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Seamless electricity trade between Canada and US Northeast

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Abstract

We analyze how the wholesale electricity market deregulation could modify exchanges between three Canadian regions (Ontario, Quebec and New Brunswick) and two US regions (New York and New England), on the base of their loads and available resources when the regulatory change took place in 1997. We find that the pre-1997 exchanges already made possible fuel cost savings of $397.2 million per year while deregulation adds annual savings of $358.7 million. Canadian regions are the main beneficiaries under the assumption that exports are priced at the marginal costs of the importing regions. Imports from the Canadian regions, although significant, are not large enough to lower the marginal costs of the US regions. Hence electricity deregulation across the border should not significantly decrease prices in the US regions although the latter are becoming more dependent upon imports from Canada. Greenhouse gas emissions increase by 4.3 Mt CO_2 eq. in the wake of the open wholesale electricity market because of the low cost of coal, particularly in Ontario. Environmental concerns and the limited availability of additional hydroelectric power in Canada could change the trade patterns as electricity demand continue to grow.

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1. Introduction

The US wholesale electricity market is open to competition since January 1997 through FERC Order 888 that allows producers, local distribution utilities or any FERC licensed marketers to exchange electricity at market prices. FERC imposed some reciprocity conditions upon foreign applicants that required the latter to give access to their transmission power grid along the lines adopted for the US wholesale market. Canadian electric utilities, which are mostly owned by the provinces, applied for and received their FERC licences to participate in this new open market. Electricity was already flowing across the border between the two countries before the structural change. In 1996, Canada exported 42.2 TWh (terawatt-hours), i.e. 7.7% of its total production, and purchased only 1.1 TWh.[1] The net export in Canada favor follows from the price differentials between the two countries. For instance, the 1996 average prices were 15.2 ¢/kWh in New York and 14.1 ¢/kWh in New England, while they were respectively 7.3, 4.9 and 6.3 ¢/kWh in Ontario, Quebec and New Brunswick, which are the northern contiguous neighbors.[2] The low Canadian prices are due to their reliance on hydro power and to public ownership.[3]

In Canada, the deregulation of the US wholesale market of electricity is seen as an opportunity for its electric power industry to increase its profit due to the cost advantage, the flexibility of hydro power production and the seasonal complementarity between the summer peak demand in the United States and the winter peak demand in Canada.[4]

The purpose of this paper is to analyze the price and trade effects for the five aforementioned regions, resulting from the seamless border created by deregulation. Because there were already significant exchanges

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[1] There was a combination of firm exchanges (electricity available at all times during the period of agreement) and interruptible exchanges (electricity available under the agreement that the delivery could be interrupted at the option of the supplier).

[2] Values are expressed in Canadian $. The Canadian $ was worth 0.73 US$ in 1996.

[3] For an analysis of the effects of public ownership on the price of electricity in the Canadian context, see Bernard and Thivierge (1988).

[4] See National Energy Board (2003).

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across these five regions, it is of interest to assess the incremental trade coming out of the new context. Particular attention is paid to the direction of power flows, the identification of transmission bottlenecks between regions, CO_2 emissions, the overall cost savings and their distribution among the five regions. The identification of critical factors such as the costs of fossil fuels facilities and the limited availability of hydro resources points to some impending problems as the demand for electricity continue to grow.

Our analysis which is based on the loads and the available resources when the regulatory change became effective, differs and complements the study realized by Hale et al. (2000). The latter probed the effects of electricity market deregulation in PJM, ECAR, New York and New England by considering individual generation plants and the transmission links to the load during the summer peak hour only. Their purpose was to measure the effects on the marginal costs of delivering power to the local load and to identify transmission bottlenecks. The regional emphasis was put on New York and New England and they identified significant transmission bottlenecks in western New York and in northern New England. Exchanges with Canada, which are larger than the exchanges with the US neighbors, are not included. We focus on electricity exchanges between regions across a seamless border. Each region has a given annual load to serve, a set of available generating capacities with their associated fuel costs and interconnections to neighboring power grids. The year is divided into four uneven periods: winter peak (300 h), spring (3930 h), summer peak (600 h) and fall (3930 h).[5] The stepwise representation of the load curve and the presence of hydro power plants with limited energy allow us to capture the flexible use of hydro power when the peak loads in Canada and US power systems do not occur at the same time. Exchanges with producers located outside the five regions of interest are taken as given and they are set at their pre-97 levels.

The presentation proceeds as follows: in Section 1, we describe the underlying analytical framework and we underline key features of the data that enter into the cost minimization problem. In Section 2, we present and discuss the results in order to highlight the potential role that could be played by electricity market deregulation. Toward this end, we build three scenarios: the first scenario assumes that each region has to satisfy its load with its own power plants only, that is, each region operates under autarky. In the second scenario, exchanges with the contiguous neighbors are set at their pre-97 levels. In the third scenario, all the available resources are pooled together to meet the load in each of the five regions subject to constraints imposed by generating capacities, interconnection capacities and hydroelectric resources. It is assumed that deregulation would lead to free trade and to overall cost minimization.[6] In Section 4, we discuss some impending problems related to growing concerns with respect to environmental protection and the link to average fuels costs and to the limited availability of new indigenous power sources.

Here are the main findings that can be drawn from our three scenarios: the pre-97 exchanges made possible fuel cost savings of \$397.2 million per year for the five regions and they reduced CO_2 emissions by 9.8 Mt CO_2 eq. or 6.1% relative to autarky. Free trade brings additional fuel cost savings of \$358.6 million per year or 7.5% of total fuel cost, while CO_2 emissions go up by 4.3 Mt CO_2 eq.[7] or 2.9% relative to the pre-97 exchange scenario. If we assume that electricity exports are sold at prices equal to the marginal costs of the importing regions, we find that the bulk of the cost savings translates into higher profits for Quebec, Ontario and New Brunswick while New England and New York receive much smaller gains. As Hale et al. (2000), we also find significant transmission bottlenecks toward New England that has relatively high fuel costs. The direction of power flows depends upon the order of the fuel costs associated with different types of generating equipment. Environmental concerns, particularly related to greenhouse gas emissions, are likely to change these fuel costs and no relief is to be expected from new hydro power due to the mature state of its development.

2. The analytical framework and electricity market information

In order to capture the short-term effects associated with the 1997 deregulation of the US wholesale electricity market, we use the 1998 data on load, available generating capacities, average fuel costs, and interconnection capacities. Under the three scenarios which are called, respectively, autarky, pre-97 exchanges and free trade, we assume that available generating resources are used to minimize the total fuel cost of satisfying the load of each region while taking into account the constraints related to generating capacities, interconnection capacities and available hydroelectricity. The results of the three cost minimization problems[8] yield the optimal use of the generating

[5] This is a crude approximation of the load curve in each region and it does not capture the use of equipment over the narrow needle peak. Furthermore, we do not consider uncertainty and the associated reserve margin requirements.

[6] The implementation of its wholesale electricity market deregulation took place over an extended period and our analysis does not reflect this ongoing process.

[7] $Mt = 10^6$ tons and CO_2 eq. = CO_2 equivalent.

[8] Matlab is used to solve the cost minimization problems.