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

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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.

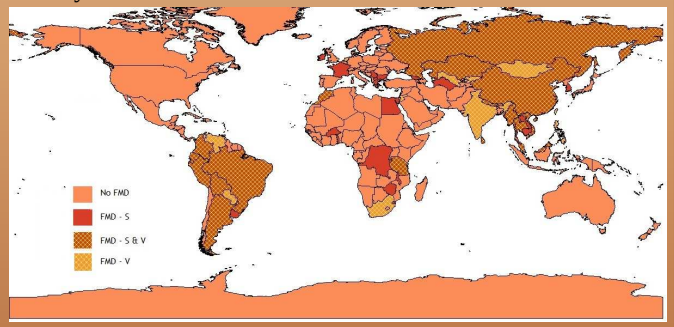
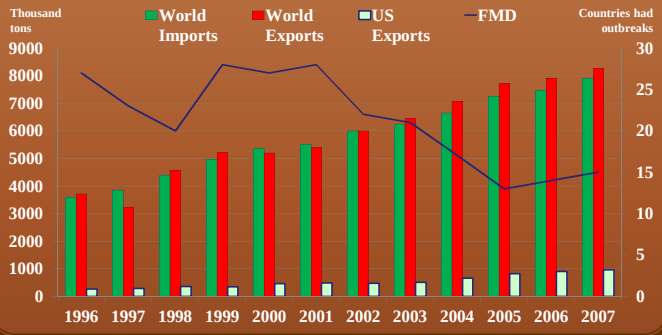


Figure above shows that 58 countries (reported a total 255 FMD outbreaks) were infected by FMD during 1996 to 2007. Figure below shows that global pork trade may have been affected by FMD outbreaks which may lead disease-free exporters to gain more market share.



Research Method

- Gravity model
  - Heteroskedasticity (Santos-Silva and Tenreyro, 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

$$ln(Export_{jt}) = \alpha_0 + \alpha_1 \ln(RGDP_{jt}) + \alpha_2 \ln(Distance_j) + \alpha_3 Language_j + \alpha_4 Colony45_j + \alpha_5 Contiguity_j + \alpha_6 RTA_{jt} + \alpha_7 FMDVA_{jt} + \alpha_8 FMDSL_{jt} + \varepsilon_{jt}$$

  - Country and time fixed effects

$$ln(Export_{jt}) = \alpha_j + \alpha_t + \alpha_0 + \alpha_1 \ln(RGDP_{jt}) + \alpha_6 RTA_{jt} + \alpha_7 FMDVA_{jt} + \alpha_8 FMDSL_{jt} + \varepsilon_{jt}$$

- Spatial Error Model – Generalized Linear Spatial Poisson Estimator
  - No time or country fixed effects

$$y_n = X_n\beta + u_n,\ u_n = \lambda M_n u_n + \varepsilon_n$$

  - Country and time fixed effects

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

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.

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?

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-CTSD[1].
- Real GDP is derived from the FAS/USDA[2] in U.S. dollars.
- FMD records are from the OIE[3] website.
- The indicators of distance, contiguity, colonial relations, and common language are CEPII[4].
- RTA can be found in WTO[5] 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

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