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# A Computable General Equilibrium Model for a Foot and Mouth Disease Outbreak Originating in the Midwest

## Macroeconomic Impacts of Foot and Mouth Disease Vaccination Strategies

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# FMD Economic Loss in Literature

- Ekboir (1999) – One of the first FMD studies to estimate the cost of response.
  - Mean welfare losses – \$1.5 billion
- Lee et al. (2002) – based on Ekboir (1999) scenarios and included export restrictions and consumption drops using partial equilibrium and I/O model.
  - Mean welfare losses – \$26 billion
- Pendell et al. (2007) – Used an I/O-model to examine impacts within Kansas for a hypothetical outbreak in Kansas. No vaccination assumption.
  - Mean welfare losses – \$0.257 billion
- Paarlberg et al. (2008) – One of first to use national partial equilibrium model to estimate national economic impacts. No vaccination assumption.
  - Mean welfare losses – \$3.5 billion
- Hayes et al. (2011) – incorporated national trade bans. Used NPV of one year NOT 10 year period. No vaccination assumption.
  - Mean welfare losses – \$12.8 billion
- Carpenter et al. (2011) – evaluated effects of delays in detection. Evaluated the effect of vaccination
  - Mean welfare losses – \$30 billion
- Schroeder et al. (2016) – 15 outbreaks, 10 year national export restrictions and 2-year consumer avoidance. Included vaccinate-to-live and vaccinate-to-die in comparison to NO-Vac assumptions.
  - Mean welfare losses – \$9.26 billion

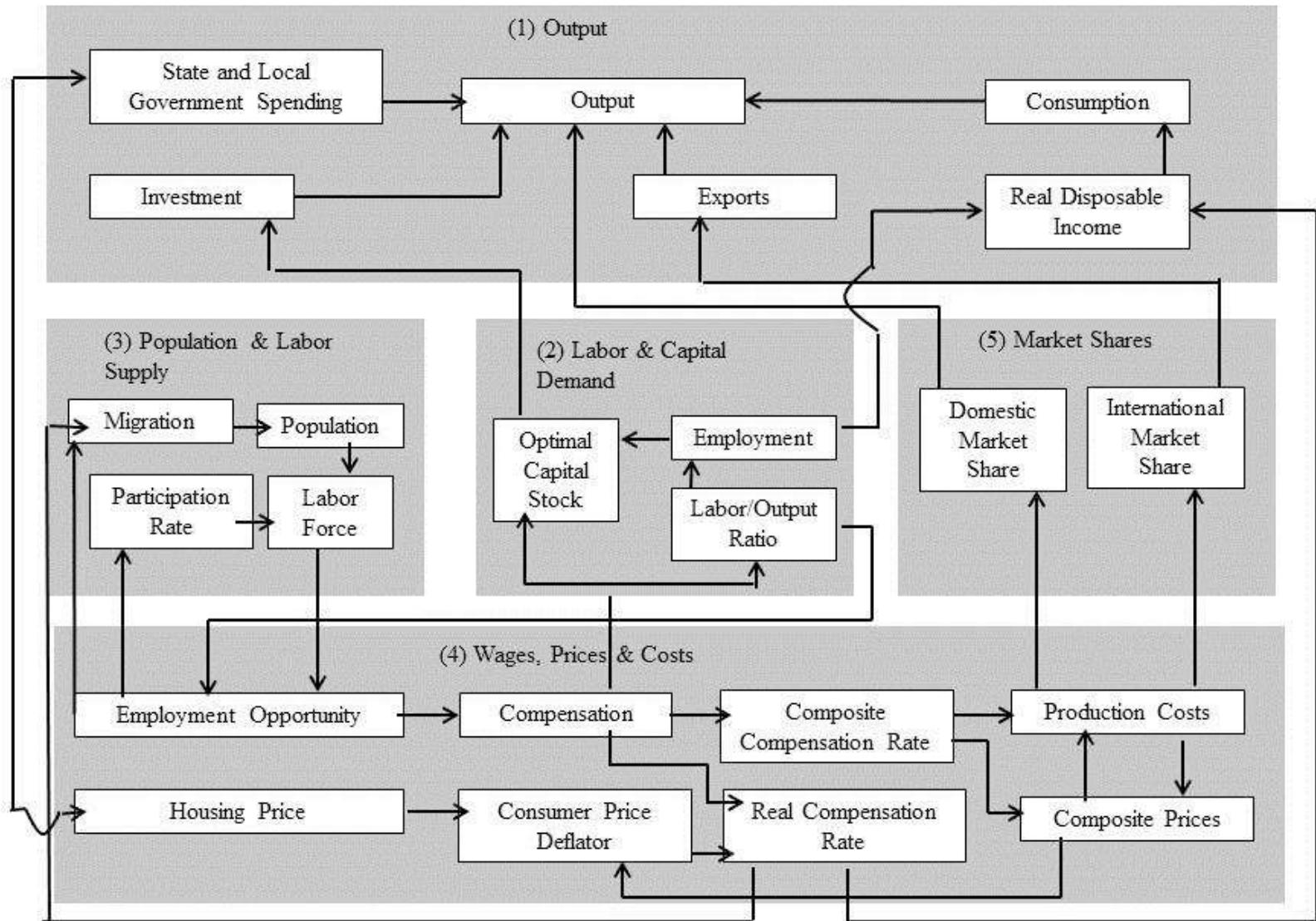
# Schroeder et al. (2016)

- *Rational discussion is useful only when there is a significant base of shared assumptions.* – Noam Chomsky
- Quarterly demand and supply model
- Economic model parameters, substitution and trade elasticities, revenue and factor shares, and livestock-feed balance information remain constant as defined by Paarlberg et al. (2008)
- NAADSM model is used to model epidemiological disease spread. This output provides the exogenous economic shocks.
- Time period is first quarter of 2009 – fourth quarter of 2018
- Simulated outbreak was in Kansas, Nebraska, Colorado, South Dakota, Wyoming, northern Oklahoma, Texas Panhandle, and northern New Mexico
- Compared the economic impact from the following assumptions of vaccination protocol:

# Vaccination Scenarios

Scenario Name <sup>t</sup>	Vaccination Strategy <sup>‡</sup>	Daily Herd Vaccination Capacity <sup>§</sup> (Day 22, Day 40)	Initial # of Herds Infected (trigger) <sup>¶</sup>	Vaccination Zone <sup>¥</sup> in km
NoVac			Slaughter without use of vaccine	
V2D/Feedlot/Fast/10km				10
V2D/Feedlot/Fast/50km		1, 3 (feedlots)	10 (fast detection)	50
V2D/Low/Fast/10km	V2D		10	10
V2D/Low/Fast/50km		5, 10 (low capacity)	100 (slow detection)	50
V2D/Low/Slow/10km			10	10
V2D/Low/Slow/50km			100 (slow detection)	50
V2D/High/Fast/10km		50, 80 (high capacity)	10	10
V2D/High/Fast/50km			(fast detection)	50
V2L/Low/Fast/10km	V2L		10	10
V2L/Low/Fast/50km		5, 10 (low capacity)	(fast detection)	50
V2L/Low/Slow/10km			100 (slow detection)	10
V2L/Low/Slow/50km			100 (slow detection)	50
V2L/High/Fast/10km		50, 80 (high capacity)	10	10
V2L/High/Fast/50km			(fast detection)	50

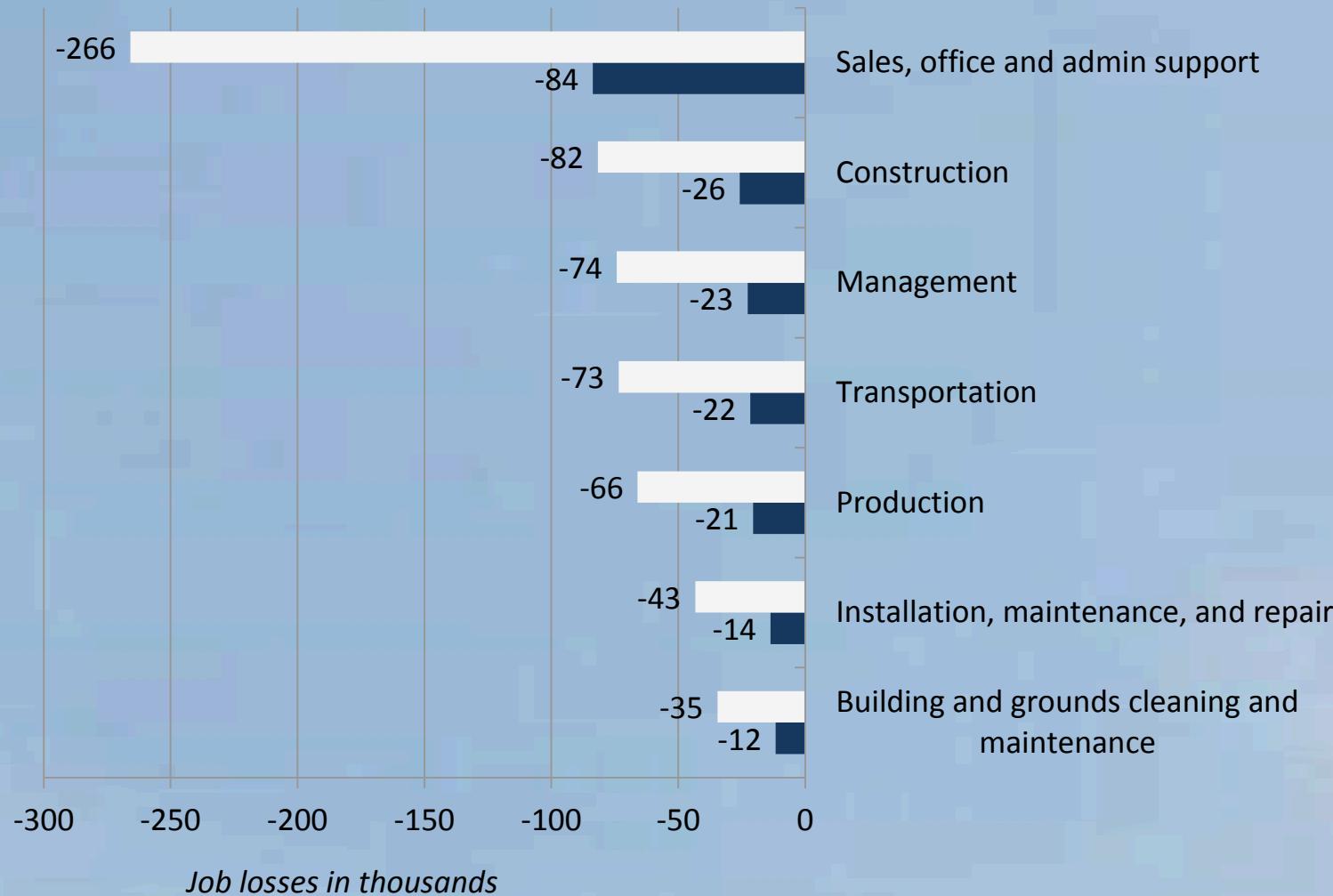
REMI MODEL Linkages (Excluding Economic Geography Linkages)



# Impacts on GDP and Employment

Vaccination Strategy	GDP loss (in billions)	Employment loss (in thousands)	GDP Savings vs. no vaccination (in billions)	Employment Savings vs. No Vaccination (in thousands)
NoVac	\$47	677	-	-
V2D/Feedlot/Fast/10km	\$35	505	\$12	172
V2D/Feedlot/Fast/50km	\$26	377	\$21	300
V2D/Low/Fast/10km	\$38	543	\$9	134
V2D/Low/Fast/50km	\$19	282	\$28	395
V2D/Low/Slow/10km	\$38	549	\$9	128
V2D/Low/Slow/50km	\$19	279	\$28	398
V2D/High/Fast/10km	\$33	463	\$14	214
V2D/High/Fast/50km	\$28	200	\$19	477
V2L/Low/Fast/10km	\$35	502	\$12	175
V2L/Low/Fast/50km	\$17	244	\$30	433
V2L/Low/Slow/10km	\$35	508	\$12	169
V2L/Low/Slow/50km	\$17	248	\$30	429
V2L/High/Fast/10km	\$30	425	\$17	252
V2L/High/Fast/50km	\$12	168	\$35	509

# Impacts on GDP and Employment NOVAC vs. V2LMax



# Conclusions

- Conservative estimates yield lower-bound estimates of economic impacts
  - NO-VAC outbreak of this size/location could be \$47 billion loss in GDP and 677,000 job losses
  - Estimates are highly dependent on outbreak parameters
- Findings support re-evaluation of FMD vaccination capacity and FMD protocols