6th International Symposium on
Energy Challenges & Mechanics
- towards a big picture

14-18 August 2016
Inverness, Scotland, UK

Measuring Plant Level Energy Efficiency and Technical Change in the U.S. Metal-Based Durable Manufacturing Sector Using Stochastic Frontier Analysis

Gale Boyd[1*] and Jonathan M. Lee[2]

[1]*Social Science Research Institute, Duke University, Box 90989, Durham NC 27708*
[2]*Department of Economics, East Carolina University, Greenville, NC 27858*

Accepted for publication on 26th March 2016

This study analyzes the electricity and thermal energy efficiency for five different metal-based durable manufacturing industries in the United States over the time person 1987-2012 at the 3 digit North American Industry Classification System (NAICS) level. Using confidential plant-level data on energy use and production from the quinquennial U.S. Economic Census, a stochastic frontier regression analysis (SFA) is applied in six repeated cross sections for each five year census. The SFA control for energy prices and climate-driven energy demand due to differences in plant level locations, as well as 6-digit NAICS industry effects. A Malmquist index is used to decompose aggregate plant technical change in energy use into indices of efficiency and frontier (best practice) change. Own energy price elasticities range from -.7 to -1.0, with electricity tending to have slightly higher elasticity than fuel. HDD is large and significant in fuel use; CDD is not significant except in 332 (Fabricated Metal Products). Both CDD and HDD have significant impacts on electricity use in every NAICS but 334 (Computer and Electronic Products). Mean efficiency estimates (100% = best practice level) range from a low of 32% (thermal 334 - Computer and Electronic Products) to 86% (electricity 332 - Fabricated Metal Products). Thermal efficiency is consistently worse than electric efficiency for all NAICS. There is no clear pattern to the decomposition of aggregate technical change. In some years efficiency improvement dominates; in other years aggregate technical change is driven by improvement in best practice.

Keywords: energy efficiency, plant-level manufacturing, metal-based durables, stochastic frontier, Malmquist index.