Modeling Regional Impacts of BSE in Alberta in Terms of Cattle Herd Structure

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Structure of Talk

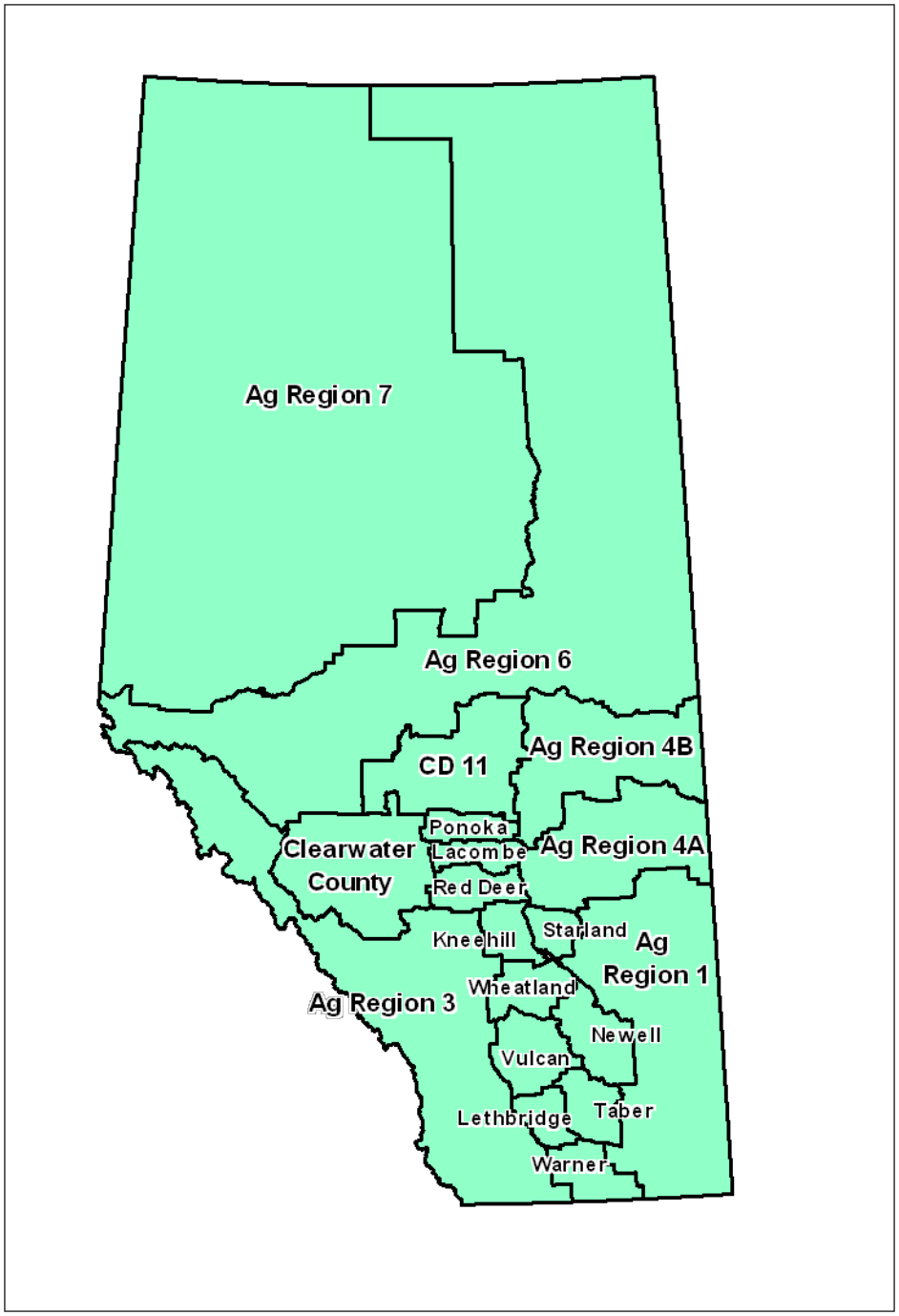
- Regional Impact of BSE Crisis
- Discuss data issues
- Describe shift and share model
  - Notation
  - Sailboat racing metaphor
  - Shift-share identity
- Examine preliminary results
- Future research

Regional Impact of BSE

- “Social Impacts of TSEs”
  - U of C, Uof A, U of L
- Alberta Prion Research Institute
  - Alberta Ingenuity Fund
  - http://www.prioninstitute.ca/
- Subprovincial scale

Long-run Effects of BSE on the structure & distribution of the *provincial* cattle herd

- Census of Agriculture 2001, 2006
- May 16th
- Exploratory: H_1, H_0
- “an unusually obstinate attempt to think clearly” (Bertrand Russell)



- Livestock census data is published at different scales:
- Nation
  - Province
    - Census Agricultural Region
      - Census Division
        - » Consolidated Census Subdivision
        - » ~ county + embedded municipalities
- Suppression problem!

Alberta's Cattle Herd Structure, 2006

Bovine type (i=1-8)	Head count	Proportion
B_1 Beef cows	2,035,841	32.0
B_2 Dairy cows	78,875	1.2
B_3 Calves	2,050,773	32.2
B_4 Dairy heifers	37,803	0.6
B_5 Beef rep heifers	275,683	4.3
B_6 Slaughter heifers	805,829	12.7
B_7 Steers	974,559	15.3
B_8 Bulls	109,753	1.7
B_T Total cattle & calves	**6,369,116**	**100.0**

Source: Statistics Canada, 2006 Census of Agriculture (2007)
http://www.statcan.ca/english/freepub/95-629-XIE/2007000/livestock.htm

Notation: Bovines and time

$$B_i, b_i, B_T, b_T$$

$$t, \quad t'$$

$$t = 2001, \quad t' = 2006$$

Notation: Incremental change

$$\Delta B_i^{t,t'} = B_i^{t'} - B_i^{t}$$

$$\Delta b_i^{t,t'} = b_i^{t'} - b_i^{t}$$

More Notation: Herd size change

$$R_i^{t,t'} = \frac{B_i^t - B_i^{t'}}{B_i^t} = \frac{\Delta B_i^{t,t'}}{B_i^t}$$

$$r_i^{t,t'} = \frac{b_i^t - b_i^{t'}}{b_i^t} = \frac{\Delta b_i^{t,t'}}{b_i^t}$$

Sailboat Racing

- What makes a winning boat?
  - Boat design and structure
  - Crew training and competitiveness

Flathead Lake, Montana, c/o Montain Photography

Shift and Share Analysis of Alberta's Cattle Herd

- What is total shift?

$$tsb_i = \Delta b_i^{t,t'} - \left(R_T^{t,t'} * b_i^t \right)$$

- tsb_i measures total number of bovines that have shifted into or out of a region
- in a sense: observed-expected
- We might "expect" (naively), that b_i should grow as B_T

Shift and Share Analysis of Alberta's Cattle Herd

- We can partition shift into components

$$tsb_i = ssb_i + rsb_i$$

- Total shift = structural shift + regional shift

Shift and Share Analysis of Alberta's Cattle Herd

- Structural shift

$$ssb_i = \left(R_i^{t,t'} - R_T^{t,t'}\right) * b_i^t$$

- The province provides our arbitrary reference rate, *R*
- We scale the *i*-*T* difference in R by regional b_i

Shift and Share Analysis of Alberta's Cattle Herd

- Regional shift

$$rsb_i = \left(r_i^{t,t'} - R_i^{t,t'}\right) * b_i^t$$

- The r_i and R_i terms measure the difference between regional and national growth by bovine type
- We scale the difference by b_i

Shift and Share Analysis of Alberta's Cattle Herd
Fleshing out the model

$$\Delta b_i^{t,t'} = \left(R_T^{t,t'} * b_i^t\right) + \left[\left(R_i^{t,t'} - R_T^{t,t'}\right) * b_i^t\right] + \left[\left(r_i^{t,t'} - R_i^{t,t'}\right) * b_i^t\right]$$

- By rearranging terms we arrive at the shift and share model expressed as three components:

$$\Delta b_i \quad = \quad pe_i \quad + \quad sse_i \quad + \quad rse_i$$

Bovine Change	=	provincial effect	+	structural shift effect	+	regional shift effect

Shift and Share Analysis of Alberta's Cattle Herd

What are the implications of herd structure for places?

- Let's consider all cattle in the region
- Total ***structural shift effect***

$$\sum_{i}^{n} ssb_i > 0$$

- A region with 'favourable' structure:
  - Has large numbers of bovine type that grew fast provincially 2001-2006
  - Has small numbers of bovine type that declined provincially 2001-2006
    - Growth could imply expectations of rising prices (replacement heifers)
    - Growth could simply imply lack of slaughter capacity (cows)

Shift and Share Analysis of Alberta's Cattle Herd
What's it all mean for regions?

- Total ***regional shift effect:***

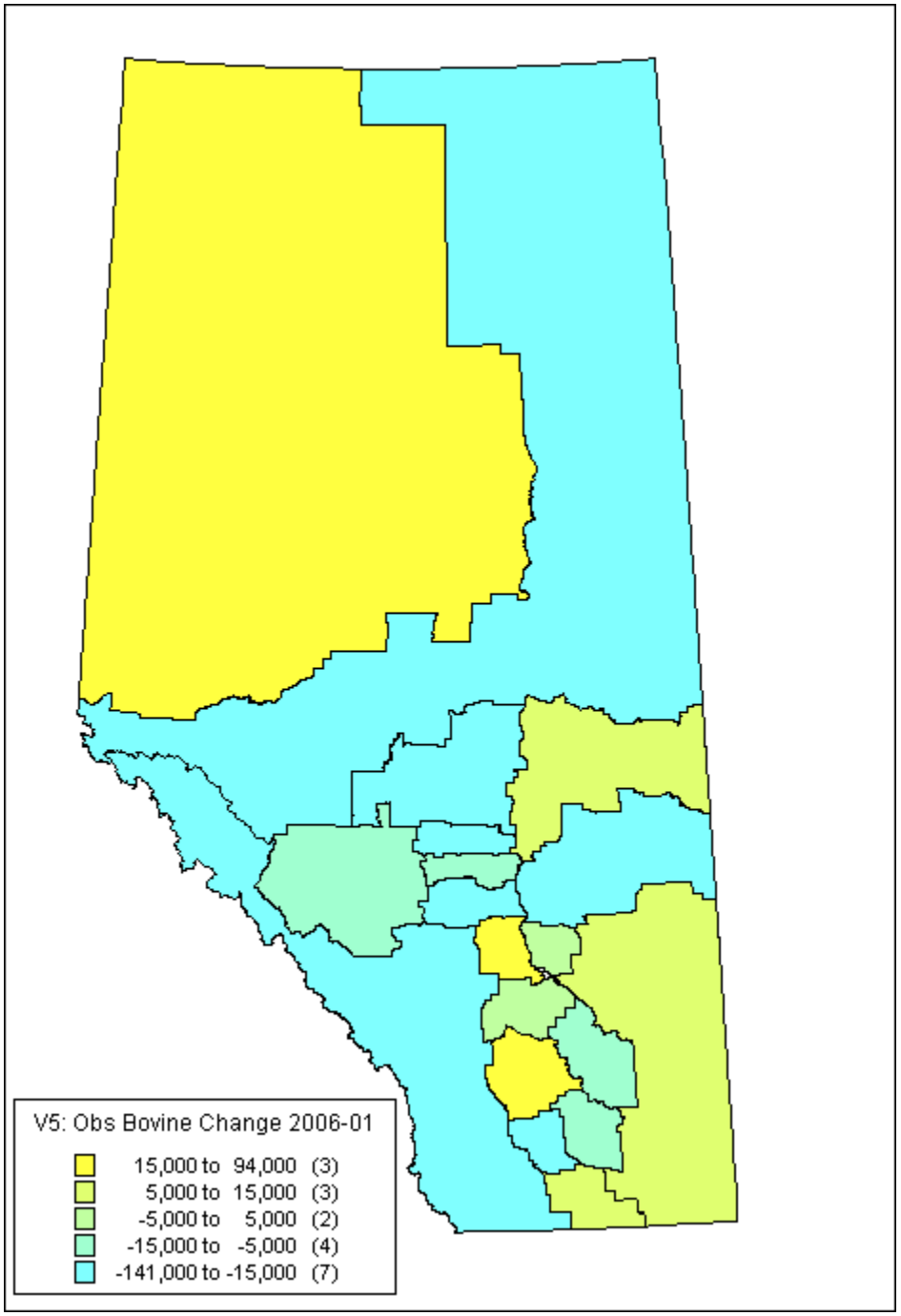
$$\sum_{i}^{n} rse_i > 0$$

- A region with a favourable regional shift effect "competes" effectively with other regions:
  - *Weather conditions/irrigation water availability*
  - *Fixed capital investment/infrastructure*
    - *(production, processing, marketing)*
  - *Proximity to U.S. markets (north-south)*

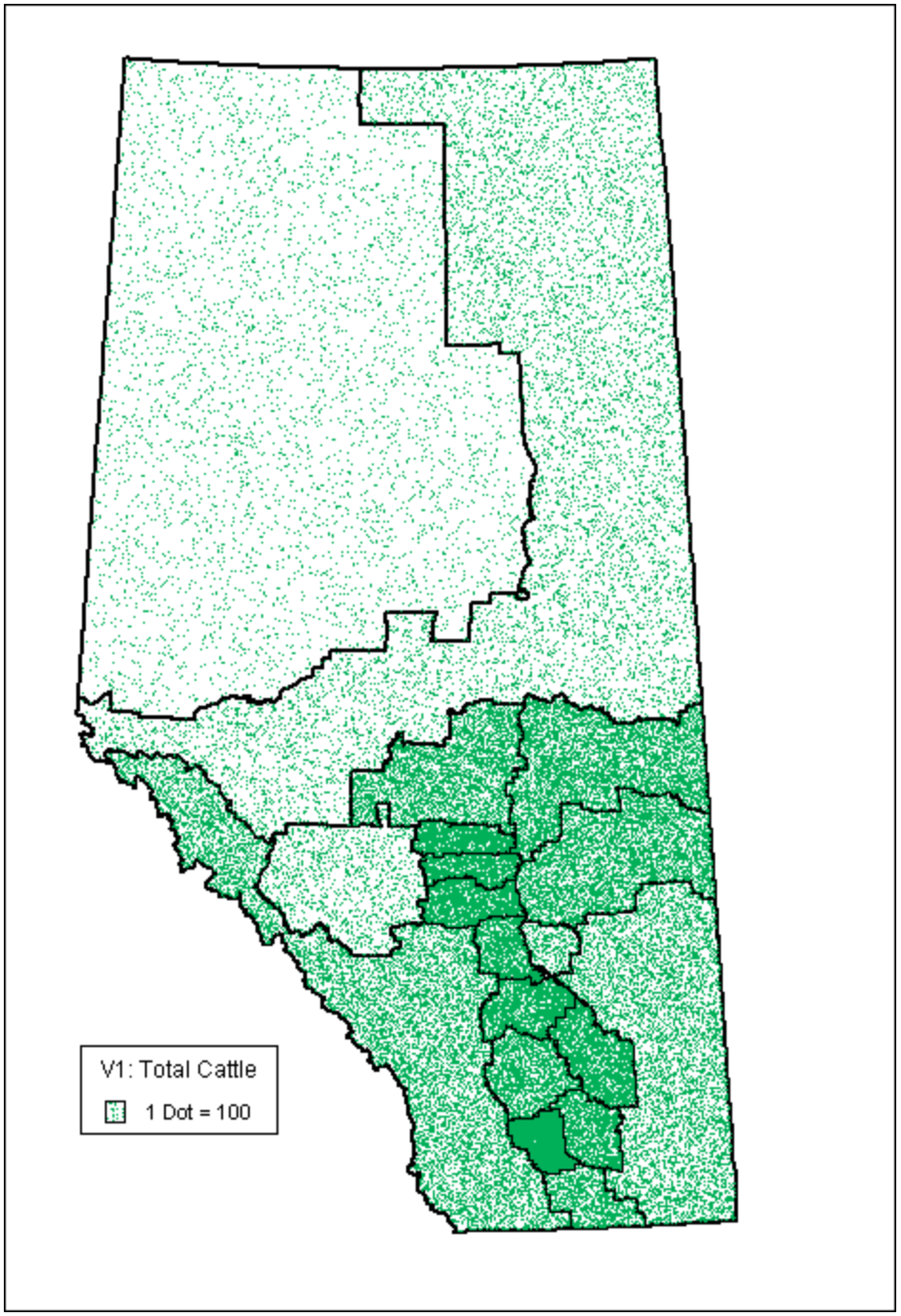
Cattle Population in Alberta, 2001-2006

Bovine type	Cattle population 2006	2001	Absolute Change	Percent Growth
Beef cows	2,035,841	2,099,288	-63,447	-3.0
Dairy cows	78,875	84,044	-5,169	-6.2
Calves	2,050,773	2,169,607	-118,834	-5.5
Dairy heifers	37,803	38,485	-682	-1.8
Beef rep heifers	275,683	359,291	-83,608	-23.3
Slaughter heifers	805,829	761,553	44,276	5.8
Steers	974,559	991,554	-16,995	-1.7
Bulls	109,753	111,379	-1,626	-1.5
Total cattle & calves	6,369,116	6,615,201	-246,085	-3.7

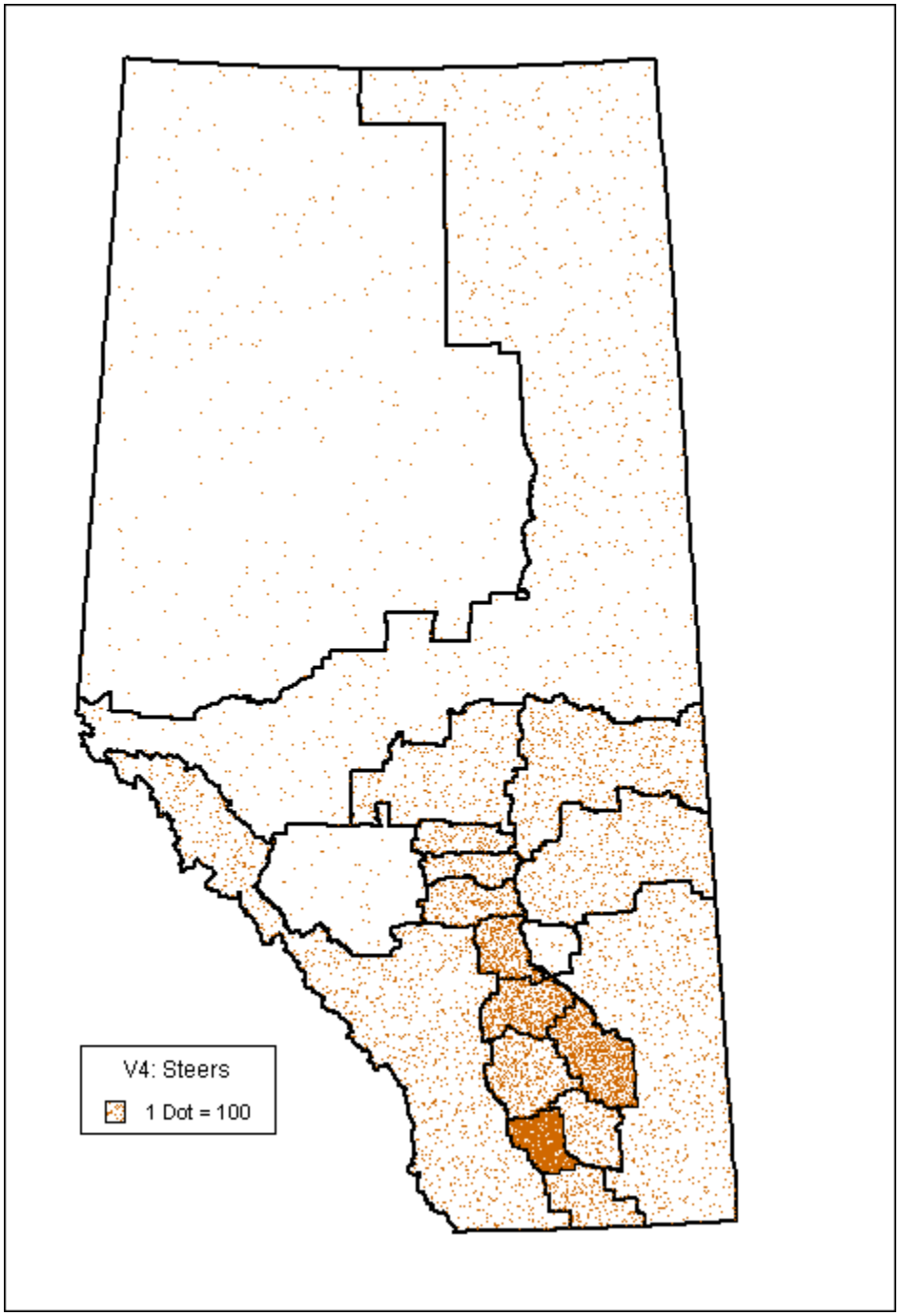
Source: Statistics Canada, 2006 Census of Agriculture, *Farm Data and Farm Operator Data*, catalogue no. 95-629-XWE.



- Viewed change against a backdrop of provincial decline
- Big gainers:
  - Vulcan
  - Kneehill
  - Peace
- Big losers:
  - Calgary/southwest
  - Ponoka
  - Lethbridge



- Highway 2 corridor
- (Canamex highway)
  - Edmonton
  - Red Deer
  - Calgary
  - Lethbridge



- Steers, distributed in proportion to feedlots

Cattle Population in Vulcan County, 2001-2006

Bovine type	Cattle population 2006	2001	Absolute change	Percent growth
Beef cows	28,154	29,660	-1,506	-5.1
Dairy cows	1,129	691	438	63.4
Calves	63,627	27,712	35,915	129.6
Dairy heifers	399	342	57	16.7
Beef rep heifers	3,402	2,655	747	28.1
Slaughter heifers	30,430	9,600	20,830	217.0
Steers	43,332	6,610	36,722	555.6
Bulls	1,496	1,481	15	1.0
Total cattle & calves	171,969	78,751	93,218	118.4

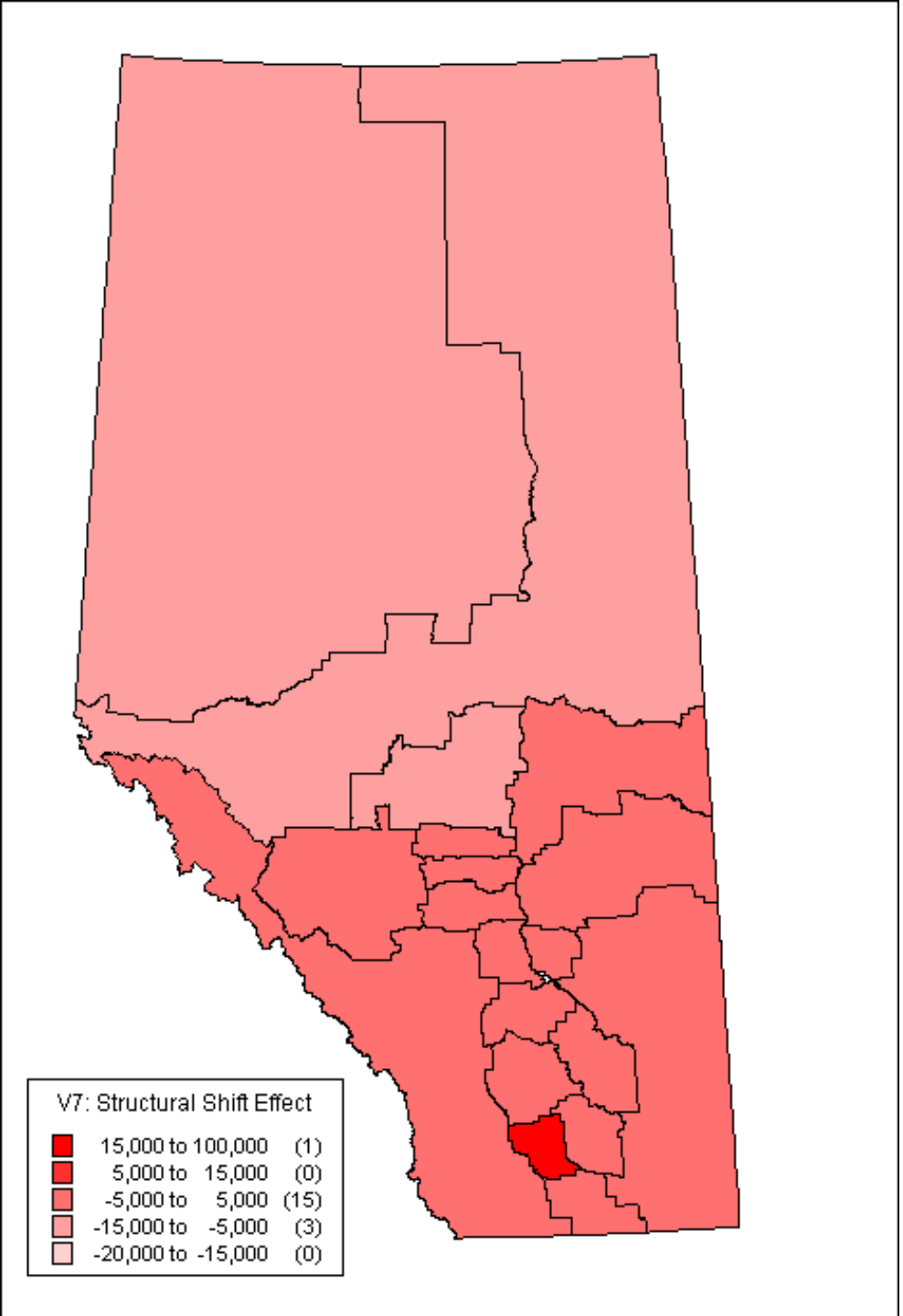
Source: Statistics Canada, 2006 Census of Agriculture, *Farm Data and Farm Operator Data*, catalogue no. 95-629-XWE.

Shift-share Parameters for Vulcan County, 2001-2006

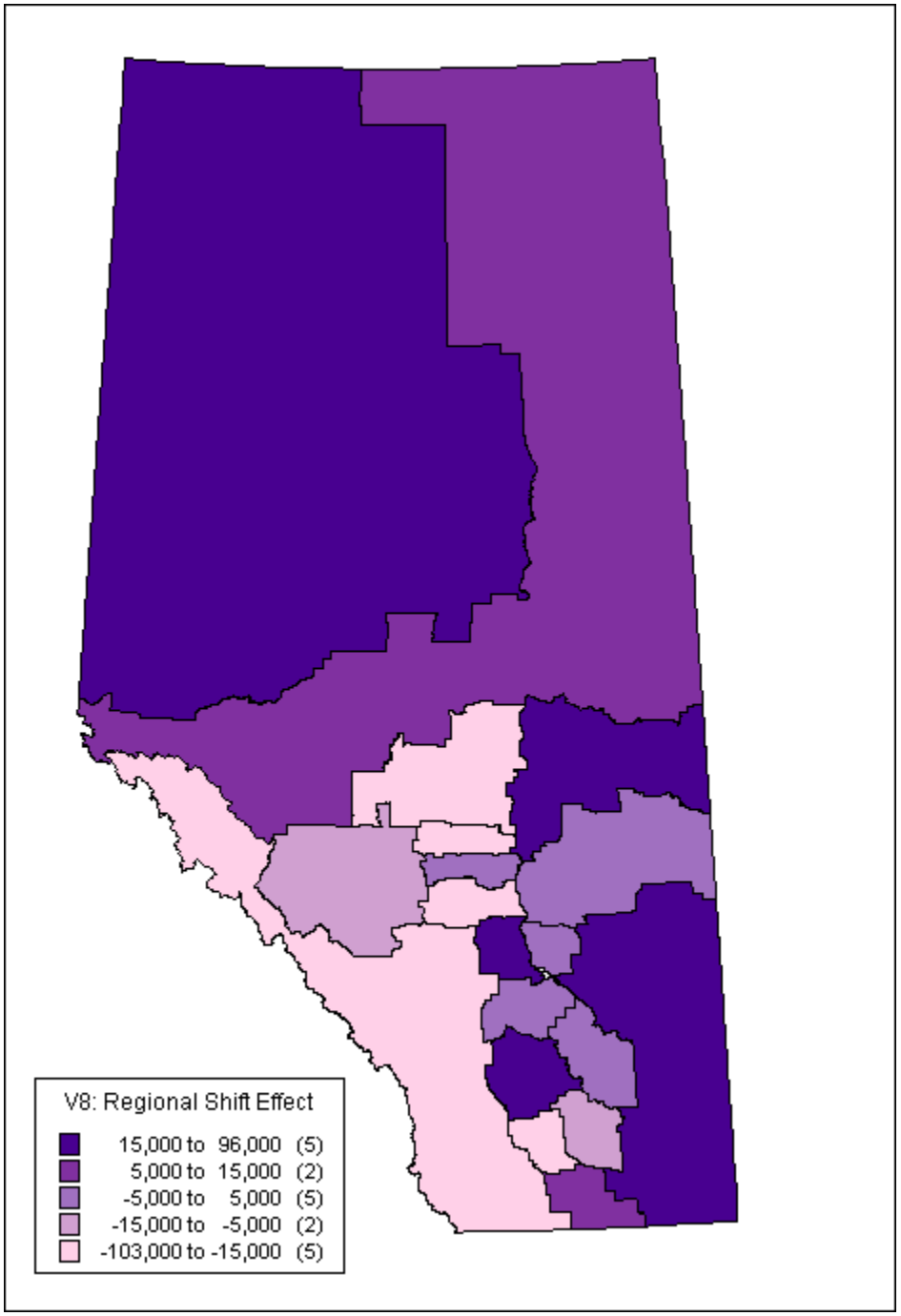
Bovine type	2006-2001 Change	Provincial growth effect	Structural effect	Regional effect
Beef cows	-1,506	-1,103	207	-609.6
Dairy cows	438	-26	-17	480.5
Calves	35,915	-1,031	-487	37,432.8
Dairy heifers	57	-13	7	63.1
Beef rep heifers	747	-99	-519	1,364.8
Slaughter heifers	20,830	-357	915	20,271.9
Steers	36,722	-246	133	36,835.3
Bulls	15	-55	33	36.6
Totals	93,218	-2,930	272	95,875.4

Shift -Share Model Summary

Region	Observed bovine change 2006-2001	Expected bovine change 2006-2001	Structural shift effect	Regional shift effect
Agricultural Region 1	10,785	-21,140	-3,811	35,736
Warner County	8,829	-3,736	430	12,134
Lethbridge County	-56,853	-21,707	25,532	-60,678
Taber MD	-6,880	-5,875	4,317	-5,323
Newell County	-7,342	-9,942	2,433	166
Vulcan County	93,218	-2,930	272	95,875
Wheatland County	-2,651	-7,771	2,123	2,997
Starland County	2,514	-1,184	-372	4,070
Kneehill County	33,877	-3,428	-630	37,935
Agricultural Region 3	-140,826	-38,549	187	-102,465
Agricultural Region 4A	-25,104	-19,122	-3,258	-2,724
Agricultural Region 4B	9,575	-19,917	-4,050	33,542
Red Deer County	-26,054	-8,874	-324	-16,855
Lacombe County	-6,717	-5,347	-1,202	-168
Ponoka County	-74,638	-9,079	323	-65,882
Clearwater County	-14,887	-4,716	-1,831	-8,340
Census Division No. 11	-37,179	-15,743	-5,130	-16,306
Agricultural Region 6	-33,735	-32,432	-8,234	6,931
Agricultural Region 7	27,983	-14,594	-6,777	49,353
Alberta Total	-246,085	-246,085	0	0



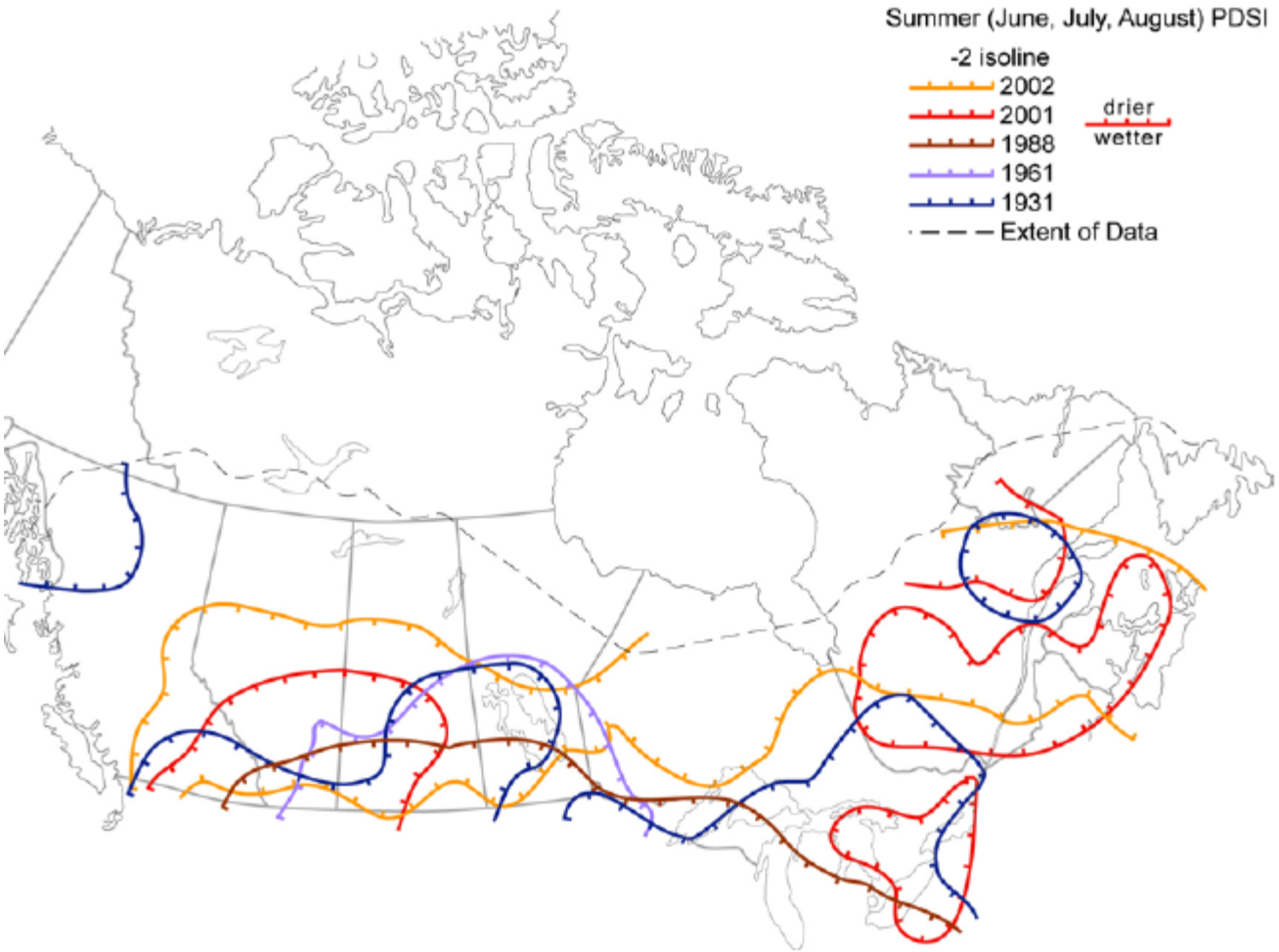
- Herd structure favours the traditional ecumene, notably Lethbridge County
- Where there is negative structure effect, it is absolutely small, northern, and affects both gainers and losers.



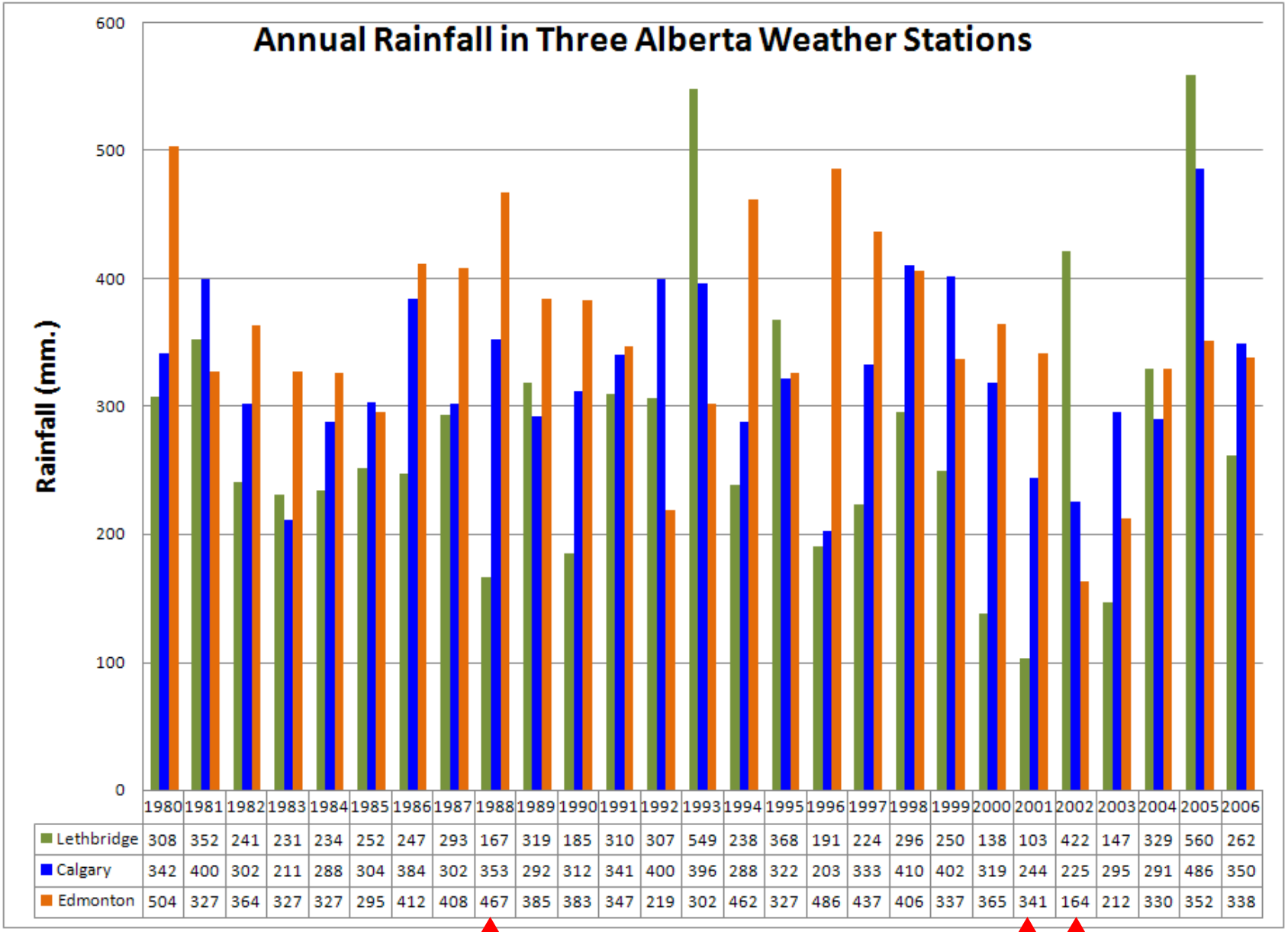
- Regional effect is strong determinant of gainers
  - Peace
  - Vulcan
  - Kneehill
- And strong determinant of losers
  - Calgary/SW
  - Ponoka
  - Lethbridge

Conclusions

- Cattle herd is but one impact of BSE
- Impact of disease detection & trade barriers are uneven
- Multiple influences (stressors) (e.g. drought)
- Sub-provincial regional impacts vary widely
  - Herd structure seems to play minor role
  - Regional shift effect is large
  - Geography matters!



Source: *Lessons Learned from the Canadian Drought Years 2001 and 2002* Synthesis Report for Agriculture and Agri-Food Canada by E. Wheaton (2005)



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Lethbridge	308	352	241	231	234	252	247	293	167	319	185	310	307	549	238	368	191	224	296	250	138	103	422	147	329	560	262
Calgary	342	400	302	211	288	304	384	302	353	292	312	341	400	396	288	322	203	333	410	402	319	244	225	295	291	486	350
Edmonton	504	327	364	327	327	295	412	408	467	385	383	347	219	302	462	327	486	437	406	337	365	341	164	212	330	352	338

Source: Environment Canada, Weather Office, http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

Further research

1. Model
   - What other kinds of regional/structural herd models are out there?
2. Suppressed regions problem
   - Repeat with full census data at CCS level
3. Livestock survey data
   - Census Ag. Region scale?
   - Track changing shift share parameters over time
   - Stable or variable?
     - Clear break after 2003?

Thank-you!