that the short run economic impact of introducing or tightening energy or CO_2 taxes is not equivalent to that of rising fossil-fuel prices (Baranzini and Weber 2013; Davis and Kilian, 2011; Li et al., 2012). While price changes due to policy intervention are seen to be rather permanent and less volatile, market price changes can be seen as transitory phenomena. We deal with this by explicitly separating the effect of energy prices (net of taxation) from energy taxes.

We control for heterogeneity at the industry level using both time-variant and time-invariant industry characteristics. The latter are represented by a full set of industry × country fixed effects. We also include year dummies, which are not collinear with energy prices and taxes due to country-specific evolution of both exchange rates and energy taxation.

As a robustness test, we also apply the approach proposed in Rajan and Zingales (1998) and subsequent papers. That is, we eliminate the energy price variable and instead include a full set of country × year effects. This approach makes it impossible to estimate the absolute effect of energy-price changes, but it identifies their *differential* effect across industries.

We find that the marginal effect (ME) of energy taxes on TFP (and net trade in the robustness runs), while being negative for low-wage sectors, becomes gradually positive for sectors with higher wage levels. At high wage levels, the tendency is sufficiently strong to produce significant positive MEs for some industries and countries. Thus, some industries seem to react so strongly to energy-tax shocks that their TFP ends up higher, in conformity with the Porter Hypothesis.

The paper is organized as follows. Section 2 reviews the empirical literature, Section 3 presents our estimation strategy and the data. Section 4 presents and discusses results and robustness runs. Section 5 concludes.

2. Environmental regulation and economic efficiency: What do we know?

The existing evidence on the PH, surveyed, inter alia, in Jaffe et al. (2003) and Vollebergh (2006), is at best a half-full half-empty bottle. Jaffe et al. (1995) reviewed 16 empirical studies of the effects of environmental regulation on competitiveness in the US manufacturing sector, and concluded that "[…] there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined" (p. 157). Albrecht (1998) found that early adoption of Montreal Protocol measures (CFC phase-out) by the US and Denmark did not affect the competitive position, measured through bilateral trade positions, of refrigerator and industrial-cooler producers; however, early adoption is likely to have been endogenous to the outcome. Snyder et al. (2003) studied the effect of chlorine regulation on a panel of US chlorine manufacturing plants over 1976–2001. They found that adopting plants had a lower probability of exit than non-adopting ones, although the PH is about the absolute performance of regulated firms, not about the relative performance of adopting vs. non-adopting firms. In the same vein, Murti and Kumar (2003) found some evidence of better performance by firms that also had a better environmental compliance record among a panel of 92 Indian manufacturing plants. Lanoie et al. (2008) constructed a sector-specific measure of the stringency of environmental regulation for a panel of manufacturing sectors in Québec and found that, while current regulatory stringency reduced productivity growth, lagged stringency raised it, suggesting learning and adaptation effects. Enervoldsen et al. (2009) estimated the impact of energy prices on gross value added for a panel of European industrial sectors and found that while they had a moderate negative impact on output via higher unit energy and labour costs, they also had a relatively strong direct impact on output, which they interpret as evidence that energy taxes stimulate product innovation, which in turn raises demand for their products.

So much for the half-full bottle. As for the half-empty, Palmer et al. (1995) surveyed firms affected by environmental regulation, including those cited by Porter and van der Linde (1995) as success stories, and found that most firms declared that regulation was a net *cost* (see also Joshi et al., 1997; Morgenstern et al., 1999). However, that managers would complain about environmental regulations in interviews might not come as a surprise. Becker and Henderson (2000) found that plant births at the country level were reduced by current regulatory stringency proxied by low attainment status under the Clean Air Act. Lanoie et al. (2011) used a recent OECD cross-country firm-level survey to regress

[4] Results with the index-based TFP derivation are available upon request.