Measuring Market Power Exertion in the U.S. Ethanol Industry

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Poster prepared for presentation at the Agricultural & Applied Economics Association 2010
AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010

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OBJECTIVE

The objective of this study is to investigate potential market power exaction in the output market of the ethanol-producing sector using the Solow Residual (SRB) test and its different modalities (primal and primal-dual). The markup estimates (Lerner's index) obtained using different instrumental variables for the primal SRB are compared to the primal-dual SRB estimates.

BACKGROUND

Recent market reports show that ethanol production in the U.S. is mostly driven by private corporations rather than individual farmers. As the next table shows, there are two companies that currently control 20% of the U.S. ethanol production in the Distillers and Enzymes (DEP) market. In addition to DEP, there are 12 other companies that together account for approximately 44% of the total planned expansion (Renewable Fuels Association, 2009). The overarching financial strength of these companies might encourage acquisitions and mergers of smaller companies.

MAJOR ETHANOL PRODUCERS IN THE U.S.

The summary statistics for the major ethanol producers in the U.S. are shown in Table 1.

SOLOW RESIDUAL

There are currently several alternative measures to the Lerner's index in an industry. To mention a few: the New Empirical Industrial Organization (NEIO) approach, the Solow Residual-Based (SRB), and Non-Parametric Instrumental Variable (NPIV) tests. Among these alternatives, the SRB test, which builds upon the theory of total factor productivity first introduced by Solow (1957), circumvents the difficulty of finding an index that is closely related to the concept of pure market power. The SRB approach, based upon a smaller set of assumptions and requires less data compared to the NEIO approach.

The primal SRB test was first introduced by Hall (1988) as a test for market power exaction. The main premise on which the test is based upon is that the difference between the year-to-year output growth rate and the weighted average of factor inputs, using the cost share of each input on revenues as weights, is not entirely explained by autonomous technical change but by a price-cost margin (or markup factor). Under Constant Returns to Scale (CRS) and price competition, input shares are equivalent and the elasticity of output respect to the inputs and sum to one. Under market power exaction, the input shares do not sum to one due to the existence of a markup (marginal cost falls short of price). Hall's approach suffers from a potential endogeneity problem between output growth and productivity growth. Hence, Hall suggested identifying an instrumental variable (IV) that is related to changes in output but unrelated to productivity growth (i.e. supply shifter). Under some restrictive assumptions, the best candidates for this category of instrumental variables would be pure demand shocks.

Roeger (1995) developed a primal-dual approach, or the difference between the quantity-based and price-based residuals, with the objective of avoiding some estimation difficulties experienced with the primal SRB method, mainly the choice of adequate IVs. Roeger's maintained hypothesis was that the difference between the primal and the dual was not only caused by fixed factors of production (labour hoarding and excess capacity) but also by a positive markup. Roeger's primal-dual approach also circumvented the markup estimation problem caused by classical measurement error.

METHODOLOGY

Primal

The model maintains the assumptions of regularity, monotonicity, concavity, and a differentiable function of a single-output (ethanol) with n inputs (materials, labor, and capital) that exhibits CRS and Hicks-neutral technical change. In this case, the test assumes a competitive equilibrium in the factor market. The production function is given as:

\[ Y = A P L^a K^b \]

where the subscript t is years (1997-2008), \( Y \) is output (gallons of ethanol), \( A \) represents a productivity shock, \( \gamma \) is the rate of Hicks-neutral technical progress and \( \delta \) is a residual due to the inclusion of materials, labor, and capital. After some mathematical manipulation, we obtain the following Solow Residual (SR) representation:

\[ y_t = \sum_{a=0}^\infty \frac{\alpha_a}{x_a x_t} = \beta_0 y_t + (1 - \beta_\gamma A_t + \gamma) \]

where the subscript \( a \) represents the inputs used (materials, labor, and capital), \( x_a \) is the input cost share of the shares \( x_a (x_{a+1}) \) per input, and an instantaneous change in any variable, \( A_t \), is denoted by \( \gamma \). The super-script represents the variables that have been normalized by \( x_a \). Solow and Hall maintain the assumption that output is valued at marginal cost in a competitive market. However, by relaxing that assumption and including a markup estimation \( \beta \) (the Lerner's index), Hall concluded that if \( \beta = 0 \), the market behaves competitively. If \( \beta > 0 \), there is a positive markup imposing market power exaction and the marginal contribution of output to revenues exceeds its marginal cost by some \( \beta \) of the marginal cost. Thus, we can estimate the SR using the following equation

\[ \text{SRB} = b_p - b_0 y_t^+ \]

In the primal-dual case, the difference between the output market \( MC = \gamma y_t A_t \), while keeping the assumption of competitive behavior and using the markup estimate \( b_p \), after some mathematical manipulations we obtain the following dual representation of the SRB:

\[ \sum_{a=0}^\infty \frac{\alpha_a A_t x_a x_t}{x_t} = -\frac{y_t}{y_t^+} \frac{1}{1 - \beta_\gamma A_t x_t \gamma} \left[ 1 + \beta_\gamma A_t x_t \gamma \right] \]

where \( p \) is the price of the output (ethanol). The super-script - represents the variables that have been normalized by \( p \). halls the left-hand side of the previous equation by SR (Solow residual-based), a simpler representation of the residual is obtained:

\[ SRB = b_p - b_0 y_t^+ \frac{1}{y_t^+} + \gamma \frac{y_t}{y_t^+} \]

By subtracting the SRB from the SR, Roeger obtained an expression that is independent of the productivity shocks. Hence, circumvents the IV estimation procedure. The resulting equation can be estimated using OLS.

\[ \text{SRB} = b_p - b_0 y_t^+ \frac{1}{y_t^+} \left( 1 + \frac{1}{y_t^+} \right) + \gamma \]

where \( \delta \) should be identical zero for all \( t \) under the maintained assumption that factors of production can be adjusted instantaneously. However, Roeger mentions that two important sources of a non-zero are classical measurement error and the presence of keynesian demand shocks. Following Roeger's methodology, the rate of change of gross domestic product (GDP) was added to the previous equation as an explanatory variable to identify if there is a source of difference between the primal and dual residuals is fixed factors of production.

DATA

Data on output and input quantities and prices were obtained for the period between 1997 and 2008 using the North American Classification System (NAICS) and the Standard Industrial Classification (SIC). The three types of inputs were considered material, labor, and capital. The total cost of materials was handled using 

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