System Dynamics and Ground Water Conservation: Irregular Thoughts, Unintended Consequences

Brent W. Auvermann, Professor and Center Director
Texas A&M AgriLife Research – Amarillo

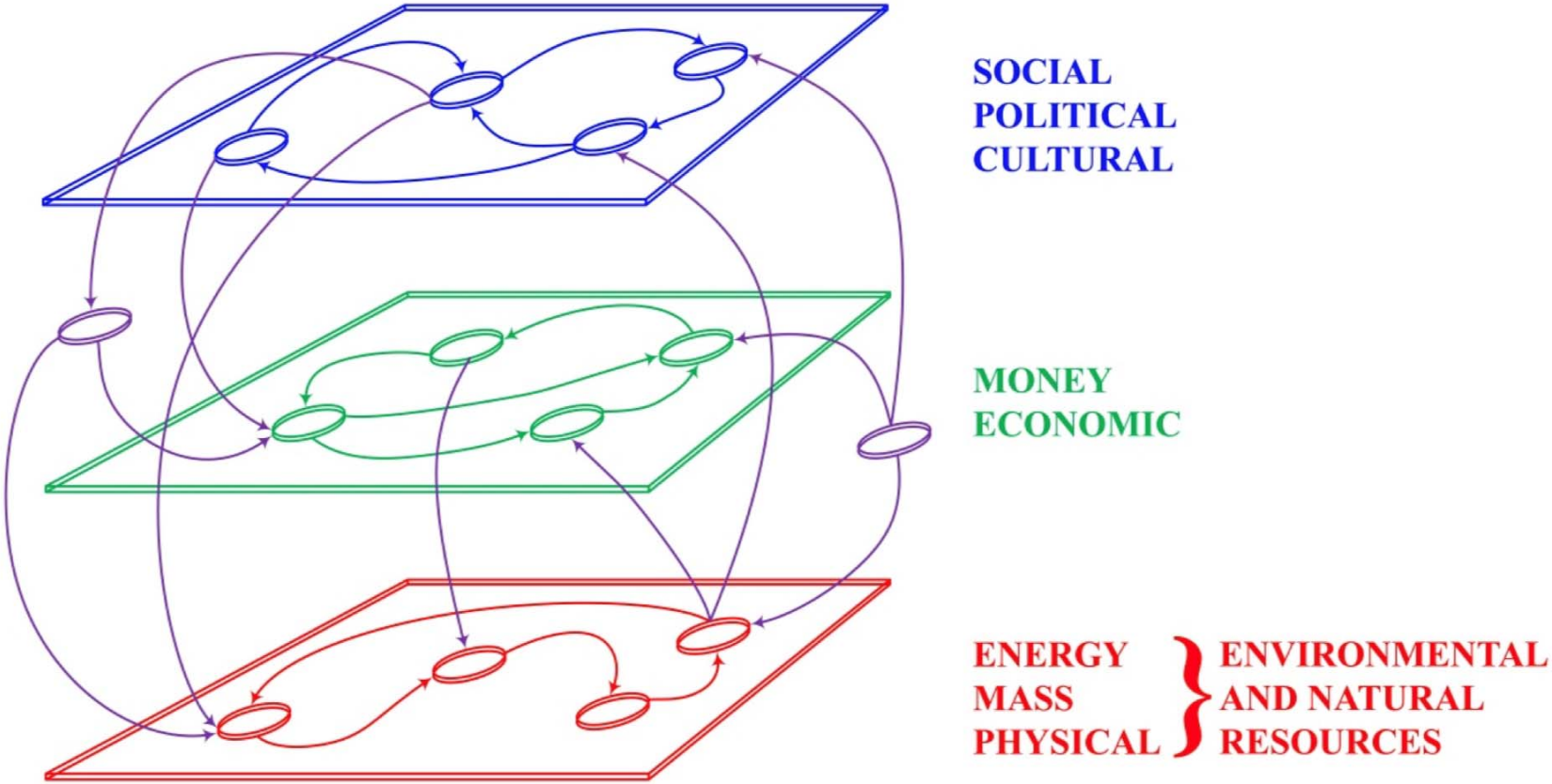
Governor's Conference on the Future of Water in Kansas
Manhattan, KS

14 Nov 2018

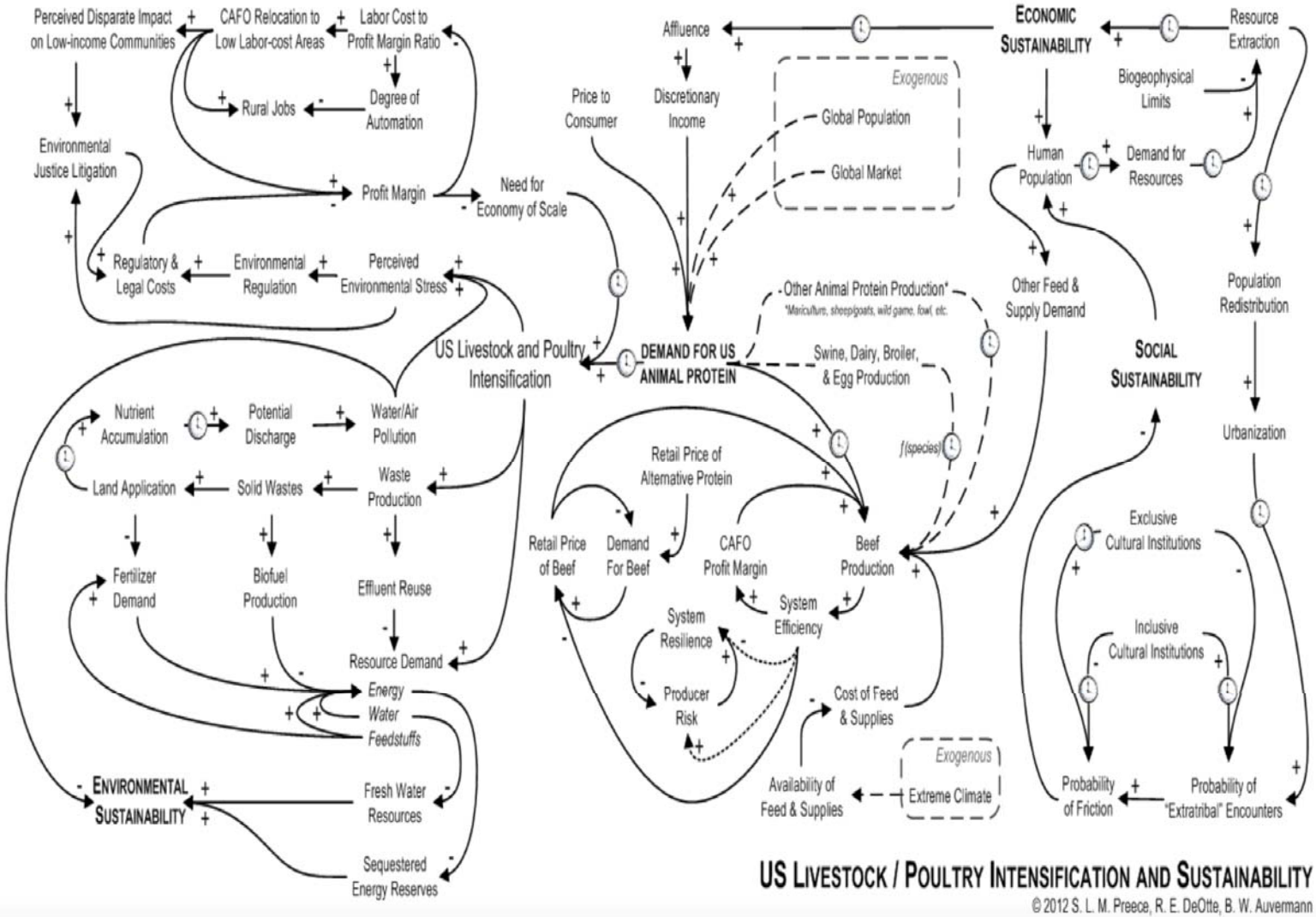
Overview

- My Eureka Moment: Modeling Livestock Systems
- Jevons' Paradox
- Simulating Human Behavior: What an Engineer is Learning

TEXAS A&M AGRILIFE RESEARCH

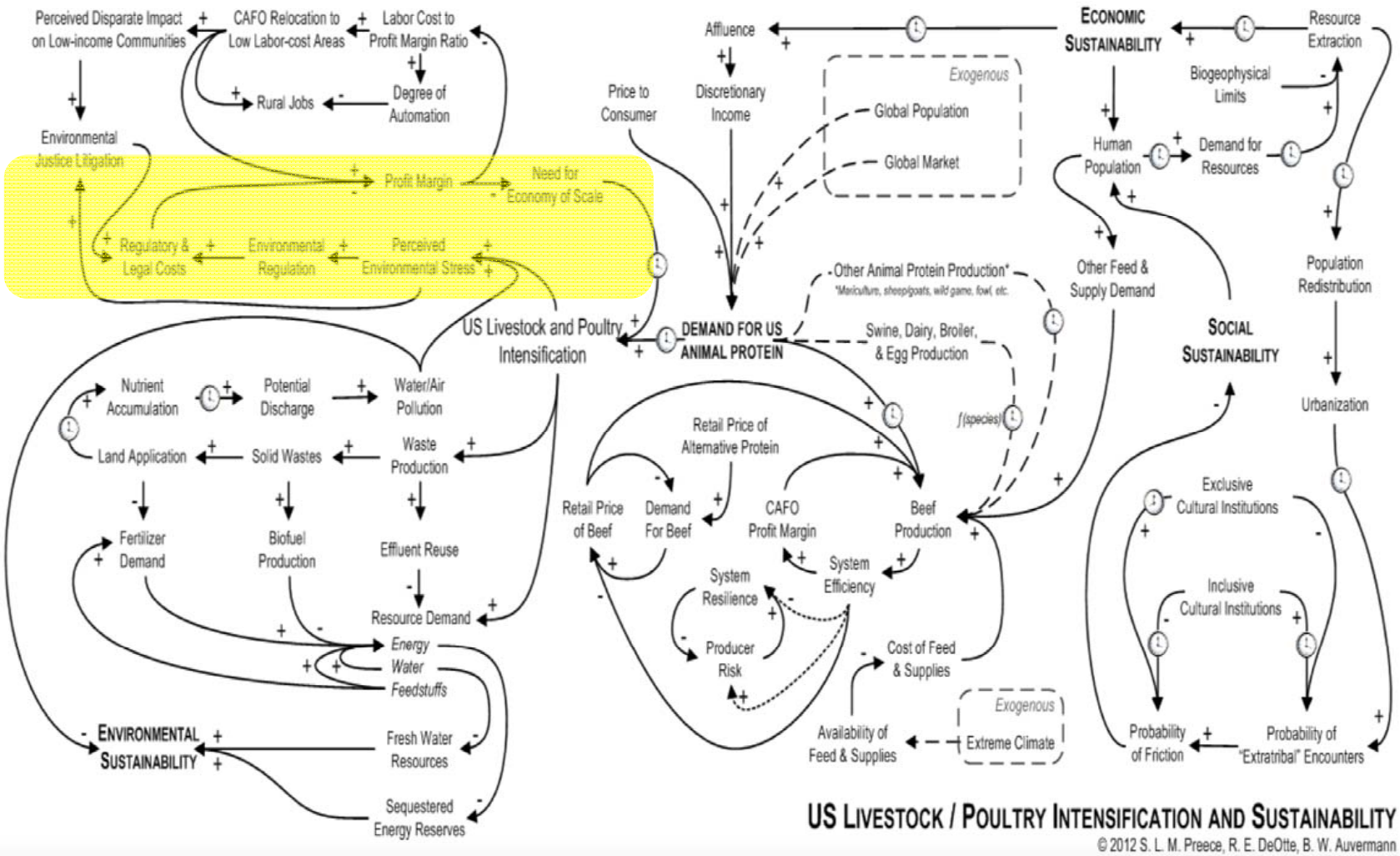


TEXAS A&M AGRILIFE RESEARCH



US LIVESTOCK / POULTRY INTENSIFICATION AND SUSTAINABILITY

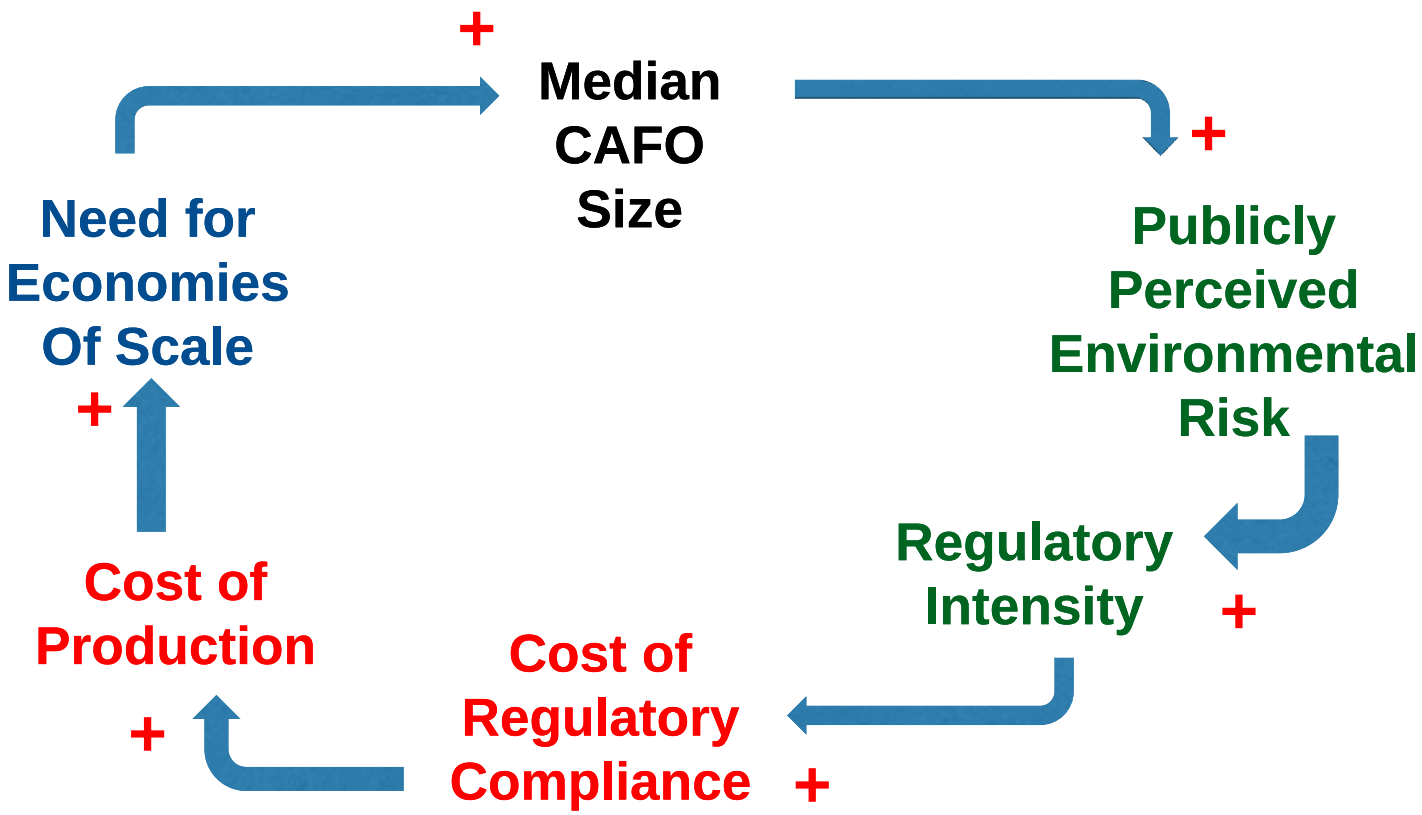
© 2012 S. L. M. Preece, R. E. DeOtte, B. W. Auvermann



US LIVESTOCK / POULTRY INTENSIFICATION AND SUSTAINABILITY

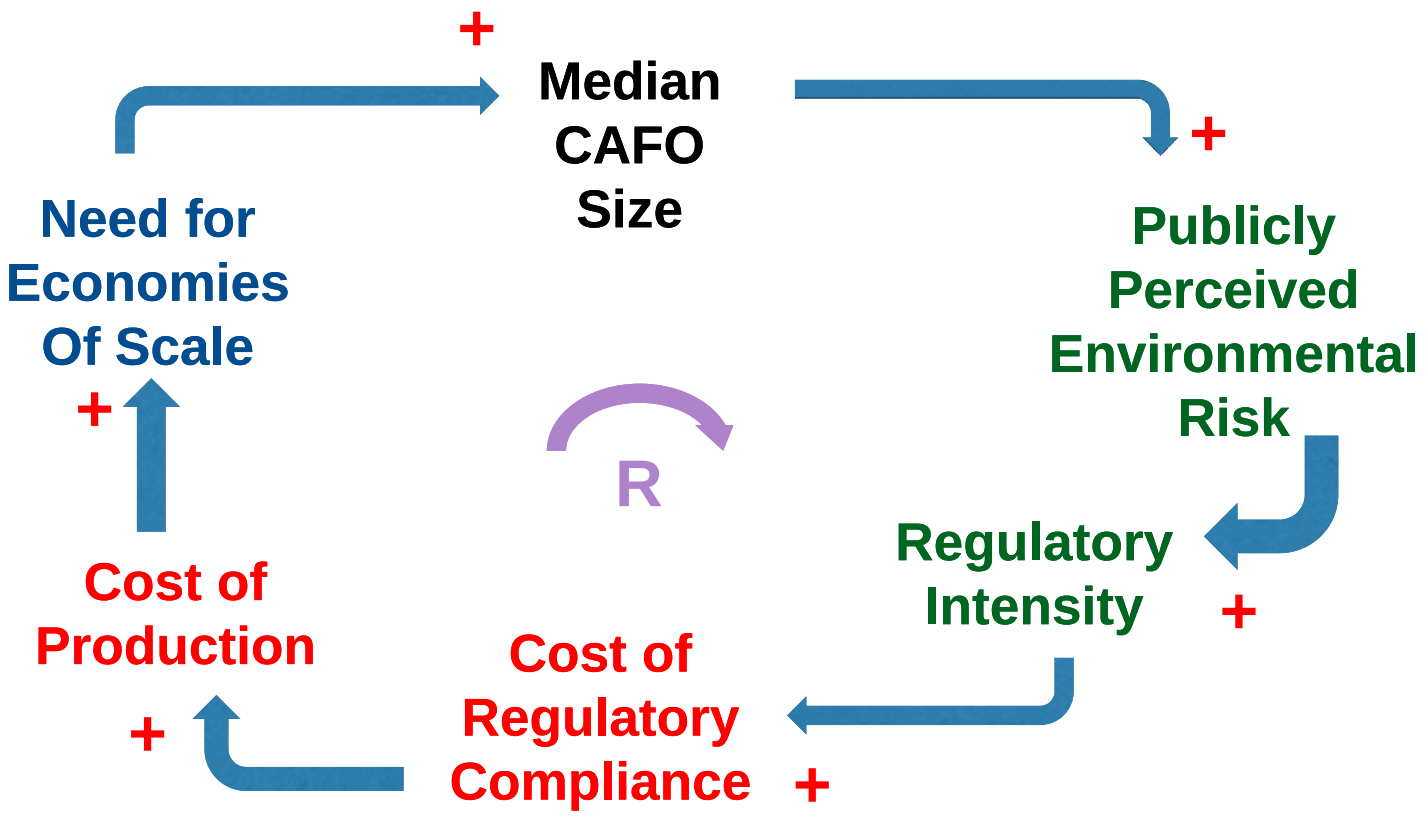
© 2012 S. L. M. Preece, R. E. DeOtte, B. W. Auvermann

Perverse Outcomes?

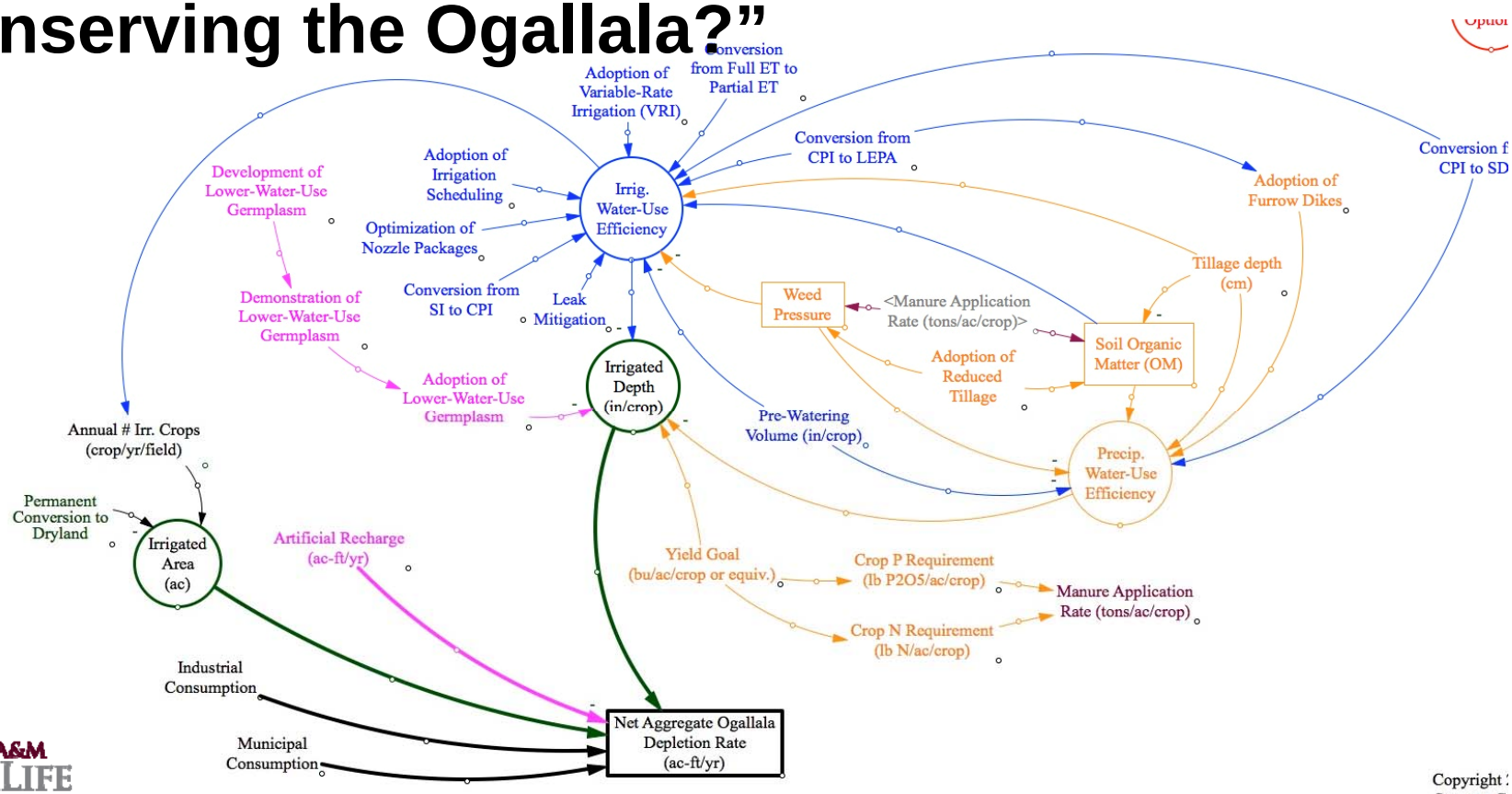


TEXAS A&M AGRILIFE

Perverse Outcomes?

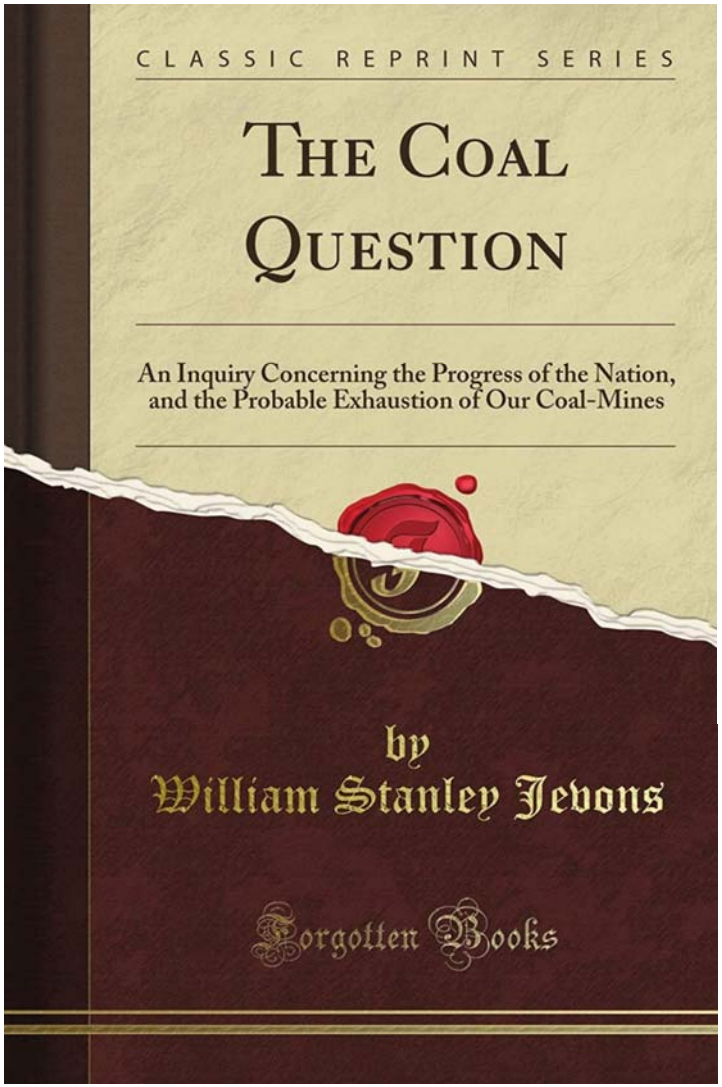


“What are the Critical Control Points for Conserving the Ogallala?”



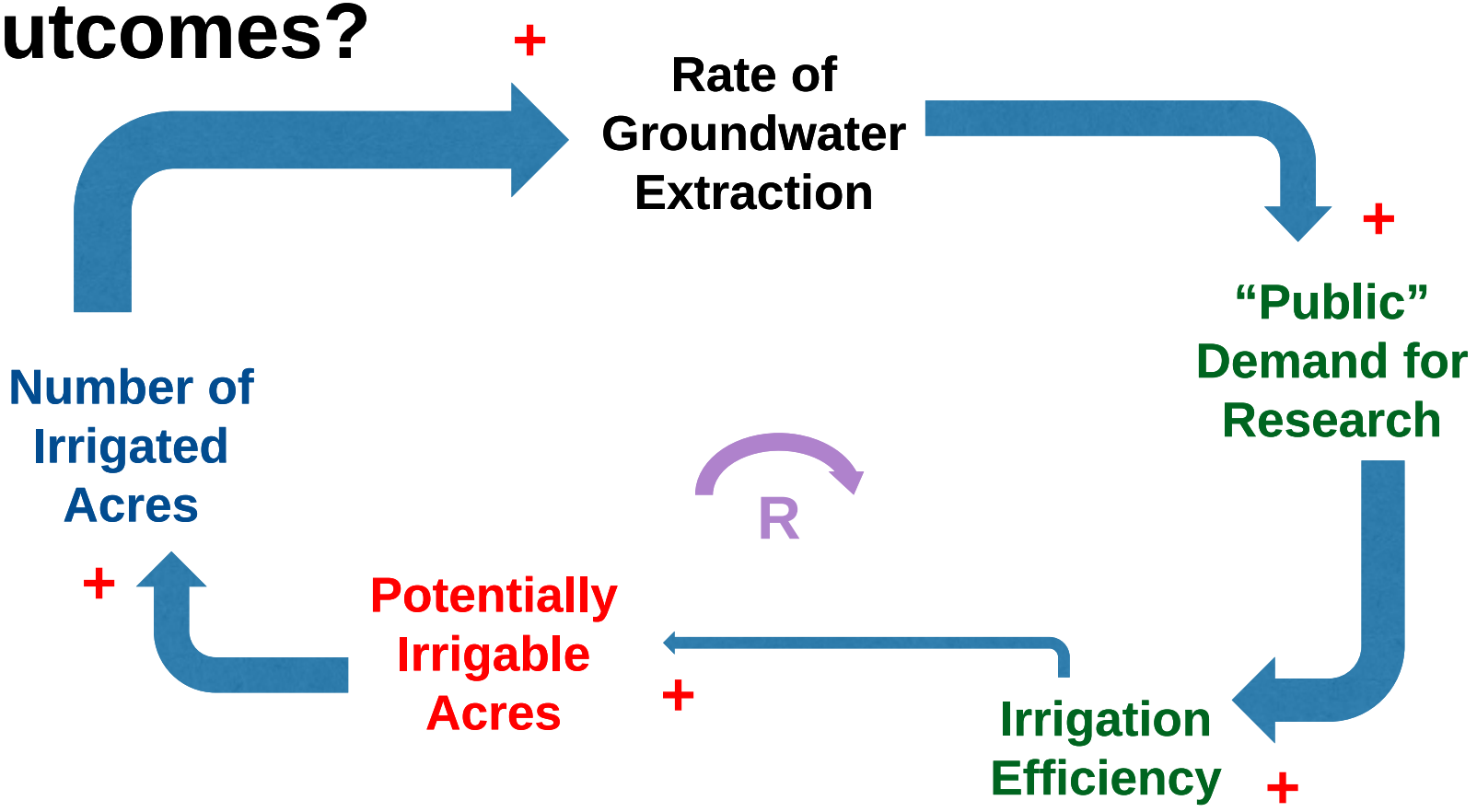
TEXAS A&M AGRILIFE RESEARCH

Copyright
Stewart, G

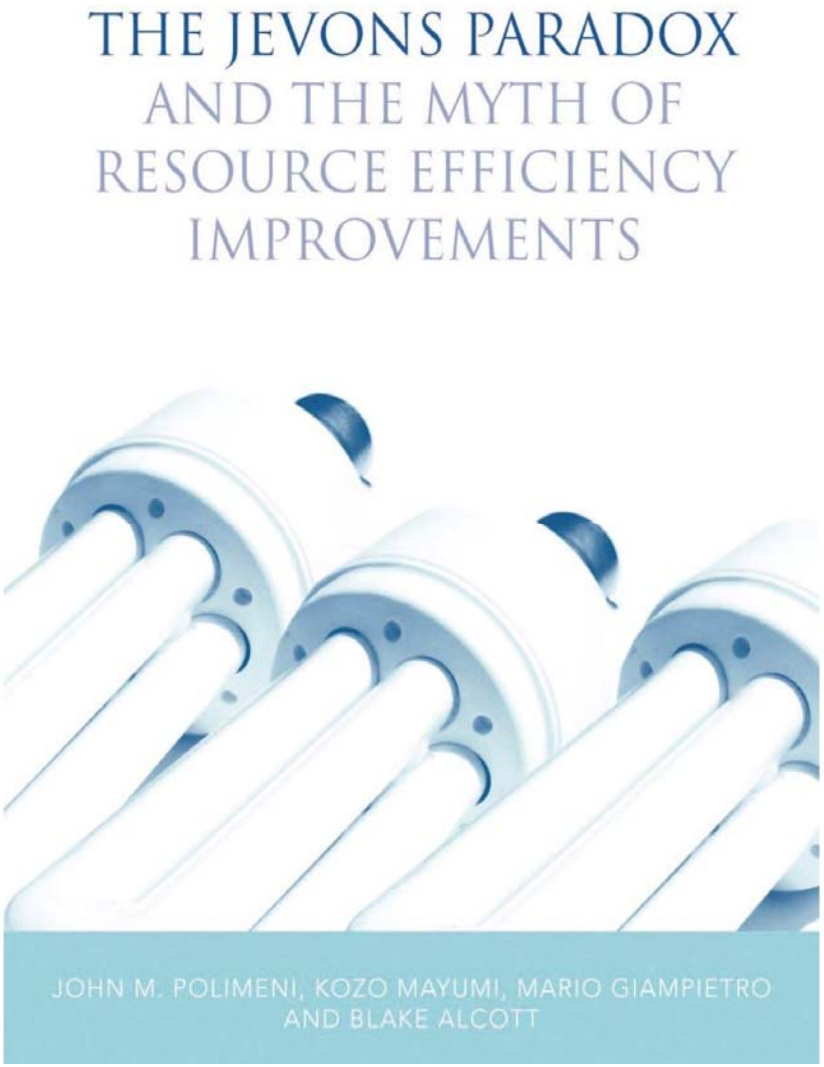

CLASSIC REPRINT SERIES
THE COAL QUESTION
An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines
by
William Stanley Jevons
Forgotten Books

1865?

Perverse Outcomes?



2015



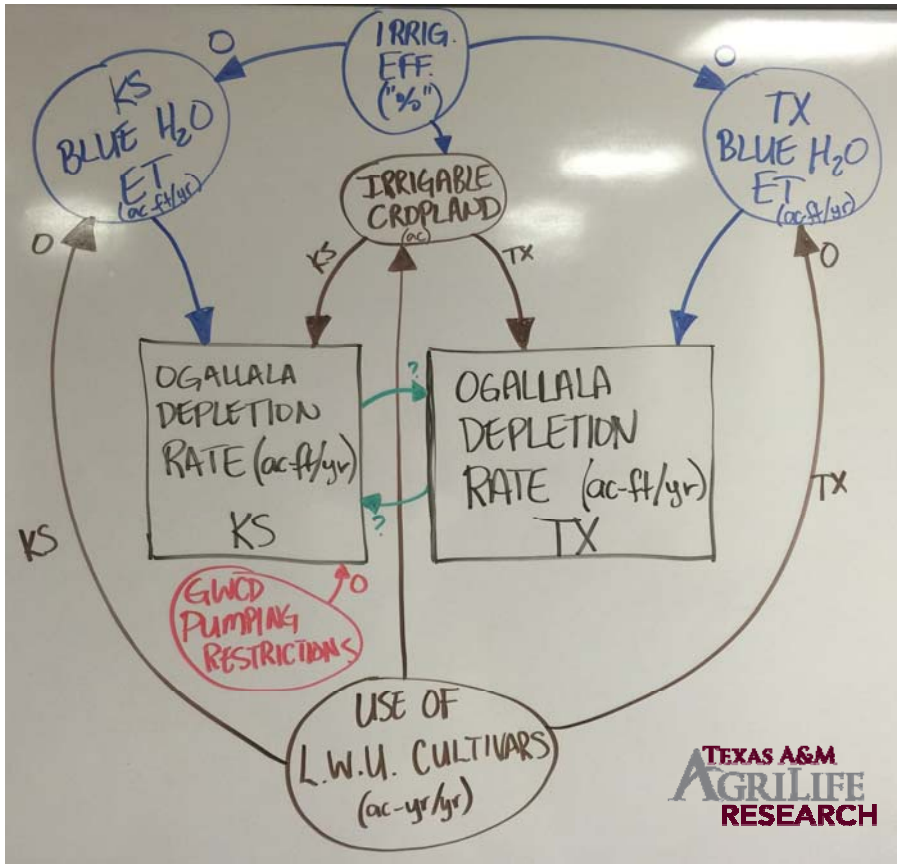
TEXAS A&M AGRILIFE RESEARCH

An Example

- Two quasi-neighboring states, TX and KS
- One (locally) hydraulically continuous* aquifer, the Ogallala
- Two different regulatory/constitutional paradigms
- **Does aggressive, intrastate conservation confer a competitive advantage or a competitive disadvantage?**
- **What modifications could change the payoff structure?**
- **Are there significant, non-economic payoff structures embedded in our communities?**

* How accurate an assumption is this, and how does that affect the structure of the question?

Big Strategies, Ambiguous Outcomes



Big Strategies:

- Increase irrigation efficiency
- Adoption of lower-water-use cultivars
- Unilateral GWCD pumping restrictions
- Other?

Ambiguous Outcomes:

- Direct decrease in water requirements?
- Indirect increase in water extraction?
- Shift in competitive advantage?
- Other?

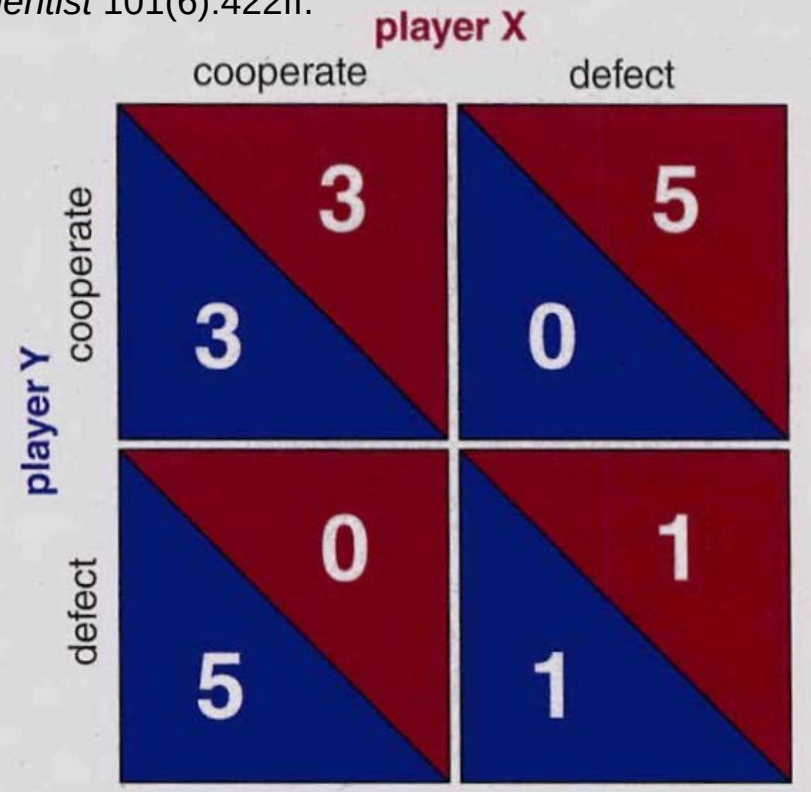
Research Tools:

- General equilibrium modeling (NPV etc.)
- Surveys (ag census; behavior)
- Game theory (coop. vs. non-coop.)

Hayes, B. 2013. New dilemmas for the prisoner. *American Scientist* 101(6):422ff.

Insights

- One game: Nash equilibrium, low payoffs
- Repeated/iterated games: Many possible strategies, long-term outcomes
- "Iterated" implies an emerging *relationship* between the parties
- Relationships create mutual knowledge, memory, discipline, and dopamine (and cortisol, yes)
- Relationships take time
- Policy should be designed to *buy time* and *create space* for (structured) relationships?



Cooperate or defect? In Prisoner's Dilemma the four possible combinations yield varying payoffs for players *X* (*red*) and *Y* (*blue*).

A bottom-up institutional approach to cooperative governance of risky commons

Vítor V. Vasconcelos[1,2,3], Francisco C. Santos[1,3] and Jorge M. Pacheco[1,4,5]★

Avoiding the effects of climate change may be framed as a public goods dilemma[1], in which the risk of future losses is non-negligible[2–7], while realizing that the public good may be far in the future[3,7–9]. The limited success of existing attempts to reach global cooperation has been also associated with a lack of sanctioning institutions and mechanisms to deal with those who do not contribute to the welfare of the planet or fail to abide by agreements[1,3,10–13]. Here we investigate the emergence and impact of different types of sanctioning to deter non-cooperative behaviour in climate agreements. We show that a bottom-up approach, in which parties create local institutions that punish free-riders, promotes the emergence of widespread cooperation, mostly when risk perception is low, as it is at present[3,7]. On the contrary, global institutions provide, at best, marginal improvements regarding overall cooperation. Our results clearly suggest that a polycentric

through time[18–21] (Methods and Supplementary Information for further details). Behavioural experiments[4,5,22], as well as other theoretical models[23,24], have implemented thresholds through repeated interactions, and other authors have highlighted the role played by pledges and communication during negotiations[1,5,25], bringing about additional layers of complexity to this problem (details and comparison with other models in the Supplementary Information).

Besides contributing to this public good, Ps also contribute with a punishment tax (π_t) to an institution that, whenever endowed with enough funding ($n_p\pi_t$) will effectively punish Ds by an amount Δ. Hence, establishing an institution stands as a second-order public good[17,20], which is only achieved above a certain threshold number of contributors n_p (ref. 14). The fact that, in both cases, contributors may pay a cost in vain increases the realism (and the inherent complexity) of the decision process modelled here.

The institution need not be a global one (such as the United

Conclusions

- I'm not breaking any new ground with these insights
- "Unintended" does not imply "unpredictable"
- Relying on efficiency gains alone is a losing battle
- Policies can often be trusted to achieve the opposite of their putative aims
- "Economic utility" is not by itself an adequate surrogate for social outcomes
- We need a compelling account of non-economic payoff structures, *if they exist*