Buffalo Hunt: International Trade and the Virtual Extinction of the North American Bison
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What happened to the American Bison? - The Timeline

- **16th century**: 25 to 30 million Buffalos in North America
  - Habitat destruction, subsistence hunting
- **1865**: 10 to 15 million Buffalos remaining

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- **1870-1871**: Tanning innovation in Europe
- **1872-1879**: Buffalo hunt in the Southern Great Plains
- **1881-1886**: Buffalo hunt in the Northern Great Plains
- **1886**: 100 Buffalos remaining in the Great Plains States.

What happened to the American Bison? - The Hypotheses

- **Classical candidates** : railroads, US Army, changes in native hunting practices
- **A new hypothesis**: the key role of international trade
  - Necessary and sufficient explanations of the Buffalo slaughter
    1. A price for buffalo products that was largely invariant to changes in supply
    2. Open access conditions with no regulation of the buffalo kill
    3. A newly invented tanning process that allowed buffalo hides to be turned into valuable commercial leather
  - Lever: focusing on a the rate of the slaughter
    1. A simple Model of Buffalo Hunting
    2. A newly constructed export data
    3. Empirical Analysis

Why should we care? - An Economics Perspective

- Historical Account
- Resource Economics
  - Trade as galvanizing force of market failues
  - (Absence of) property rights and institution adaptation
    - Fixed price for Bison limiting economic incentives for regulation and preventing scarcity signals
    - D. Lueck (2002) ; B. Benson (2006)
  - Market forces and the depletion of renewable resources
    - A.M. Carlos and F.D. Lewis (1993, 1999) ; Patterson and Wilen (1977) ; R.C. All and I. Keay (2004)
- Policy
  - Developing countries relying on resource exports and pressured by globalization

Proving Sufficiency Through a Model - Setup

- **The Hunter's problem** : $\max\{\underbrace{p \cdot h = p \cdot \alpha \cdot S(t)}_{\text{Hunting}}; \quad \underbrace{w = 1}_{\text{Outside option, numeraire}} \quad \}.$

  α hunter's hunting skills $\sim F(\alpha)$; α^* marginal hunter
- **Buffalo Herd $S(t)$ Growth LOM:**

$$\dot{S} = \underbrace{G(S)}_{\text{Biological Growth}} - K(p, S)$$

$$G'(S) > 0; G''(S) \leq 0; G(0) = 0$$

- **Resource constraint**

$$\underbrace{\bar{K}(\alpha^*, S)}_{\#\text{ buffalo killed}} = \underbrace{N \cdot \int_{\alpha^*}^{\bar{\alpha}} f(\alpha)}_{\#\text{ hunters}} \underbrace{S \cdot \alpha}_{\text{productivity}} \, d\alpha$$

$$\frac{dK(p,s)}{dS} = N \int_{\alpha^*}^{\bar{\alpha}} \alpha f(\alpha) d\alpha - NS\alpha^* f(\alpha^*) \underbrace{\frac{d\alpha^*}{dS}}_{<0} > 0$$

Proving Sufficiency Through a Model - Steady State

Proposition: Assume $C > S_s$, then there exists

(i) a unique interior steady state herd size $S^* \in [S_s, C]$

(ii) a unique marginal hunter $\alpha^*(p, S^*) \in (0, \bar{\alpha})$

(iii) starting from any $S > 0$, convergence to S^* is monotonic

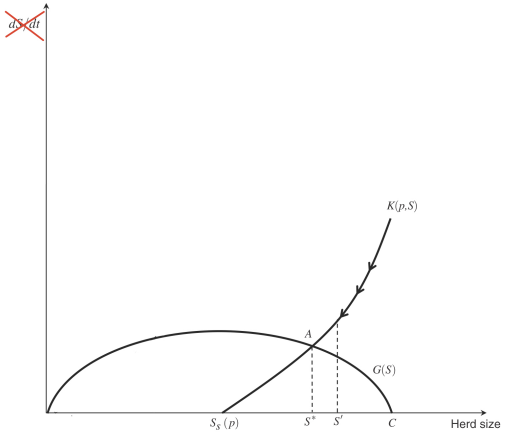


FIGURE 1. THE STEADY STATE

$$\dot{S} = G(S) - K(p, S)$$

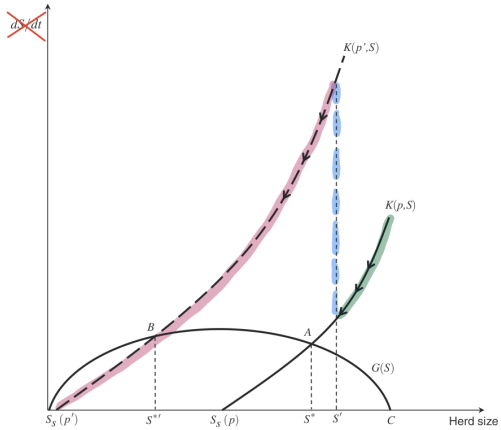
Proving Sufficiency Through a Model - The buffalo Hunt

- Pre-1870: transition path
- Introduction of buffalo hide tanning

$$\begin{array}{cc} p \to p' & p' > p \\ \alpha^*_{S'}(p) \to \alpha^*_{S'}(p') & \alpha^*(p') < \alpha^*(p) \\ K \uparrow & \end{array}$$

- Along 1880s

$$K \downarrow \qquad S' \to \underbrace{S^{*'} \to S_s(p')}_{\text{extinction}}$$



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Proving Necessity (0) - Building New Import/Export Data

Historical evidence documenting the rate of the slaughter

- Data on shipments of hides by the railroads operating in Buffalo country (Dodge, Hornaday, Koucky late 1880s)

New data establishing the role of international trade

- **Import** buffalo hide estimates for European countries.
- A multistep procedure to recover **export** buffalo hide estimates
  1) Obtain the value of US hide exports for 1865-1886.
  2) Convert hide values into hide numbers using estimates of hide prices (Warrent and Pearce price index, New York Change of Commerce reports).
  3) Eliminate cattle hides from the volume of hide export series using a model of cattle cycle.
  4) Use historical sources to motivate the key assumption that prior to 1870, and after 1886 the buffalo hide market was inexistent.

Proving Necessity (1) - Documenting the Assumptions

A consistent timeline

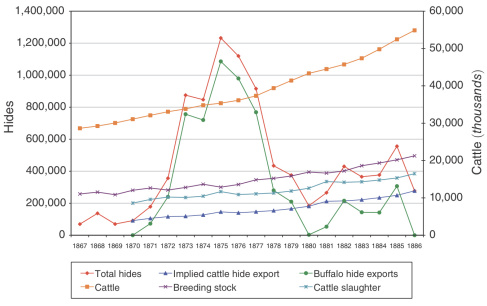

FIGURE 2. THE CONSTRUCTION OF BUFFALO HIDE EXPORTS

Invariant buffalo hide prices

TABLE 1—HIDE PRICES (DOLLAR/HIDE)

Year	WP	NY	HP	Year	WP	NY	HP
1866	4.56	4.74	0	1876	3.25	4.04	2.32
1867	4.12	4.82	0	1877	3.40	3.42	2.43
1868	3.93	4.43	0	1878	2.96	3.03	2.12
1869	4.18	4.66	0	1879	3.12	4.51	2.23
1870	3.99	4.51	0	1880	3.53	3.58	2.52
1871	3.93	4.35	2.81	1881	3.40	3.42	2.43
1872	4.06	4.35	2.90	1882	3.37	3.26	2.41
1873	4.12	4.35	2.94	1883	3.34	3.34	2.38
1874	3.99	4.20	2.85	1884	3.46	3.26	2.47
1875	3.84	3.89	2.74	1885	3.28	3.58	2.34

Notes: WP is hide prices found using the Warren and Pearson price index. NY is hide prices found using data drawn from the Annual Reports of the New York Chamber of Commerce. HP is the price-to-hunters series.

Proving Necessity (1) - Documenting the Assumptions

- Cattle & buffalo hides are perfect substitutes
- US buffalo supply is small relative to the total number of hides transacted in world markets (3-4 % at peak)

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Proving Necessity (2) - Exploiting a Quasi-experiment

$$s_{it} = \alpha_i + \beta_i t + \gamma T_{it}^S + \delta T_{it}^N + \epsilon_{it}$$

Rulling out
- a US Supply Shock to Cattle Production
- a European Demand Shock

TABLE 2—A QUASI EXPERIMENT

Dependent variable. s_{it} $i = \{Canada, France, UK\}$	(1)	(2)	(3)	(4)	(5)	(6)
France intercept	−0.33	−0.33	0.24			
	(0.89)	(0.89)	(0.67)			
UK intercept	1.24	1.24	0.67			
	(0.85)	(0.85)	(0.84)			
Europe intercept				0.46	0.47	0.60
				(0.41)	(0.67)	(0.78)
Canada intercept		91.12***	91.12***	91.12***	91.08***	90.73***
		(2.99)	(2.96)	(2.94)	(2.09)	(1.86)
France time	− 0.08	0.09				
	(0.06)	(0.07)				
UK time	−0.01	−0.01				
	(0.07)	(0.07)				
Europe time			0.04	0.03		
			(0.05)	(0.05)		
Canada time		0.03	0.03	0.03		
		(0.18)	(0.17)	(0.17)		
Time					0.04	0.07
					(.09)	(.06)
North treatment	1.07	1.07	1.07	1.07	1.10	
	(0.71)	(0.71)	(0.67)	(0.67)	(1.05)	
South treatment	4.80***	4.80***	4.80***	4.80***	4.81***	4.38***
	(1.10)	(1.10)	(1.08)	(1.09)	(1.09)	(1.07)
Adjusted R^2	0.65	0.99	0.99	0.99	0.99	0.99
RMSE	3.03	4.67	4.63	4.60	4.56	4.53
Observations	44	66	66	66	66	66

Note: Robust standard errors are in parentheses.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Proving Necessity (3) - Rulling out Alternative Hypothesis

a) The Army and Federal Government Story
b) The Railroads Story
c) The Environmental Change and Native Overhunting Story

Conclusion : The role of International Trade

By making [your favorite local rush] a minor event on the world stage, international trade plays a role...

1. ... as a vehicle for bringing advanced foreign technology to bear on local markets
2. ... as a mechanism limiting price adjustment and masking scarcity signals
   - Buffalo hide prices did not decrease with increased supply
3. ... as a mechanism increasing the likelihood of extreme events (Copeland and Taylor 1999)
4. ... as a mechanism altering the incentives for environmental regulation (McAusland 2003, 2008)
   - A bison export tax would be born entirely by the domestic hide hunters