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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)

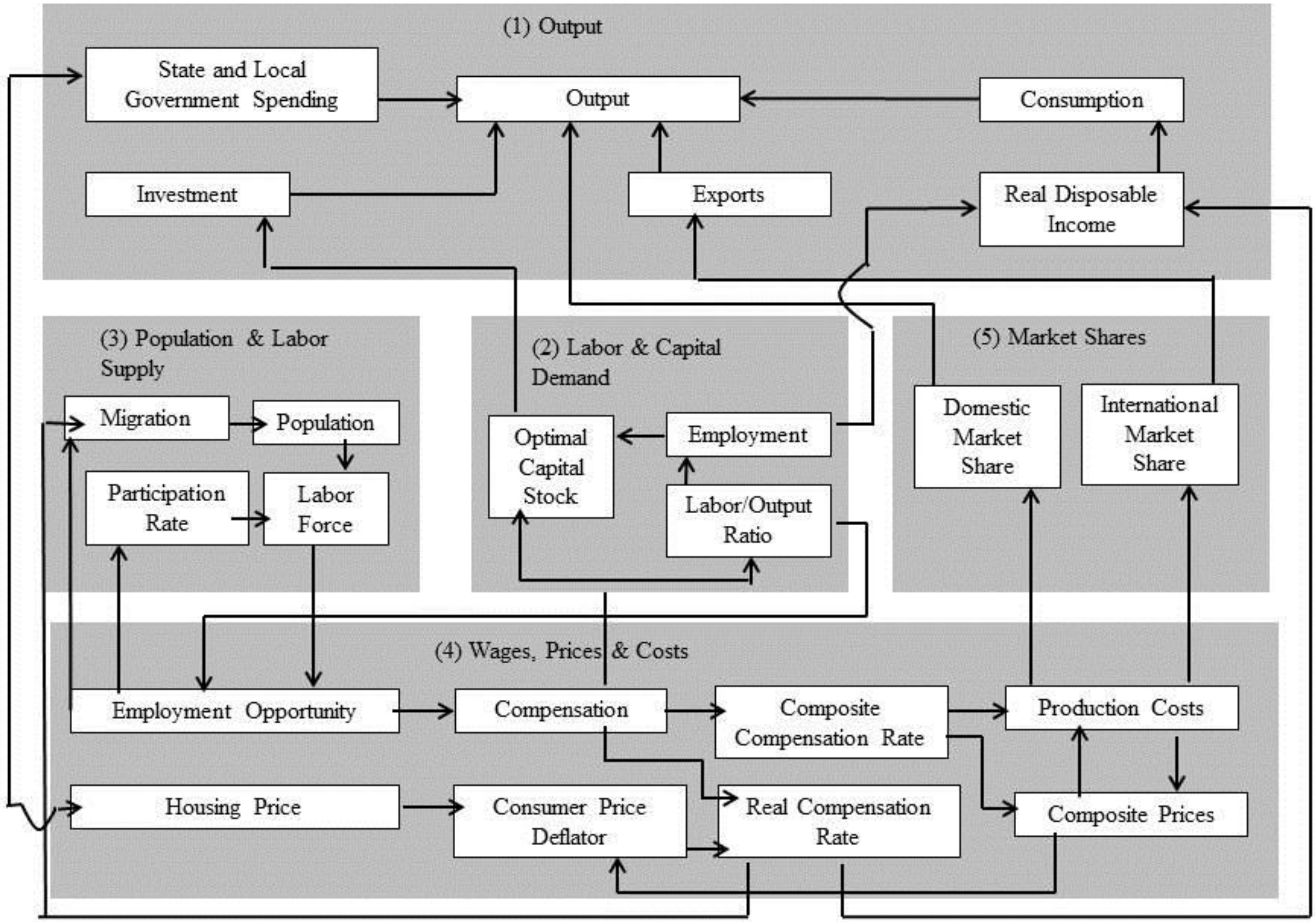
- *Rational discussion is useful only when there is a significant base of shared assumptions*. – Noam Chomsky

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

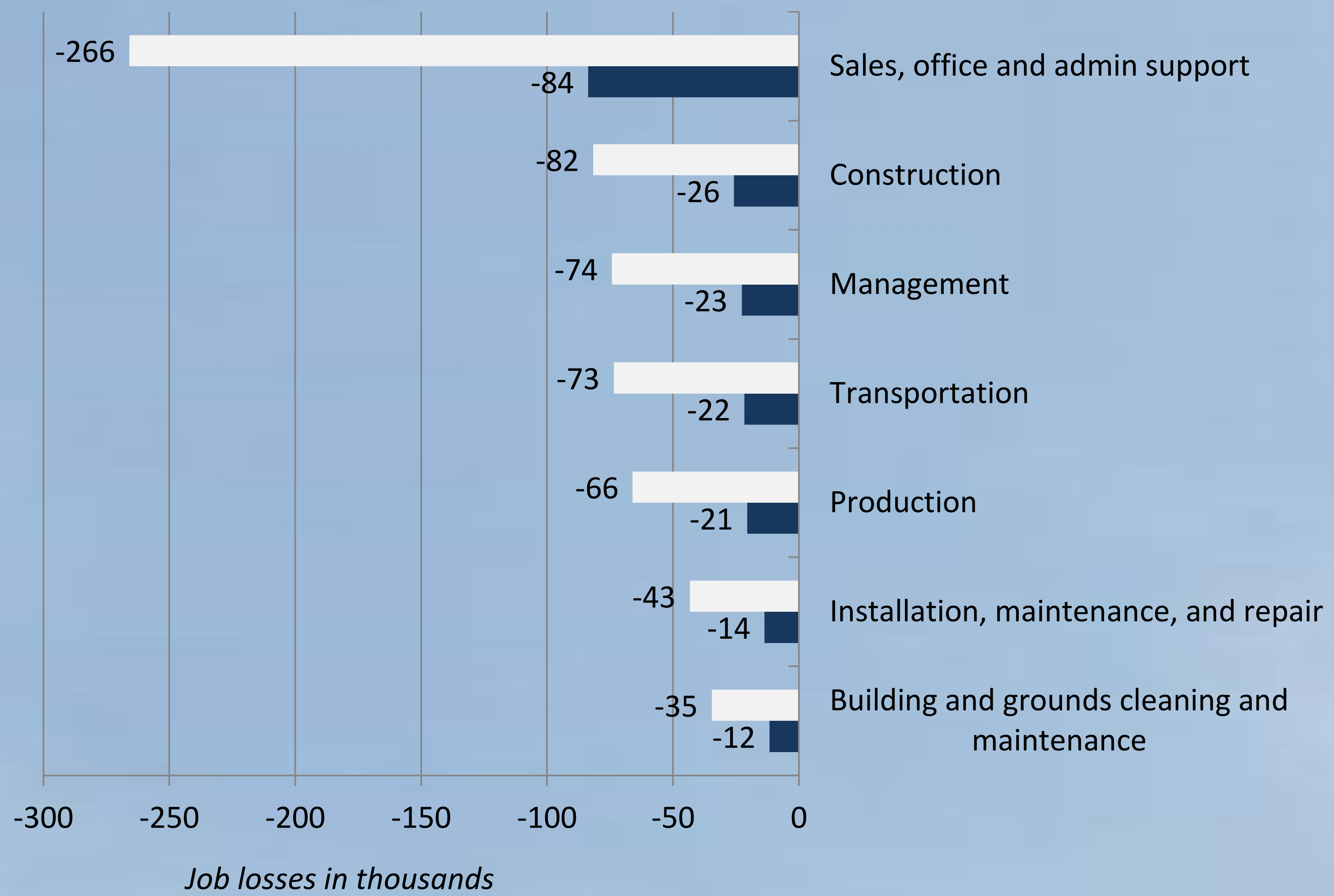
REMI MODEL Linkages (Excluding Economic Geography Linkages)



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