

Using REMI PI+ to model the impact of an FMD spread



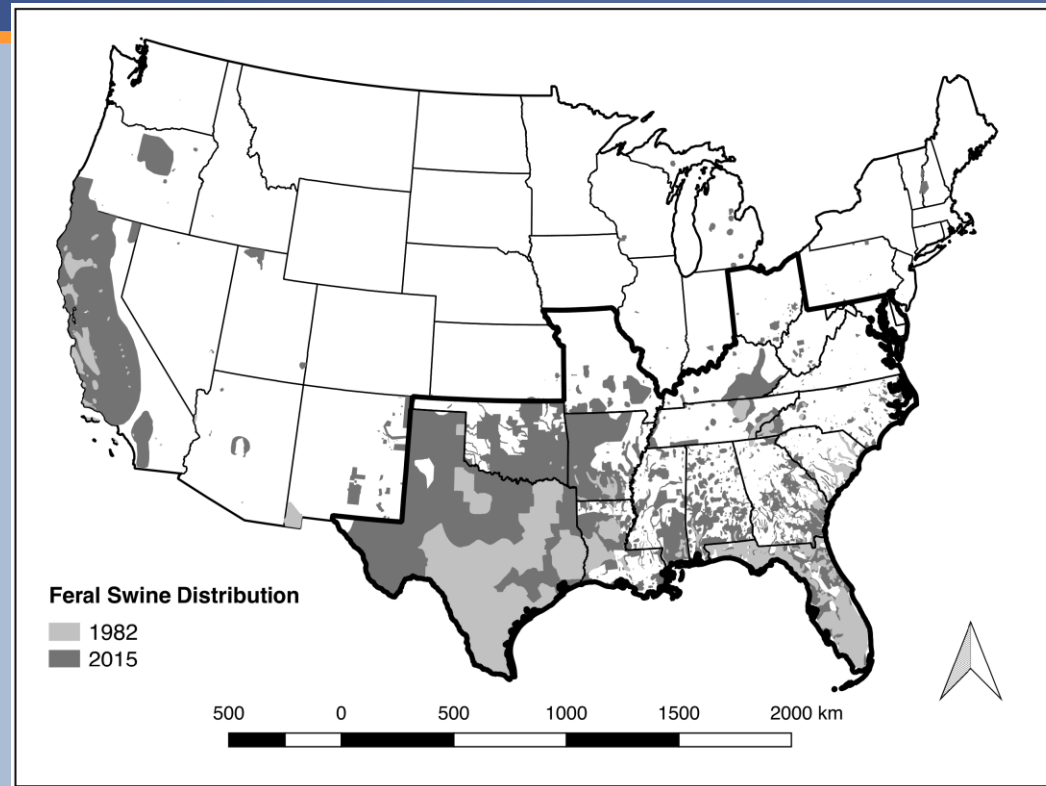
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The Economics of Wildlife Diseases

Motivation for this study

- Feral swine (FS) at the wildlife-livestock interface
 - Pathogens of FS
 - FAD (FMD)
- Vulnerability of US livestock production
 - Distribution of FS & livestock



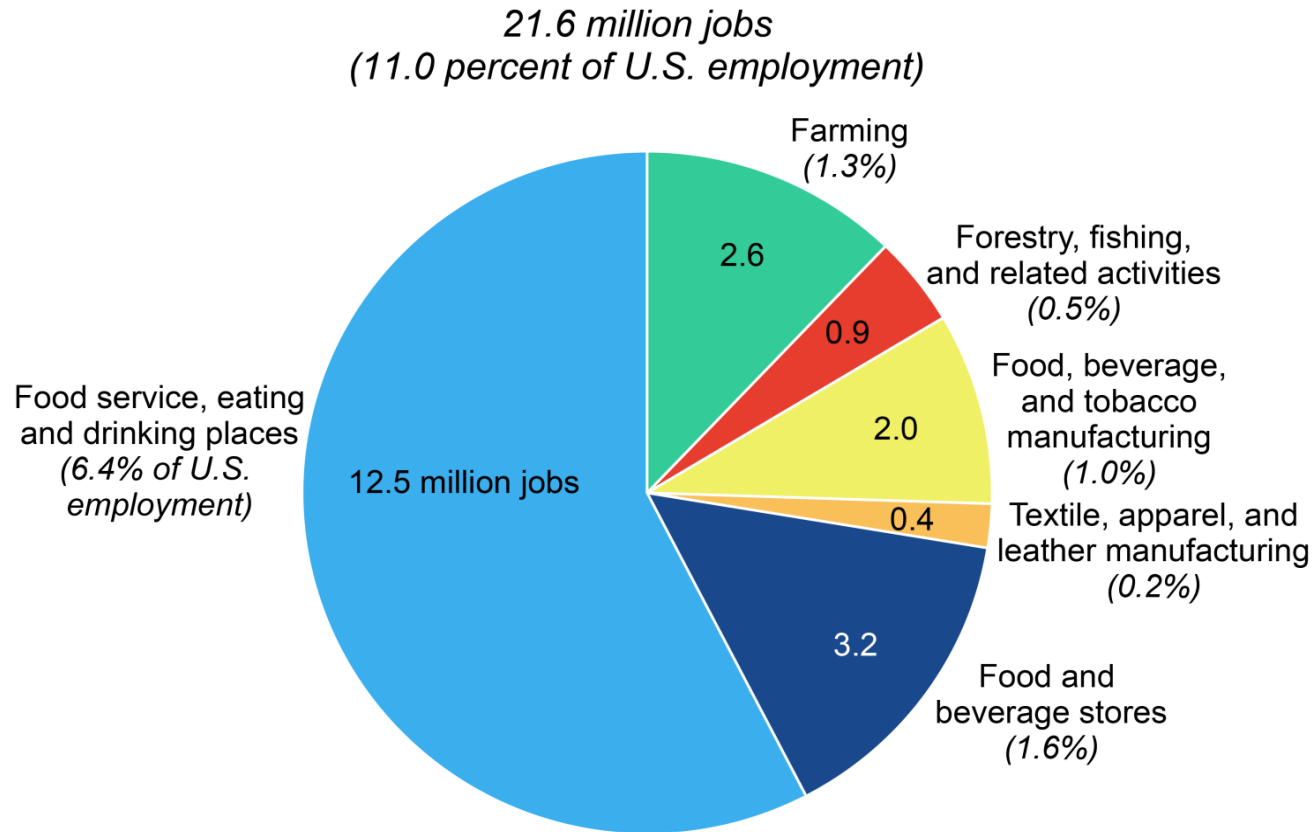
Estimating the domestic impacts

- Foot & Mouth Disease (FMD)
 - What are the potential economic impacts of FMD spread in the US

US Livestock Production: Background

- US is a net exporter of food
- 1/3 of US beef goes to Mexico & Canada
- Many US states report livestock production
- US livestock production is economically significant

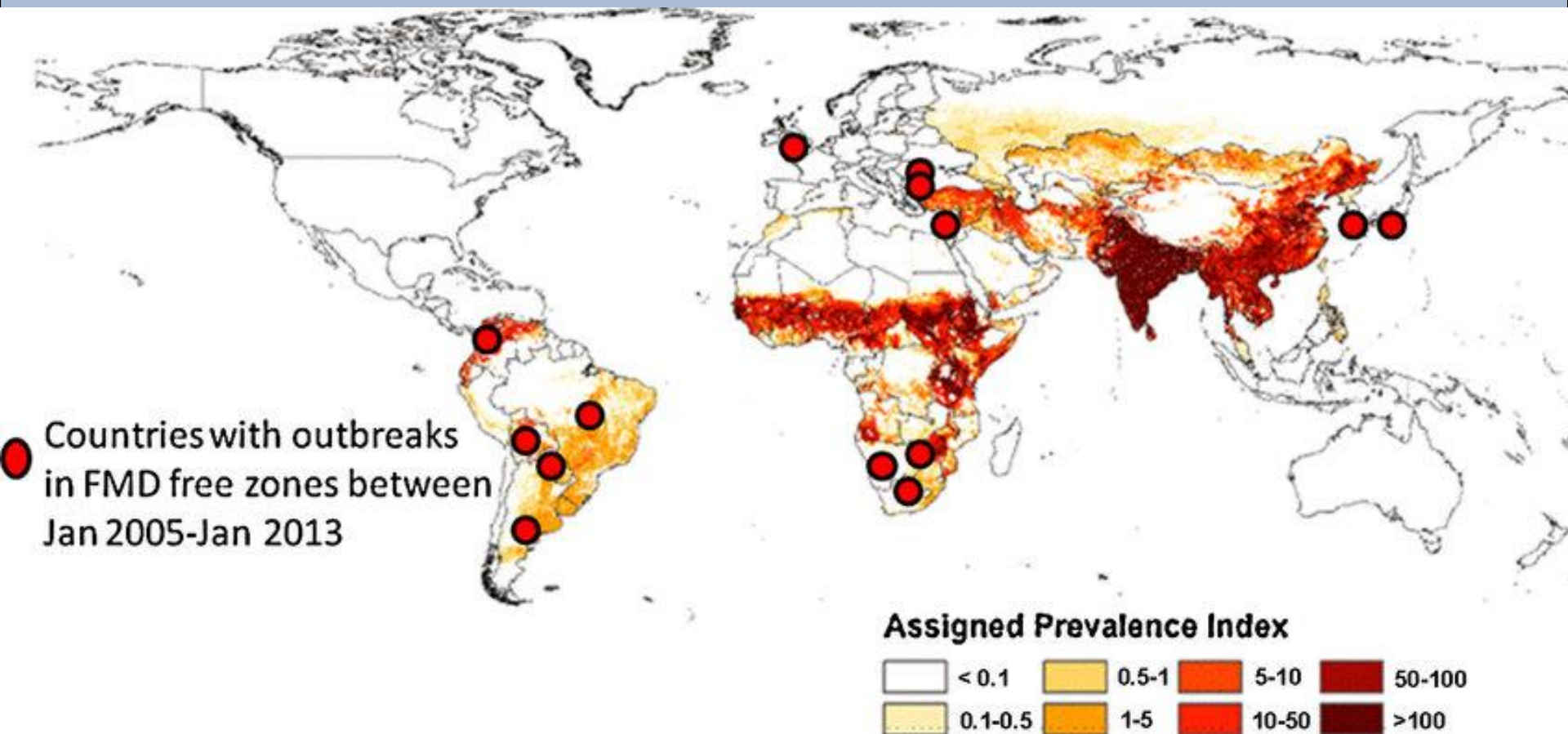
Employment* in agriculture, food, and related industries, 2017



*Full- and part-time jobs. Categories may not sum to total due to rounding.

Source: USDA, Economic Research Service using data from U.S. Department of Commerce, Bureau of Economic Analysis. Data as of September 25, 2018.

FMD Outbreaks: Incidence



T.J.D. Knight-Jones and J. Rushton (2013)

Measuring the impacts

What happens to domestic production when an FMD outbreak occurs?

- Several studies have examined this including Schroeder et al. (2015), Lee et al. (2012), Hagerman et al. (2012), Elbakidze et al. (2009) and Pendell et al. (2007)
 - Most have projected \$billions and very few have examined the macroeconomic impact of losses at the producer level.

What are the implications for the macroeconomy?

- Impacts to employment, prices, taxes, revenue, etc., in a specific region or all of the US.

What are the benefits of different strategies to reduce these impacts?

- Culling vs. vaccination to live vs. vaccination to die

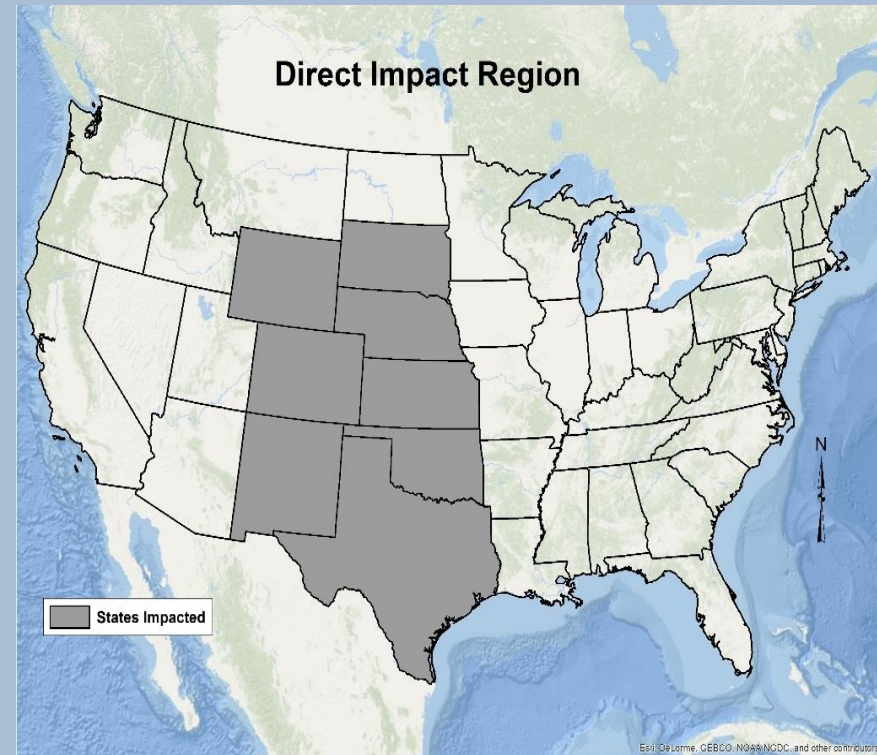
Author	Study Region	Modeling Software	Direct Impacts (millions)	Control Costs (millions)	Indirect impacts	
					Revenue (millions)	Jobs (thousands)
Miller <i>et al.</i> , 2018	Kansas, Nebraska, Colorado, South Dakota, Wyoming, northern Oklahoma, panhandle of Texas, northern New Mexico	REMI			\$12,000-47,000	172 - 685
Schroeder <i>et al.</i> , 2015	Kansas, Nebraska, Colorado, South Dakota, Wyoming, northern Oklahoma, panhandle of Texas, northern New Mexico	NAADSM	\$16,000-188,000	\$20-14,000		
Lee <i>et al.</i> , 2012	South San Joaquin Valley, California	NIEMO	\$8,000-12,000		\$23,000-34,000	
Ekboir, 1999	California				\$6,800-13,500	
Elbakidze <i>et al.</i> , 2009	Panhandle of Texas	AusSpread	\$600-1,000			
Pendell <i>et al.</i> , 2007	Southwest Kansas	NAADSM			\$50-1,300	
Bates <i>et al.</i> , 2003	3 counties in California		\$61-551			
Schoenbaum & Disney, 2003	South central U.S., north central U.S., western U.S.	Delphi 4.0	\$260-3,270			
Oladosu <i>et al.</i> , 2013	3 cases evaluated: South San Joaquin Valley, CA; 8% of livestock affected; 30% of livestock affected	IMPLAN	\$37,000-228,000			

Domestic Impacts

Schroeder et al. (2015)

- Estimated the direct economic impacts of a FMD outbreak in terms of producer and consumer losses
- Operations impacted included, cow-calf, feedlot, dairy, swine, and sheep
- Total project impacted with movement control, biosecurity, stamping out, and no vaccination, could reach \$188 billion and government disease control and management costs could reach \$11 billion.

So what is the value of a vaccination program?



Modeled Domestic Impacts

Scenario Name [†]	Vaccination Strategy [‡]	Daily Herd Vaccination Capacity [§]	Initial # of Herds Infected (vaccine trigger) [¶]	Vaccination Zone [*]	Duration (months)
		(Day 22, Day 40)		in km	
NoVac		Slaughter without use of vaccine			27
V2D/Feedlot/Fast/10km	V2D	1, 3 (feedlots)	10 (fast adoption)	10	21
V2D/Feedlot/Fast/50km				50	15
V2D/Low/Fast/10km		5, 10 (low capacity)	10 (fast adoption)	10	21
V2D/Low/Fast/50km				50	9
V2D/Low/Slow/10km			100 (slow adoption)	10	21
V2D/Low/Slow/50km				50	9
V2D/High/Fast/10km		50, 80 (high capacity)	10 (fast adoption)	10	18
V2D/High/Fast/50km				50	---
V2L/Low/Fast/10km	V2L	5, 10 (low capacity)	10 (fast adoption)	10	21
V2L/Low/Fast/50km				50	9
V2L/Low/Slow/10km			100 (slow adoption)	10	21
V2L/Low/Slow/50km				50	9
V2L/High/Fast/10km		50, 80 (high capacity)	10 (fast adoption)	10	18
V2L/High/Fast/50km				50	---

Modeling Assumptions

- Choices were made to assure lower bound estimates
- Quarterly vs Annually
- Splitting the livestock output impacts:
 - 80% first year and 20% second year
 - 60% first year and 40% second year
- Government spending exogenous: emergency funds or reallocation of funds

PI+ Inputs

- Livestock industry output impact
 - Beef cattle-> *Beef cattle ranching and farming*
 - Dairy costs-> *Dairy cattle and milk production*
 - Sheep and swine impact-> *Animal production, except cattle, poultry, and eggs*
- Government mitigation expenses
 - Euthanasia-> *Vet services*
 - Vaccination-> *Vet services*
 - Disposal costs-> *Services to building and dwellings*
 - Indemnity payments-> *Compensation to agricultures*

PI+ Inputs

- Consumer surplus->

Consumer price for food and nonalcoholic beverages purchased for of-premises consumption

PI+ Actual Model Inputs

The screenshot shows a web application interface for "PI+ Actual Model Inputs". At the top is a navigation bar with tabs for "FILE", "HOME", and "Navigation". Below the "Navigation" tab is a sub-menu with icons and labels for "Select Inputs", "Inputs List", "Forecast Options", and "Results". The main content area is divided into three columns:

- Featured:** Contains four tiles with images and labels: "Employment" (office desk), "Sales" (stack of coins), "BizDev" (hand writing on a chart), and "Taxes" (tax form with a star icon). Below these is a larger tile for "Custom and Detailed Variables" featuring an image of the White House and the text "Government Expenditure".
- Variables:** Contains three tiles: "Favorites" with a star icon, "Full List" with a book icon (highlighted with a yellow border), and a large "Model Linkages" tile. The "Model Linkages" tile has a background image of interlocking chains and text: "Display a block diagram of the model structure. Clicking on an area of the diagram will show the policy variables related to that area." Below these is a "Model Blocks" tile with a group of people icon and the text "Labor and Capital Demand".
- Topics & Scenarios:** Contains six tiles: "Industries" (factory icon), "Business Costs" (calculator icon), "Consumer Prices" (dollar sign icon), "More Topics" (bus icon), "Base Realignment and Closure" (military tank image), "Higher Education" (graduation cap image), "Minimum Wage" (stacks of coins image), and "More Scenarios" (photo icon).

Inputs: Excel Spreadsheet

Proprietors' Income (amount)	Agriculture and forestry support activities	Alabama	Nominal \$ (000s)	-1093.82	
Detailed Farm Output (amount)	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	Alaska	Nominal \$ (000s)	-32152.8	
Detailed Farm Output (amount)	Dairy cattle and milk production	California	Nominal \$ (000s)	-41608.3	
Detailed Farm Output (amount)	Animal production, except cattle and poultry and eggs	Florida	Nominal \$ (000s)	-17326.3	
Consumer Price (amount)	Food and nonalcoholic beverages purchased for off-premises consumption	Georgia	Nominal \$ (000s)	2398.65	
	Alabama				
	Alaska				
	California				
	Florida				
	Georgia				
	Louisiana				
	Michigan				
	Missouri				
	Mississippi				
	North Carolina				
	South Carolina				
	Texas				
	Washington				
	Rest of U.S.				

And Now The Model...

The screenshot shows a web application interface with a navigation bar at the top. The navigation bar includes tabs for 'FILE', 'HOME', and 'Navigation'. Below the 'Navigation' tab, there are four icons: 'Select Inputs', 'Inputs List', 'Forecast Options', and 'Results'. The main content area is divided into three columns: 'Featured', 'Variables', and 'Topics & Scenarios'.

Featured

- Employment
- Sales
- BizDev
- Taxes
- Custom and Detailed Variables
Government Expenditure

Variables

- Favorites
- Full List
- Model Linkages
Display a block diagram of the model structure. Clicking on an area of the diagram will show the policy variables related to that area.
- Model Blocks
Labor and Capital Demand

Topics & Scenarios

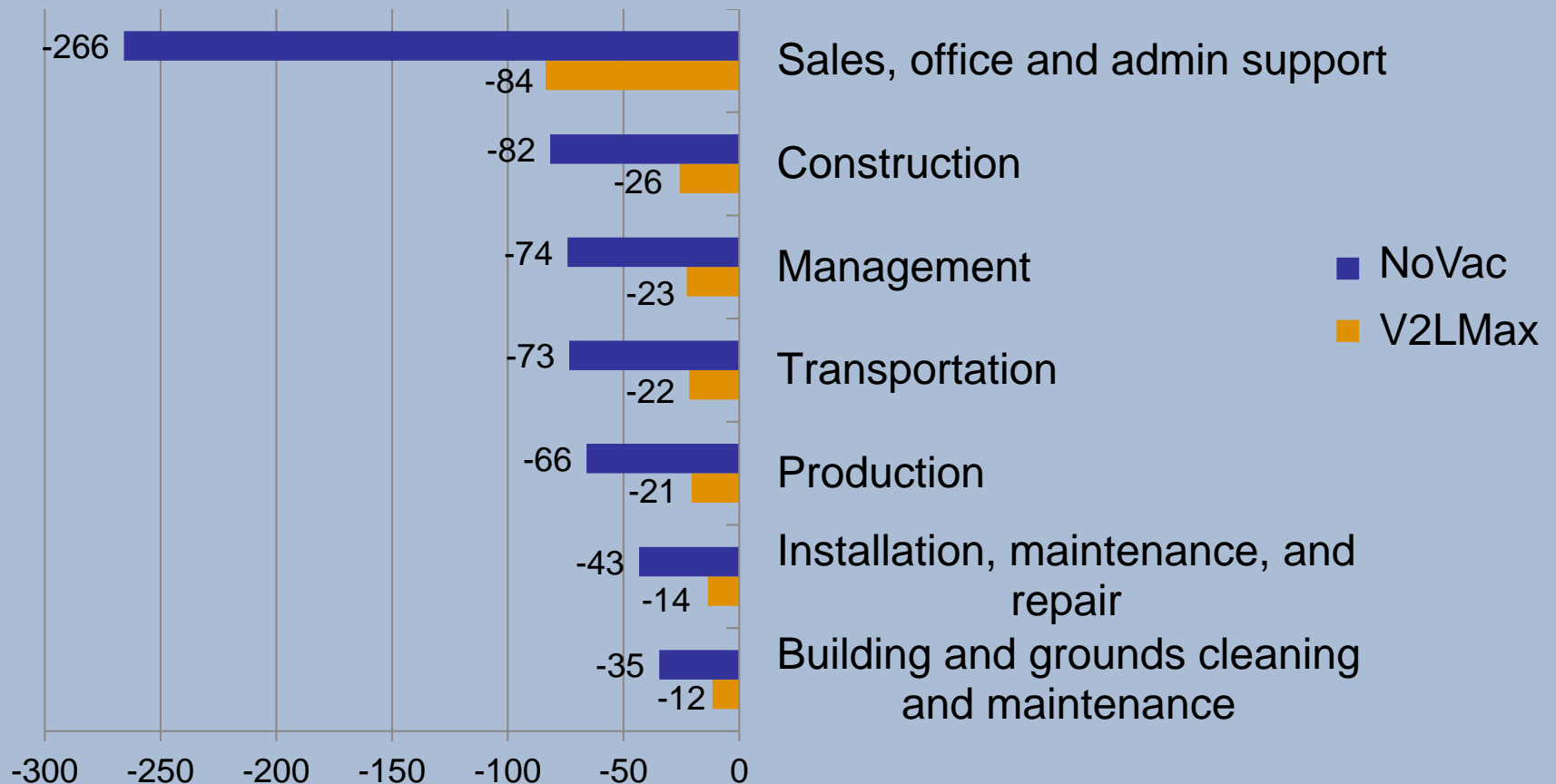
- Industries
- Business Costs
- Consumer Prices
- More Topics
Commuters
- Base Realignment and Closure
- Higher Education
- Minimum Wage
- More Scenarios

PI+ Output

Steve

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	247	\$30	430
V2L/High/Fast/10km	\$30	425	\$17	252
V2L/High/Fast/50km	\$12	168	\$35	509

PI+ Output: Employment



Summary of Findings

- NOVAC strategy results in 677,000 job loss with \$47 billion GDP loss.
- Optional vaccination strategy can save as many as 509,000 jobs.
- Job losses can go far beyond the farm sector.
- Future Work:
 - Feral Hogs
 - Export bans

Economic Impacts of Wildlife to Agriculture Production

- Bird damage
 - Dairies, crops, infrastructure
 - Ex. Consumption & destruction of fruit
 - Final fruit
 - Implications for using REMI
 - Intermediate inputs
- Mitigation methods
 - Scare devices
 - Netting
 - Kestrels
 - Habitat modification



Economic Impacts of Wildlife to Agriculture Production

- Kestrel Nest Box Study
 - Reduce bird presence and fruit consumption
 - Field study to estimate reduced fruit consumption
 - Benefit-Cost Analysis
 - Economically efficient (\$131 to \$557 saved per dollar spent)
 - REMI
 - Results: 72 to 77 jobs created, \$3.5 million to \$3.8 million increased income



Photo: American Kestrel Partnership

Stephanie

Conclusions

- This is a unique application of the REMI model given the unconventional nature of wildlife damage
- First estimates of modeling wildlife damage beyond the farm gate in terms of macroeconomic impacts
 - Ecological/Biological Impacts ➡ Economic Impacts
- Provides results that are meaningful to a broad group of stakeholders

Questions?

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