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U.S. Potential Biofuel Trade: A Worldwide Country-Pair

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Background

- Biofuels are known to be one of the best preferences to lead the transition away from petroleum fuels in the near-term.
- Global biofuel production (2007) accounted for 1.8 % of total global transport fuel consumption in energy terms.
- Brazil and U.S. together account for almost three-quarters of global supply.
- The two chief biofuels that are currently used are ethanol and biodiesel (Osei Yeboah and Shaik, 2009).

Background Cont'd

- Brazil has been by far the largest exporter of ethanol in recent years.
- The E.U. and U.S. jointly account for over 95 % of the global biofuel demand.
- The primary goal of this paper is to analyze the potential for U.S. bilateral trade in biofuels with over 200 countries worldwide using country-pair analysis.

Literature Review: Country Pair Analysis

- Country-pair analysis is popular in analyzing bilateral trade between countries. It explains better the cross country variation (Calderón, 2007; Hertel, 2007; Helpman, 2008).
- Country-pair analysis usually employs gravity model (Tzouvelekas, 2007; Westerlund and Wilhelmsson, 2007).
- The problem with gravity model is the prevalence of zero bilateral trade (Hummels and Klenow, 2005; Santos Silva and Tenreyro, 2006; Bikker, 2007; Hillbery and Hummels, 2008).

Literature Review: Country Pair Analysis

Cont'd

- Zero trade flows are undefined when converted into logarithms for estimation using log-linear gravity model (Eaton and Kortum, 2002; Hallak, 2006; Baldwin and Harrigan, 2007; Helpman et al 2008).
- The most common response to the problem of zero trade is to truncate the sample by deleting the observations with zero trade.
- Truncation, in principle, is inefficient, since it ignores the information in the limit observations.

Literature Review: Country Pair Analysis

Cont'd

- Also, when data are censored, values of the dependent variable that could in principle be observed are masked.
- To avoid the problem of zero trade values researchers often use Limited Dependent Variable Models-(Egger and Larch, 2008; Head, Cameron and Trivedi, 2009; Mayer and Ries, 2010).

Literature Review: Limited Dependent Variable Model

- Limited Dependent Variable Model is an approach of estimation that systematically takes into account the information in the limit observations.
- In general, the natural method to handle data generated by a limited-dependent variable process is the Tobit model.
- Tobit model accounts for country-pairs with zero trade.

Literature Review: Limited Dependent Variable Model Cont'd

- Tobit is a maximum likelihood procedure that looks at the limit observations where the dependent variable is equal to zero and the non limit observations where the dependent variable is greater than zero.
- Tobit incorporates the zeros and is usually preferred over the traditional gravity model (Egger and Larch, 2008; Head, Cameron and Trivedi, 2009; Mayer and Ries, 2010).

Standard Tobit Model

- The standard tobit model can be defined as

$$y_{it}^* = f((x_{it}; \beta), t) + \varepsilon_{it}$$
$$y_{it} = \begin{cases} y_{it}^* & \text{if } y_{it}^* > 0 \\ 0 & \text{if } y_{it}^* \leq 0 \end{cases}$$

Standard Tobit Model

- The log-likelihood function of the standard tobit model is

$$l = \sum_{it \in [y_{it}=0]} \ln \left[1 - \Phi \left(x'_{it} \beta / \sigma \right) \right] + \\ \sum_{it \in [y_{it}>0]} \ln \left[\varphi \left(\left(\frac{y_{it} - x'_{it} \beta}{\sigma} \right) / \sigma \right) \right]$$

$\Phi = CDF$ and $\varphi = PDF$

of the standard normal distribution

Table 1: Summary of Descriptive Results

Variables	U.S. Exporting other Countries		Other countries exporting to U.S.	
	Mean	Standard Deviation	Mean	Standard Deviation
BIOFUELE (\$'1000)	102.394	213.853	153.048	255.904
AGGDPOC (\$'1000)	1129.69	2750.48	180.654	461.985
REXRATEO (Per \$)	0.29471E+08	0.280989E+09	0.511576E+07	0.196399E+08
POPOC ('1000)	369737	0.573121E+07	85366.2	245153
DISTANCE (miles)	42691.4	107623	21443.6	102542

Summary of Descriptive Results

- A summary of the descriptive results are presented in table 1.
- Over the period (2000-2008), U.S. biofuel export to other countries is \$ 102, 000 on the average whereas its imports from other countries is \$ 153, 000 on the average.
- Thus, in the net, U.S. is an importer of biofuel.

Table 2: Tobit Model results of U.S Exporting to other Countries

Variable	Coefficient	Marginal Effect	b / St.Er.	Mean of X
Constant	-21.6726	-0.00217	-0.590	
AGGDPOC	-0.82802***	-0.0001***	-3.551	1127.88
REXRATEO	-0.00013***	-0.12776D-07***	-10.195	0.295D+08
POPOC	0.00035***	0.34685D-07***	3.644	369737
DISTANCE	-0.00306	-0.30621D-06	-0.568	42098.5

Lhs=BIOFUELE

Note: *** = Significance at 1 % level

Note: nnnnn.D-xx or D+xx → multiply by 10 to -xx or +xx.

Tobit Model results of U.S Exporting to Other Countries

- The empirical results of U.S. as an origin country of biofuel are presented in table 2.
- The size of agricultural GDP (AGGDP) of U.S. is significant at 1 % and exerts a negative effect on biofuel export.
- Real Exchange Rate of the foreign currency to the dollar is also significant at 1 % and shows a negative effect on biofuel export.
- U.S. population is significant at 1 % and has a positive effect on biofuel export.
- Distance between U.S. capital and capital cities of other countries serves as a proxy for transportation cost.

Marginal Effects: U.S Exporting to Other Countries

- Marginal effects were computed at the means of the explanatory variables for all observations (with zeros) and are also presented in table 2.
- This accounts for the fact that a country pair that has not traded in the past may choose to trade if conditions change.
- The negative marginal effect of -0.0001 AGGDP implies a 1 % increase in AGGDP would potentially generate 0.0001 % less of biofuel export from the U.S.

Marginal Effects: U.S Exporting to Other Countries Cont'd.

- The marginal effect of -0.000000013 for exchange rate means a 1% depreciation of the foreign currency will reduce U.S. biofuel exports by less than 1 percent.
- The positive marginal effect of 0.000000035 implies that 1 % increase in U.S. population would mean an expected increase in U.S. biofuel export by less than 1 percent.

Table 3: Tobit Model results of Other Countries Exporting to U.S. (U.S. Imports)

Variable	Coefficient	Marginal Effect	b / St.Er.	Mean of X
Constant	-11.9836	-0.00120	-0.177	
AGGDPOC	6.86335***	0.0007***	4.272	180.654
REXRATEO	-0.00359***	-0.35910D-06***	-8.675	0.512D+07
POPOC	-0.00046**	-0.45538D-07**	-2.116	85366.2
DISTANCE	0.02542**	-0.25423D-05**	-2.105	20868.2

Lhs=BIOFUELE

Note: ***, ** = Significance at 1 %, 5 % level

Note: nnnnn.D-xx or D+xx → multiply by 10 to -xx or +xx.

Tobit Model results of Other Countries Exporting to U.S

- The empirical results of other countries as an origin countries of biofuel are presented in table 3.
- The size of agricultural GDP (AGGDP) in other countries is significant at 1 % and exerts a positive effect on biofuel export as expected.
- Real Exchange Rate of the foreign currency to the dollar is also significant at 1 % and shows a negative effect on biofuel export.
- Other countries' population is also significant at 5 % and has a negative effect on biofuel export.
- Distance between capital cities of other countries and U.S. capital is significant at 5 % and exerts a negative effect.

Marginal Effects: Other Countries Exporting to U.S

- The marginal effects are also presented in table 3.
- The positive marginal effect of 0.0007 AGGDP implies that a 1 % increase in AGGDP would potentially generate 0.0007 % more of biofuel export from other countries to the U.S.
- The marginal effect of -0.00000036 for exchange rate means a 1% depreciation of the dollar will reduce other countries biofuel exports to the U.S. by less than 1 percent.

Marginal Effects: Other Countries Exporting to U.S Cont'd.

- The negative marginal effect of -0.000000046 implies that a 1 % increase in foreign countries population would mean an expected decrease in their biofuel export to U.S. by less than 1 percent.
- It is assumed that the larger the population, the less the country will export. This is because, that exporting country will want to make sure it provides for its growing population.

Marginal Effects: Other Countries Exporting to U.S Cont'd.

- The negative marginal effect of -0.0000025 implies that a 1 % increase in the distance between other countries and the U.S. in terms of biofuel export, will result in an expected decrease in the biofuel exports of these countries to the U.S. by less than 1 percent.
- This means that the greater the distance between two countries, the lower the level of trade between them.

Conclusions

- This paper extends the traditional gravity model to analyze the potential for U.S. bilateral trade in biofuels with over 200 countries worldwide using country-pair Tobit analysis.
- The above results are consistent but provide differential output with and without the inclusion of country-pairwise data.