Energy Policy 39 (2011) 5449–5456

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Energy transition, carbon dioxide reduction and output growth in the Swedish pulp and paper industry: 1973–2006

Magnus Lindmark, Ann-Kristin Bergquist*, Lars Fredrik Andersson

Department of Economic History, Umeå University, SE-901-87, Sweden

ARTICLE INFO

Article history:
Received 2 September 2010
Accepted 12 May 2011
Available online 12 June 2011

Keywords:
CO_2 reduction
Pulp and paper industry
Technical change

ABSTRACT

This study examines the historical relation between carbon dioxide emission and output growth in the Swedish pulp and paper industry from 1973 to 2006. We find that the industry achieved an 80 percent reduction in carbon dioxide emission, where most of the reduction took place before the implementation of active climate policy in 1991. Foremost energy substitution and also efficiency improvements contributed to the reduction. Growing prices of fossil fuel due to market price change and taxes and subsidies, explains most of the efficiency improvements and substitution. The study finds that energy transformation was coinciding with ongoing structural change in the industry during the 1970s and 1980s as well as a strong period of environmental adaption. We therefore suggest that the oil reduction was reinforced through the dynamics between the energy issue and an overall renewing process of the industry. This suggests a need to coordinate climate and environmental policy measures with the long-term industrial dynamics of structural change.

1. Introduction

Sweden introduced an active climate policy during the early 1990s, with the carbon dioxide (CO_2) tax as a main policy tool. Furthermore, Sweden ratified the Kyoto protocol in 2002 and became part of the EU-ETS in 2005. The country is also recognised as having high ambitions in the field of climate policy. Especially, the CO_2 tax has been advocated as a main explanation for the decoupling between emissions and GDP (Johansson, 2001; Ds, 1997:26; Ds, 2005:55; ER, 2006:06; Scrimgeour et al., 2005) during the past 15 years or so. The lion's share of downright reductions of Swedish CO_2 emissions did, however, take place between the early 1970s and late 1980s. During this period, approximately, a 40 percent reduction did take place accordingly prior to the introduction of an active climate policy. Explaining the emissions cuts before the era of active climate policy may therefore inform contemporary environmental policy makers and planners.

The manufacturing industry, the energy sector as well as dwellings and housing experienced the largest reductions, where the size of the reductions in these sectors was of approximately the same magnitude (Andersson and Lindmark, 2010). Turning to the manufacturing sector, the largest reductions were found within the pulp and paper, chemicals and basic metal industries, all characterised as highly energy intensive. Here, the pulp and paper industry experienced the largest reductions of CO_2 emissions—80 percent during the period 1973–1990—while its output increased by 18 percent (see Fig. 1).

Given these developments, the overall purpose of this paper is to explore the main events, motivations and characteristics behind the reduction of CO_2 emissions in the Swedish pulp and paper industry over the period 1973–2006. The start of the investigation period is motivated by the 1973 oil crisis, which triggered both business and government strategies to reduce oil dependency. We find that focusing on a Swedish case is especially relevant since the Swedish energy transition led to one of the largest CO_2 emission cuts in any advanced peace-time economy (see appendix 1). However, this process has not been fully explored and reported in the international economic literature. A study by Liaskas et al. (2000), which covers the Swedish manufacturing industry between 1973 and 1993 points at comparatively large effects on CO_2 emissions from improved energy efficiency and fuel mix; the effects due to changes in the output structure, however small, tended to increase emissions. Also Torvanger (1991) included the Swedish manufacturing industry in comparison with the developments of CO_2 intensities in manufacturing for 9 OECD countries for the period 1973–1987. The results are, however, not fully compatible with contemporary official carbon reporting since Torvanger estimated CO_2 emissions counted grossly, while contemporary practice is to assume zero net CO_2 emissions for bio fuels. However, neither of these studies addressed the determinants of CO_2 emissions in terms of relative prices or business strategies for developing new technologies.

* Corresponding author. Tel.: +46 90 786 7656; fax: +46 90 7869995.
E-mail address: ann-kristin.bergquist@ekhist.umu.se (A.-K. Bergquist).

0301-4215/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2011.05.018

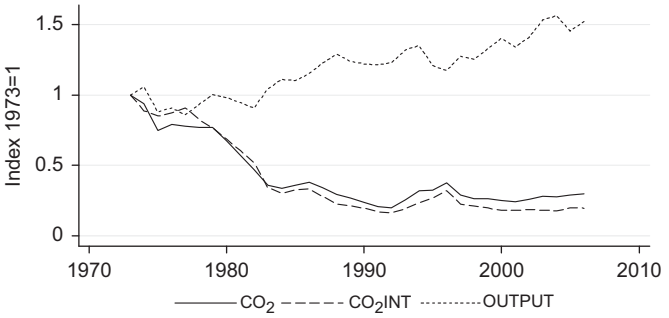

Fig. 1. Annual output and CO_2 emission in the Swedish pulp and paper industry 1973–2006 and Index 1973 = 100. *Note*: CO_2 measured as CO_2 emissions from fuel combustion, OUTPUT measured as sectoral output volume and CO_2INT is CO_2/OUTPUT. All measures are converted to indices. Base year is 1973.
Source: own estimates based on Swedish Official Manufacturing Industry Statistics (SOS Industrin) and the Swedish National Accounts.

We find that focusing on the pulp and paper industry is motivated for several reasons. We recognise that the pulp and paper industry has been given little attention in the contemporary and global climate policy debate despite being a rapidly growing sector in several developing countries. The Intergovernmental Panel on Climate Change (IPCC) has therefore emphasised the importance of development and transfer of clean technologies in this sector (IPCC, 2007). As the Swedish pulp and paper industry is noticed by the IEA as the most CO_2 efficient in the world (IEA, 2007a, b, Fig. 7.7) there may be, apart from downright technology transfers, also the policy lessons to be learned from the Swedish case. According to IEA, Sweden, closely followed by Norway, Finland and Canada has the lowest emissions per tonne of product, thanks to high levels of hydroelectric power and high biomass use for energy. In the United Kingdom, Korea and Germany, CO_2 emissions per tonne of product have fallen significantly since 1990s as a result of higher recycling rates (IEA, 2007a, b, p. 194) but are still higher than Sweden. However, The United States and Spain have the highest emissions, per tonne due to high fossil fuel use for energy production.

Contemporary climate policy is based on a mix of economic and administrative policy tools. The general approach in this study is to explore the historical dynamics between market price changes, government energy and environmental policy as well as the industry level strategies to accomplish technical change allowing for oil substitution and increased energy efficiency. More specifically, we will investigate the reduced emissions in terms of substitution and technical change (Newell et al., 1999; Popp, 2002; Gillingham et al., 2007; Kumar and Mangi, 2009). Finally, we will decompose the effects of CO_2 emissions on price changes gross and net of energy taxation and subsidies.

The organisation of the study is the following: The next section provides an outline of Swedish energy policy since the 1970s, thus providing the institutional context. The third section provides the data and methodology applied in the study. The fourth and fifth section provides the results while the last section concludes and discusses the results.

2. Institutional background

Heavy industries, including pulp and paper as well as basic metal production formed the backbone of Swedish industrialisation from the 1890s and onwards. This in turn implied an energy and pollution intensive industrial structure in Sweden. Even today, the manufacturing industry accounts for 40 percent of the total domestic energy use (SEA, 2009). It is worth noticing that the Swedish manufacturing industry is electricity intensive. Of importance from a climate policy perspective is that the electricity production is still non-CO_2 extensive due to the significant share of hydro, nuclear and bio power (SEA, 2009). This means that even though electricity consumption has increased considerably over time—by 60 percent during the period 1970–1990 and by 10 percent during the period 1990–2007—it has only caused minor increases of indirect CO_2 emissions from the energy sector. The transformation of the energy system during this period facilitated a pronounced reduction of oil consumption which was demonstrated in the pulp and paper industry. In 1973, oil accounted for 43 percent of external fuel usages in the Swedish pulp and paper industry, but only 8 percent in 2007 (Federation of Swedish Forest Industries, 2007). Following the historical events during this period, including the oil crises and within energy politics, it is fair to assume that the reduction of oil consumption was driven by some combination of market forces and policy induced measures.

Prior to 1970s, energy policy was not an independent policy field in Sweden. Energy issues were at the time an integrated part of industrial policy with the basic goals to ensure cheap energy, a favourable balance of trade and energy security in the case of international conflicts (Vedung, 1982). The preferred strategy to meet these goals was nuclear power based on domestic uranium supplies (SOU, 1956:46). However, nuclear power was not readily available in this period. A heavy expansion of relatively capital extensive oil plants was carried out as an intermediate solution to meet electricity demand. It is therefore not surprising to learn that oil amounted to 75 percent of the Swedish energy supply by the early 1970s (SEA, 2009). By 2004, oil constituted 31 percent of the total energy supply illuminating the changes that had taken place over the past 30 years.

The high dependency on oil meant that OPEC I caused a serious deterioration of Sweden's terms-of-trade. This is one important explanation as to why energy policy became one of the most expanded policy sectors in Sweden during 1970s (Vedung, 1982). One of the prime objectives of the 'new' energy policy was to improve the balance of trade by cutting back on oil imports. This was somewhat facilitated as the OPEC I coincided with the starting up of the first large scale commercial nuclear reactor in 1973. In addition to further expansion of nuclear power, the energy policy also saw new features in the development of domestic bio energy and energy conservation (SOU, 1978:17). Both administrative, market based and informative policy tools were means used for meeting these ends. The basic outlines of the policy introduced in the early 1970s remained for 20 years, as the reduction of CO_2 emissions became an explicit goal in the Swedish climate policy which embraced both energy and environmental policy (SOU, 1995:139).

Concerning the main policy tools it is worth noticing that energy taxes were first introduced in 1924 with the petrol tax (SFS, 1924:137). The 1950s saw the introduction of the electricity tax (SFS, 1951:374) and the general energy tax in 1957 (SFS, 1957:262). All these taxes were motivated from purely fiscal reasons.

The energy tax system underwent significant changes during the early 1990s (SOU, 1997:11, pp. 107). One of the major reforms in 1991 was the introduction of VAT on energy, which was levied after the addition of selective purchase taxes and environmental taxes. Furthermore, the CO_2 tax was also implemented in 1991. This was and still is an unbalanced tax as the tax rate today varies from zero to approximately 100 EUR per tonne depending on sector. In order to balance the increased overall pressure of taxation due to the *VAT* and CO_2 tax, the energy tax on electricity was at the same time reduced by 30 percent while the energy tax on petrol was reduced by 50 percent. One important consequence of the reforms was that the energy taxes carried by households