Electricity Efficiency and U.S. Manufacturing Exports

In estimating the change in an industry's trade competitiveness that results from improvements in the efficiency of its electricity use, one can employ an industry-specific economic model that is straightforward to apply to up-to-date data for 85 four-digit manufacturing industries. The calculations based on the industry-specific model provide reasonable approximations for the effects predicted by a more elaborate computable general equilibrium (CGE) model.

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I. Introduction

Promoting the energy efficiency of U.S. industry is an important priority of energy policy at the federal and state levels. Tax credits, loan guarantees, and technical assistance are the policies most often used to target unrealized energy efficiencies.[1] The policies can generate economic benefits, in the form of reduced production costs and improved competitiveness of U.S. industry, as well environmental benefits.

However, measuring the magnitude of these economic benefits can be complex. Even with an engineering estimate of prospective energy savings, estimating the impact on the industry's competitiveness requires understanding how the change in costs will affect upstream and downstream industries and competing producers throughout the global

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economy. The goal of this article is to develop an economic model that has limited data requirements and transparent assumptions but still generates predictions about these economic benefits that are reasonably close to those of more elaborate models.

First, I present an industry-specific model that predicts the change in the industry's exports in response to an increase in the efficiency of electricity as an input into industrial production. Three economic factors jointly determine the magnitude of the resulting change in U.S. exports: the U.S. industry's electricity share of marginal costs, the U.S. industry's current share of export markets, and the extent of international product differentiation.

Second, I calculate the response of exports to improvements in the efficiency of electricity use in 85 U.S. industries classified by their four-digit NAICS (North American Industry Classification System) codes in the 2009 *Annual Survey of Manufactures*. For example, in the U.S. Iron and Steel Mills industry, a 10 percent reduction in the electricity requirements of U.S. producers, with no corresponding change in the electricity requirements of foreign competitors in the same industry, would increase the industry's U.S. exports by 2.58 percent. The model predicts that a 5 percent improvement in the efficiency of electricity use in all U.S. manufacturing industries in 2009 would increase annual U.S. exports by $1.57 billion. I analyze the sensitivity of these estimates to several of the assumptions of the model.

Finally, I demonstrate that the industry-specific model provide a reasonable approximation of the predictions of the GTAP model, a more elaborate computable general equilibrium (CGE) model of global trade. The CGE model relaxes many of the simplifying assumptions in the industry-specific model: it takes into account adjustments in the prices of foreign competitors and spillovers to other U.S. manufacturing industries. These factors do affect the magnitude of the change in the industry's exports, but their contributions are small.

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Each of the models has advantages. The industry-specific model can be applied to more up-to-date data for more disaggregated industries. It is well suited for evaluating the change in U.S. exports resulting from country-specific and industry-specific improvements in the efficiency of electricity use. On the other hand, the global CGE model is better equipped to analyze the effect of improvements in efficiency that are matched by similar improvements abroad.

II. An Industry-Specific Model

A country-specific improvement in the efficiency of electricity use can significantly increase an industry's U.S. exports. The magnitude of the change in exports is determined by several factors. The first factor is international product differentiation. Following Anderson and van Wincoop (2003) and the economics literature on gravity models of international trade flows, I assume that products within an industry are differentiated by country of origin and that consumers have a constant elasticity of substitution (CES) between these differentiated products. The parameter σ_{it} represents this elasticity of substitution within industry i in year t. Consumers allocate a constant share of their expenditures to each industry.

The second factor is the U.S. share of total expenditures on industry i products in export markets, S_{it}. This expenditure share determines the effect of a reduction in the prices of U.S. exports on the industry price index in the export market. The larger is S_{it}, the smaller is the change in relative prices in the export market.[2]