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**Foot-and-Mouth Disease Impacts on U.S. Pork Exports: A Comparative Study of
the Spatial Econometric Model versus the Gravity Model**

Shang-Ho Yang

Agricultural Economics, University of Kentucky
417 C.E. Barnhart Building, Lexington, KY 40546-0276
Phone Number: 859-257-7283; Fax: (859) 257-7290
E-mail: bruce.yang@uky.edu

Michael Reed

Agricultural Economics, University of Kentucky
308 C.E. Barnhart Building, Lexington, KY 40546-0276
Phone Number: 859-257-7259; Fax: (859) 257-7290
E-mail: mrreed@uky.edu

Sayed Saghaian

Agricultural Economics, University of Kentucky
314 C.E. Barnhart Building, Lexington, KY 40546-0276
Phone Number: 859-257-2356; Fax: (859) 257-7290
E-mail: ssaghaian@uky.edu

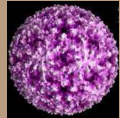
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The Impact of Foot-and-Mouth Disease on U.S. Pork Exports: A Comparative Study of the Spatial Econometric Model versus the Gravity Model

Shang-Ho Yang[±], Michael Reed[±], and Sayed Saghaian[±]

[±]Department of Agricultural Economics, University of Kentucky at Lexington, Kentucky 40546



Introduction

Foot-and-Mouth Disease (FMD) is a highly contagious disease that affects cloven-hoofed animals such as cattle, goats, and pigs. FMD causes a high fever, blisters inside the mouth and on the feet that may rupture and cause lameness. A serious FMD outbreak can create tremendous negative impacts on animal health, domestic meat production, and agricultural economic activity.

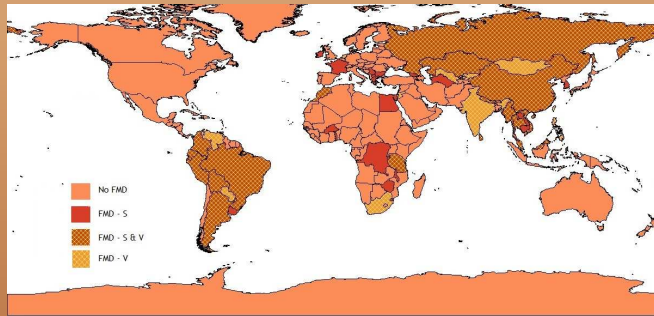
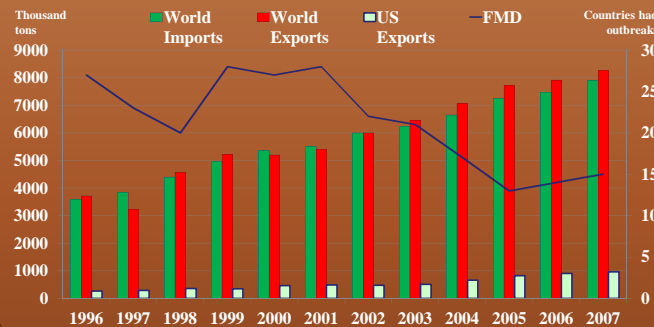


Figure above shows that 58 countries (reported a total 255 FMD outbreaks) were infected by FMD during 1996 to 2007. Figure below shows that global pork trade may have been affected by FMD outbreaks which may lead disease-free exporters to gain more market share.



Research Questions

- ❖ Do U.S. pork exports gain more market share while other importers develop FMD?
- ❖ FMD-affected countries can adopt a slaughter or vaccination policy to deal with FMD. Do different policies adopted by FMD-affected importers lead to different impacts on U.S. pork exporters?
- ❖ A gravity model and spatial econometric model are used and compared. Do the estimators of these two models in this study have consistent results?

Research Method

- ❖ Gravity model
 - ❖ Heteroskedasticity (Santos-Silva and Tenreiro, 2006) and endogenous multilateral resistance terms (Baier and Bergstrand, 2007) should be aware when using gravity model.
 - ❖ Poisson Pseudo-Maximum-Likelihood (PPML) with fixed effects is used in this study.
- ❖ Spatial Econometric Model
 - ❖ Spatial dependence: A lack of independence among observations – the errors due to the presence of spatial dependence.
 - ❖ Two different spatial dependence models: Spatial Error Model (SEM); Spatial Lag Model.
 - ❖ SEM, where space matters only in the error process, is applied to investigate U.S. pork exports.
 - ❖ Fixed effects in a spatial autoregressive structure are introducing additional exogenous information, which augments the sample data information.

Empirical Model

- ❖ Gravity Model – PPML Estimator:
 - ❖ No time or country fixed effects

$$\ln(Export_{jt}) = \alpha_0 + \alpha_1 \ln(RGDP_{jt}) + \alpha_2 \ln(Distance_j) + \alpha_3 Language_j + \alpha_4 Colony45_j + \alpha_5 Contiguity_j + \alpha_6 RTA_{jt} + \alpha_7 FMDVA_{jt} + \alpha_8 FMDSL_{jt} + \epsilon_{jt}$$
 - ❖ Country and time fixed effects

$$\ln(Export_{jt}) = \alpha_j + \alpha_t + \alpha_0 + \alpha_1 \ln(RGDP_{jt}) + \alpha_6 RTA_{jt} + \alpha_7 FMDVA_{jt} + \alpha_8 FMDSL_{jt} + \epsilon_{jt}$$
- ❖ Spatial Error Model – Generalized Linear Spatial Poisson Estimator
 - ❖ No time or country fixed effects

$$y_n = X_n \beta + u_n, u_n = \lambda M_n u_n + \epsilon_n$$
 - ❖ Country and time fixed effects

$$y_n = \alpha_n + X_n \beta + u_n, u_n = \lambda M_n u_n + \epsilon_n$$

y_n is a vector of obser. on the Export; X is exogenous variable as previous equation; M is matrices of spatial weights; λ is scalar parameter.

Data

- ❖ Data include U.S. pork exports to the 181 importing countries during 1996 to 2007.
- ❖ Annual value of U.S. pork exports are derived from the UN-CTSD¹.
- ❖ Real GDP is derived from the FAS/USDA² in U.S. dollars.
- ❖ FMD records are from the OIE³ website.
- ❖ The indicators of distance, contiguity, colonial relations, and common language are CEPII⁴.
- ❖ RTA can be found in WTO⁵ website.

Empirical Results

❖ Zero-valued trade excluded

Dependent variable: Export	No Fixed Effects		With Fixed Effects (α_j, α_t)	
	SEM	PPML	SEM	PPML
RGDP	0.095 ***	0.048 ***	0.099 ***	0.123 ***
Distance		-0.110 ***		
Language	0.035	0.015	.	.
Colony45	0.164	0.119 ***	.	.
Contiguity	0.455 ***	0.014	.	.
RTA	0.128 *	0.073 **	0.059 ***	0.074 ***
FMDVA	0.121 ***	0.047 **	0.013	0.014
FMDSL	-0.050	-0.004	0.020	0.024
Observation	941	941	941	941
AIC	4.338	4.722	4.971	4.732
BIC	4120.792	4487.479	5375.944	5054.300
Log Likelihood	-2033.008		-2194.992	
Lambda (λ)	0.593 ***		-0.239	

Note: * = 0.10, ** = 0.05, and *** = 0.01.

❖ Cragg's Model for Participation and Outcome Questions

Dependent Variable:	Participation Question		Outcome Question	
	Probit	PPML	SEM	SEM
Export in Binary				
Export in Continuous				
RGDP	0.299 ***	0.048 ***	0.095 ***	0.095 ***
Distance	-1.565 ***	-0.110 ***		
Language	0.602 ***	0.015	0.035	0.035
Colony45	Omitted	0.119 ***	0.164	0.164
Contiguity	Omitted	0.014	0.455 ***	0.455 ***
RTA	0.622 ***	0.073 **	0.128 *	0.128 *
FMDVA	0.235 *	0.047 **	0.121 ***	0.121 ***
FMDSL	0.534 ***	-0.004	-0.050	-0.050
Observation	2172	941	941	941
LR χ^2	844.160	6820.297		
AIC	0.974	4.722	4.338	4.338
BIC	2120.686	4487.479	4120.792	4120.792
Log Likelihood	-1033.510		-2033.008	

Note: * = 0.10, ** = 0.05, and *** = 0.01.

Conclusion

- ✓ Disease impacts on importing countries lead to increased imports from the U.S. This implies that U.S. pork exports gain more market share while other importers develop FMD.
- ✓ The results of Cragg's model show that only importers with a vaccination policy are more likely to enhance pork imports from the U.S.
- ✓ The empirical results for SEM and PPML estimators are similar and consistent when fixed effects and zero-valued trade are excluded in the U.S. example.

Footnotes

- ¹ United Nations Commodity Trade Statistics Database.
- ² Foreign Agricultural Service/ U.S. Department of Agriculture
- ³ Office International des Epizooties
- ⁴ Centre d'Etudes Prospectives et d'Informations Internationales
- ⁵ World Trade Organization