

Innovation of Biofuel Ethanol

30 years of experience in the U.S. and in Brazil

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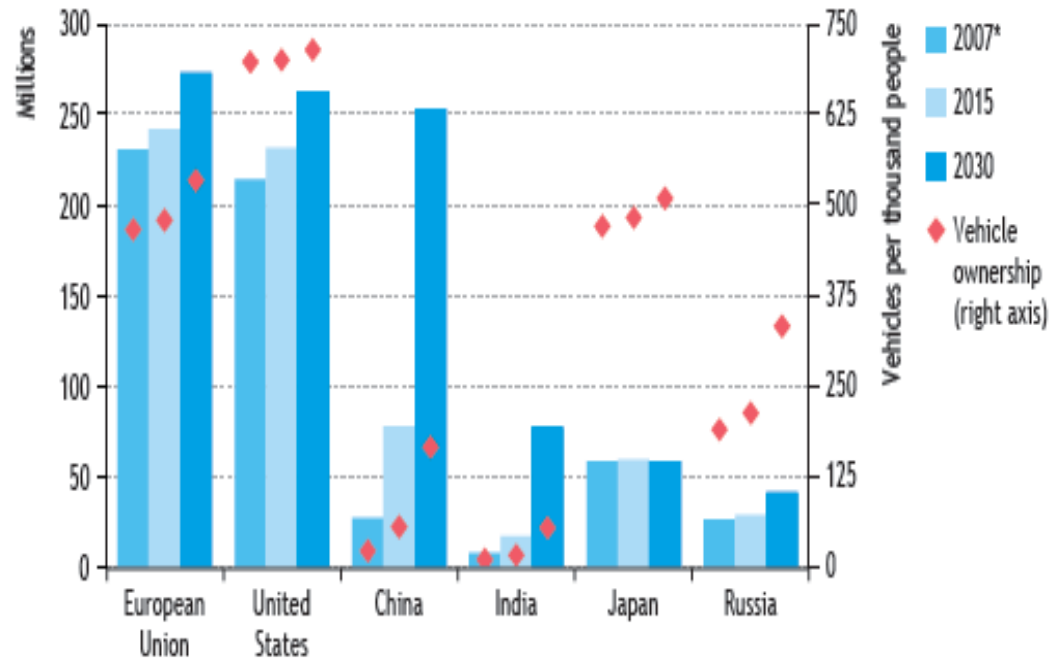
Technology Policy Assessment Center

Georgia Institute of Technology

Transportation, oil, and GHG emissions

U.S. → 1/3 GHG emissions

US supply is 96% dependent on oil



IEA World Energy Outlook 2009; US DOE EIO 2010

Research Questions

1. How does the process of innovation of ethanol in the U.S. compares with the process of innovation of ethanol in Brazil?
2. What are the blocking and inducing mechanisms that prevent and promote innovation of ethanol in the two countries?

Outline

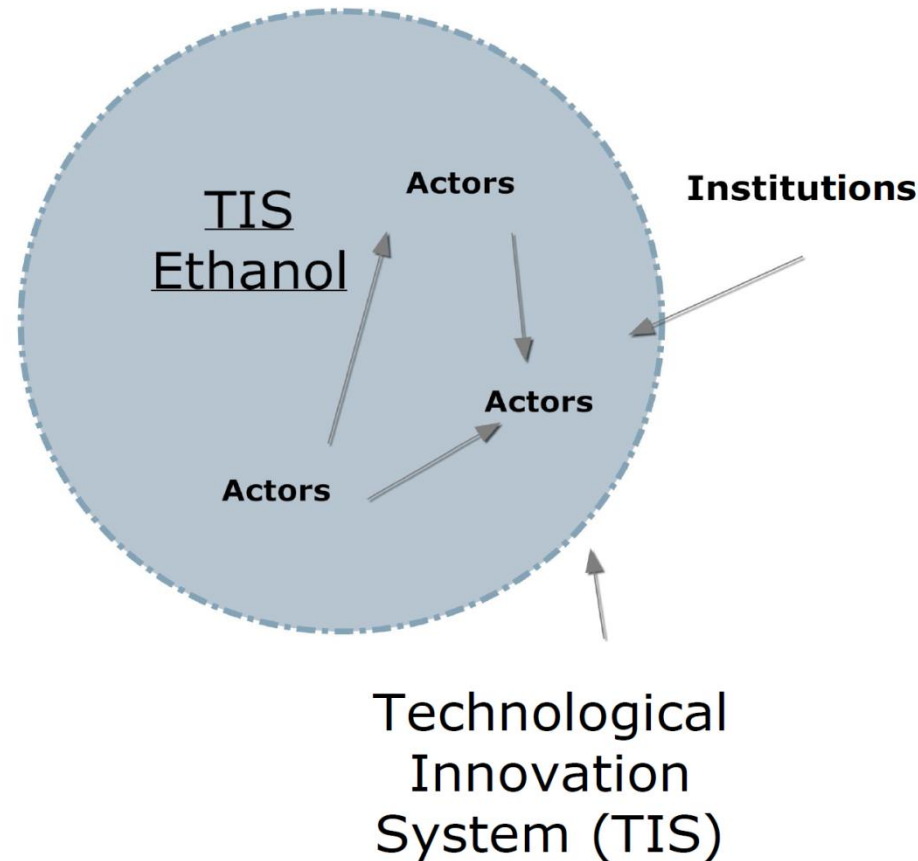
- Theory: innovation systems
- Two cases: U.S. and Brazil
- Data and Methodology
- Results
- Conclusions and policy implications

Innovation is a Process

- Innovation system (Freeman, Nelson, Lundvall, Edquist)
- Process → learning, evolutionary, path dependent
- Innovation → systemic, interactive
- Development, diffusion, and adoption of new knowledge or new technologies

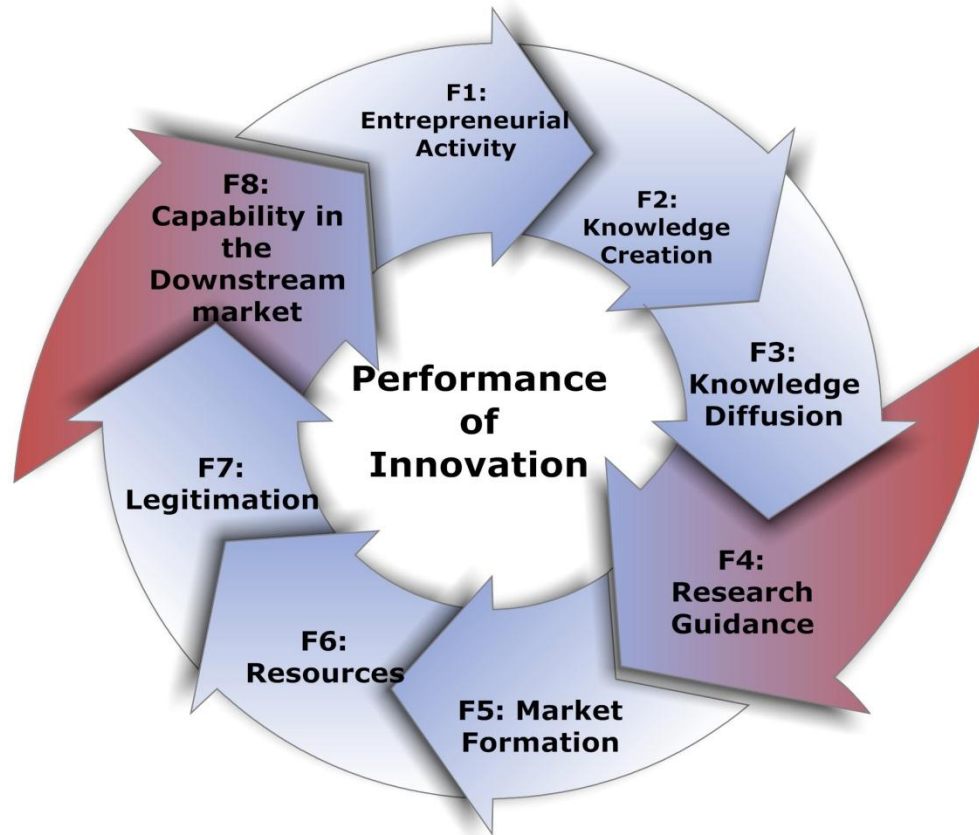
Technology capabilities ↔ Institutions ↔ Market demands

Ethanol develops within a Technological Innovation System (Carlson and Stankiewicz, 1991)



Functions of Innovation Systems

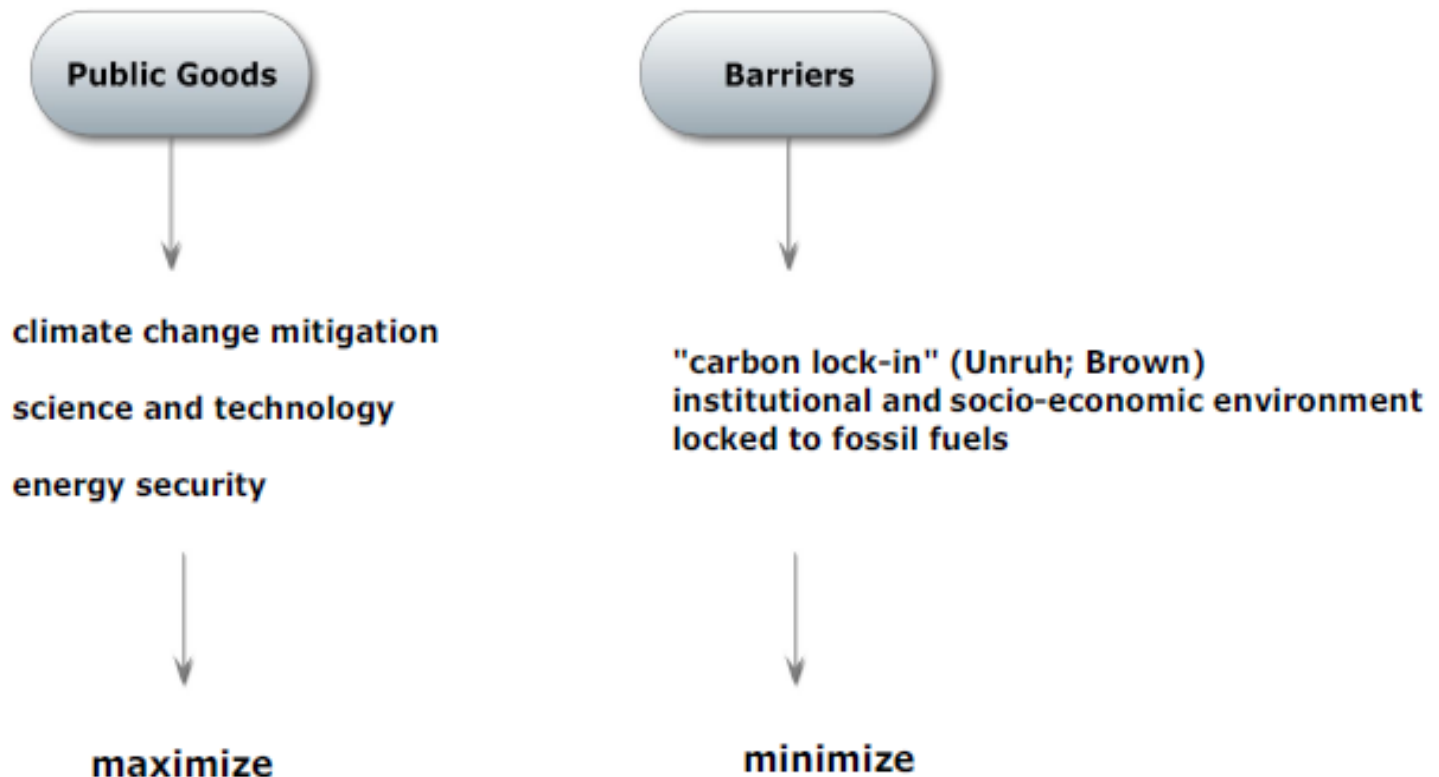
F1 – F7 (Hekkert et al. 2007); F8 (Berger based on Bergek)



Functions of Innovation Systems (F1-F7 – Hekkert et al, 2007; F8: Berger, based on Bergek 2008)

	Name	Description
F1 → -	Entrepreneurial Activity	Events that reflect growing or diminishing industrial capacity, new projects and plants.
F2 →	Knowledge Creation	Events related to Research, Development, and Demonstration of technologies.
F3 →	Knowledge Diffusion	Conferences, workshops, meetings, collaborations.
F4 →	Guidance of Research	Events that help the selection of technological options, or those related to the enactment of policy targets. They also reflect the expectations about the technological options expressed by the various actors.
F5 →	Market Formation	Events that facilitate the market penetration of the emerging technology.
F6 →	Resource Mobilization	Events related to physical and human investments, be public or private.
F7 →	Legitimation	Events related to lobbies, coalitions (interest groups, NGOs, industry associations) or political forces (congressional and executive leaders).
F8 →	Cap. Building in the Downstream Market	Events that reflect the development of capabilities in the distribution and in the automobile segments.

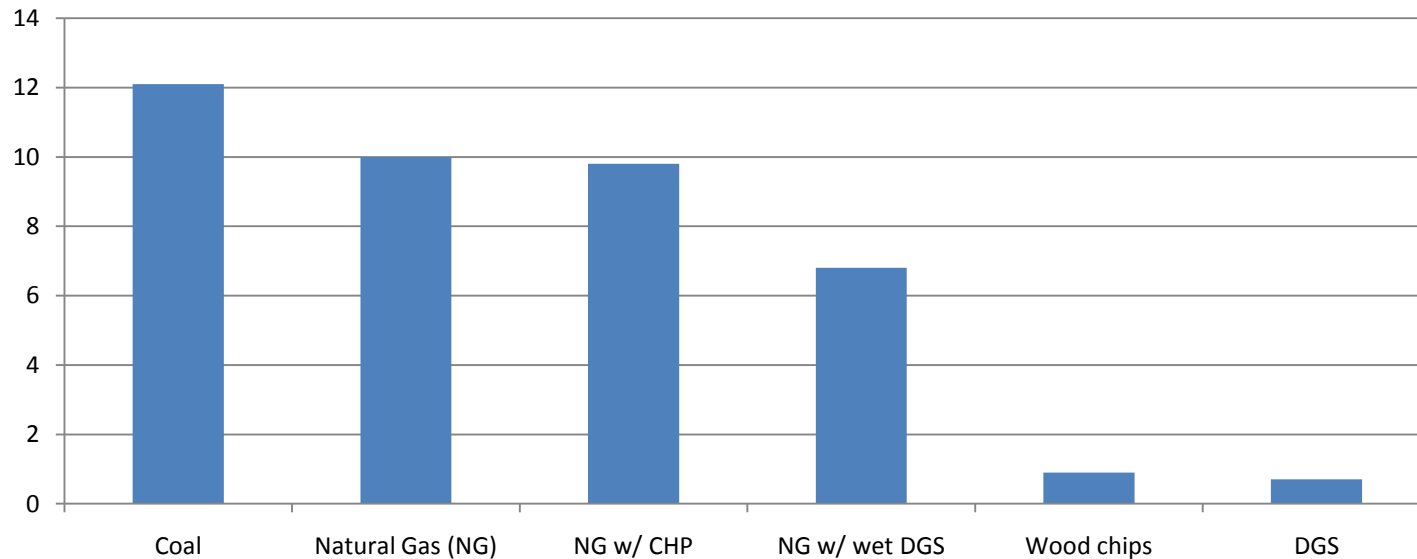
Public policies can induce innovation. Maximize provision of public goods; minimize barriers



Technology change has positive environmental impact

Energy Consumption vs
Energy Source/Technology (Wang 2007)

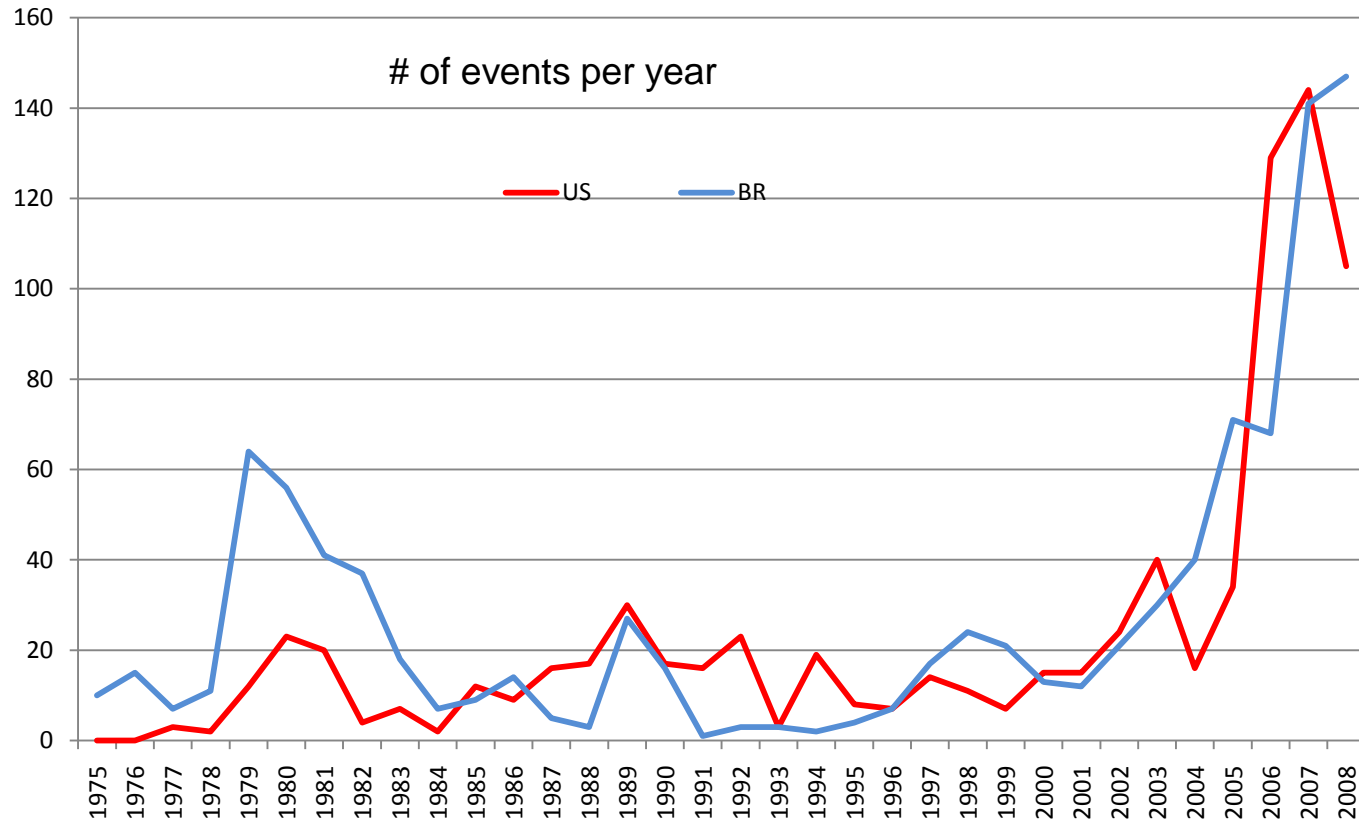
MJ/liter



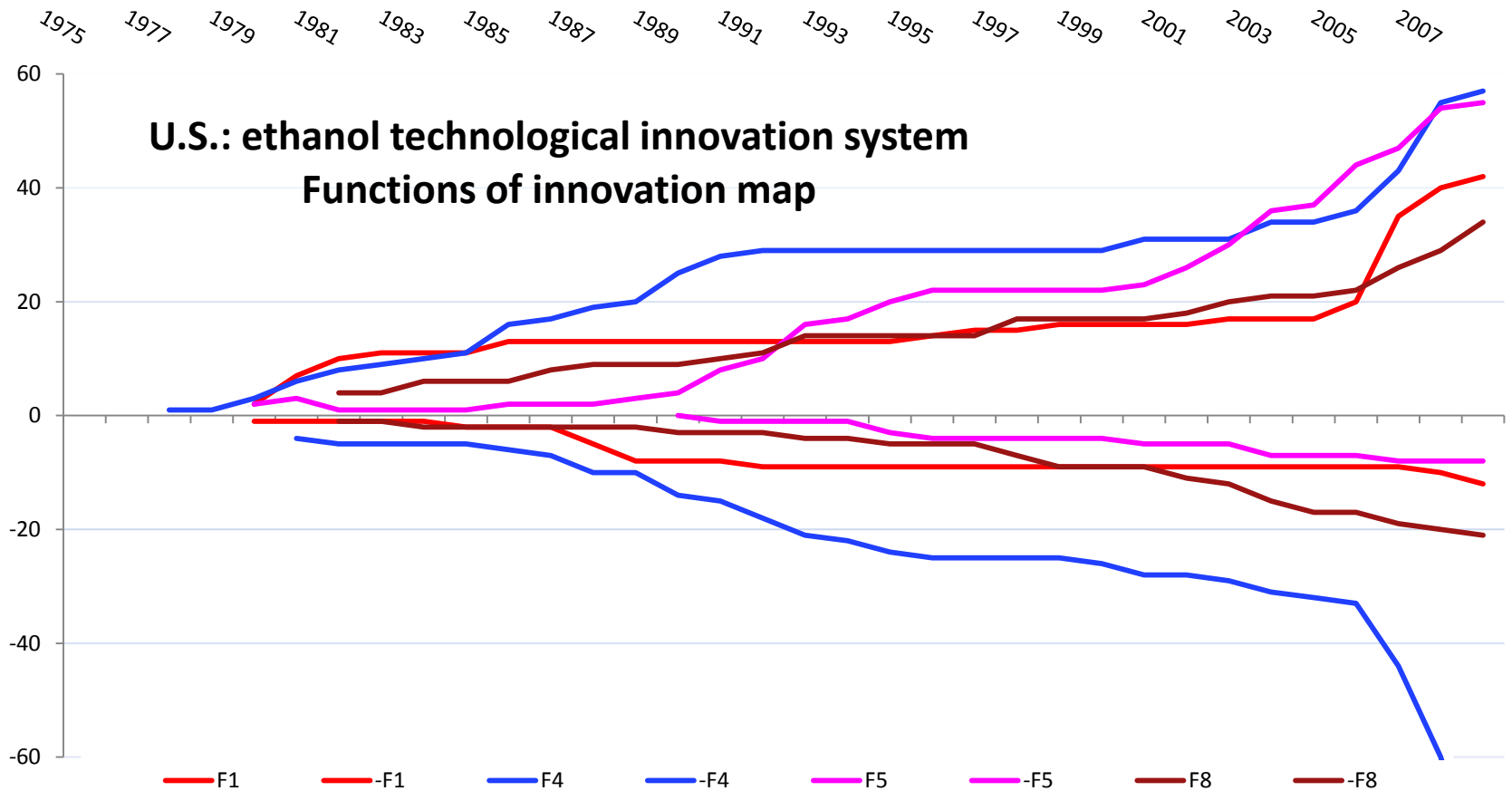
Data and Methodology: historic events as unit of analysis

- 1975 – 2008 → 1,750 articles
 - U.S.: New York Time and Washington Post
 - Brazil: O Estado de Sao Paulo
1. Bibliographic search
 2. Coding
 3. Data analysis and plotting
 4. Interview with specialists
 5. Process analysis (narrative)
 6. Comparative analysis

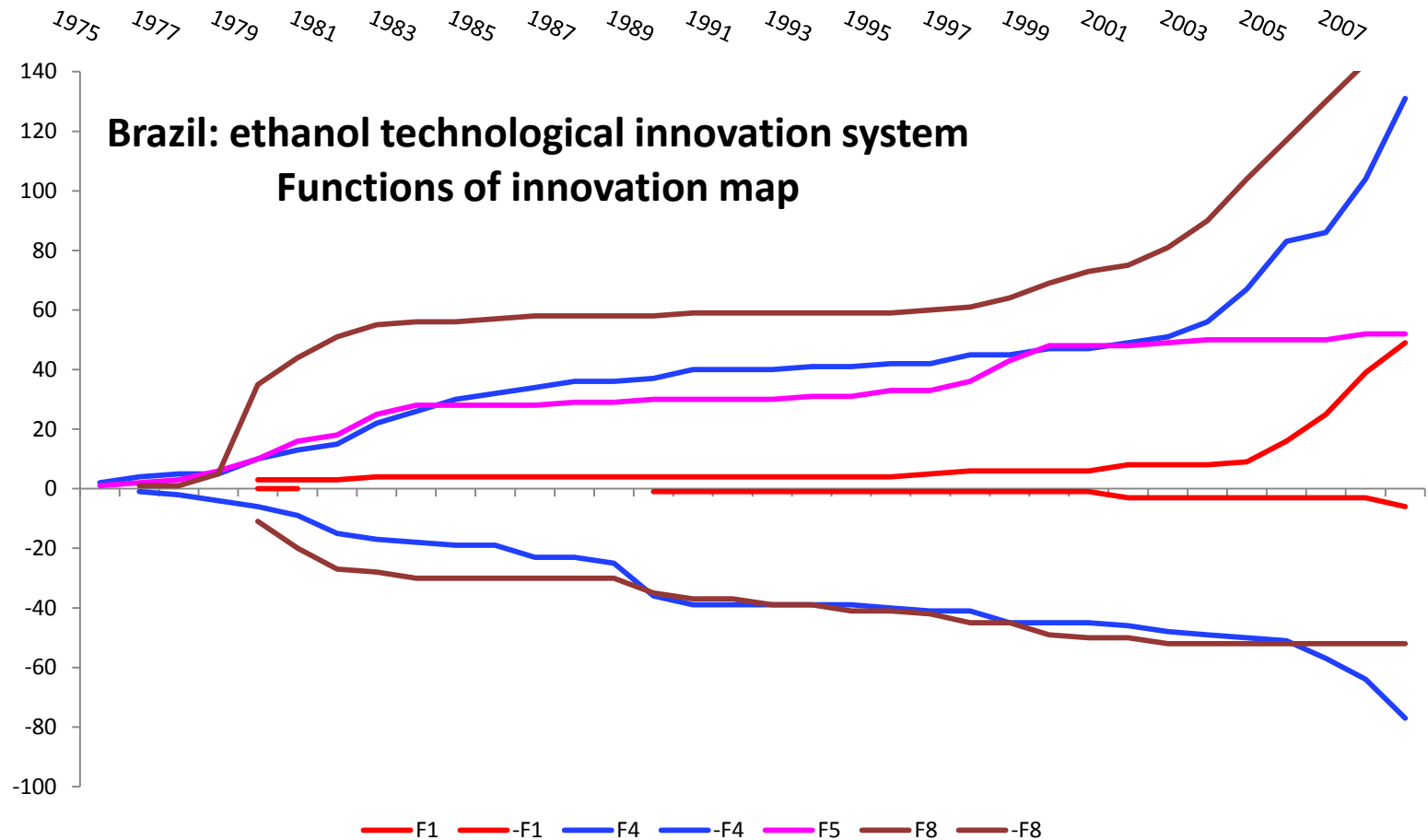
U.S. and Brazil: events reporting on ethanol



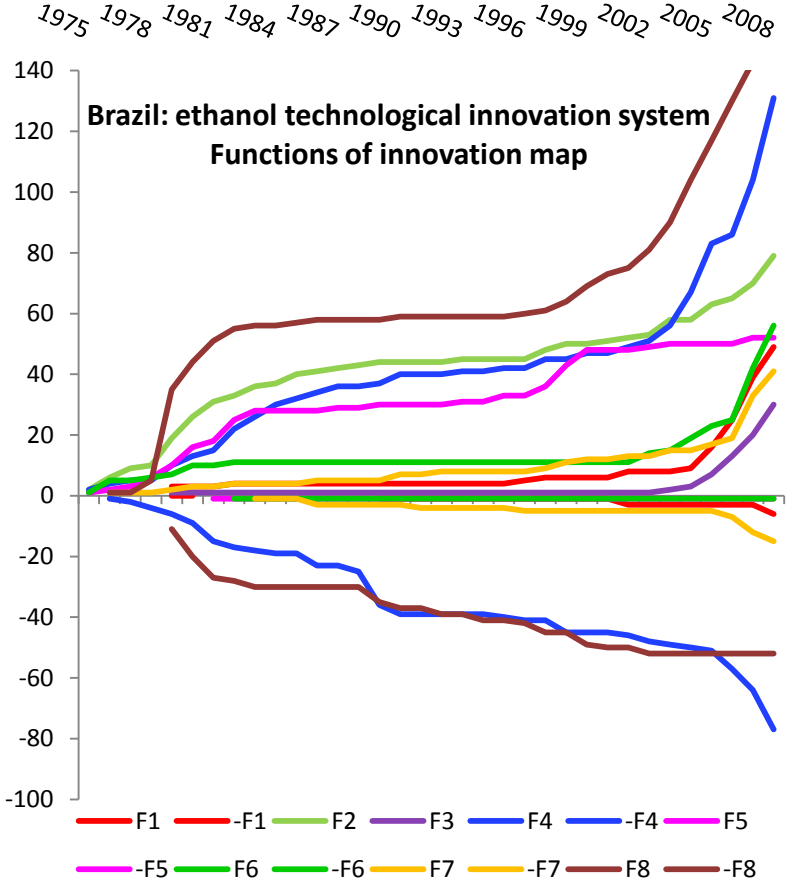
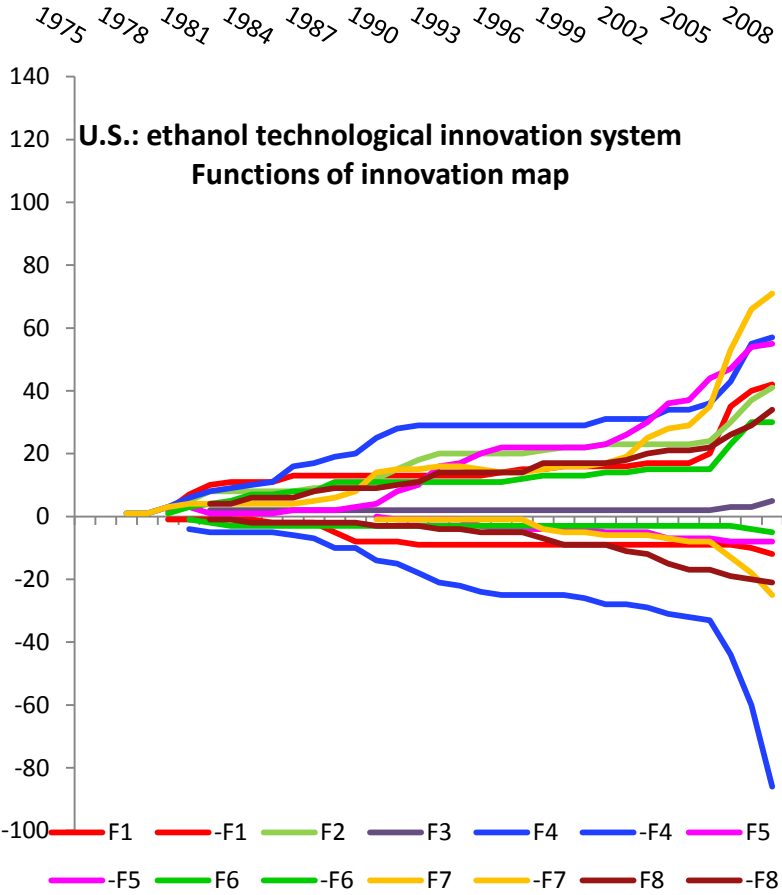
U.S.: Guidance of Research (F4) and Cap. in the Downstream Market (F8) are barriers



Brazil: Guidance of Research (F4) and Cap. in the Downstream Market (F8) induced innovation



Comparative Analysis

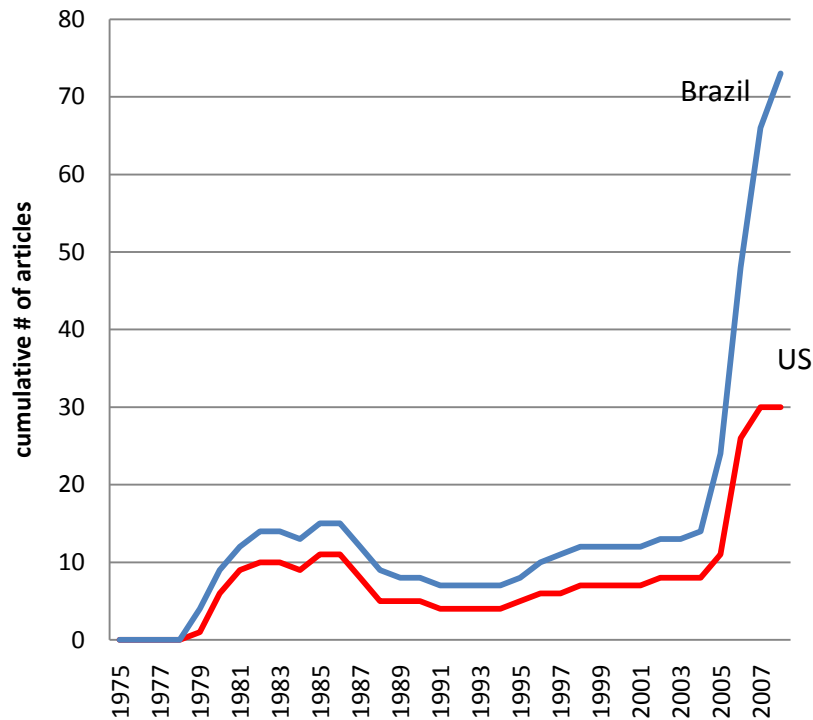


Functions by country, by year

Pearson correlation test

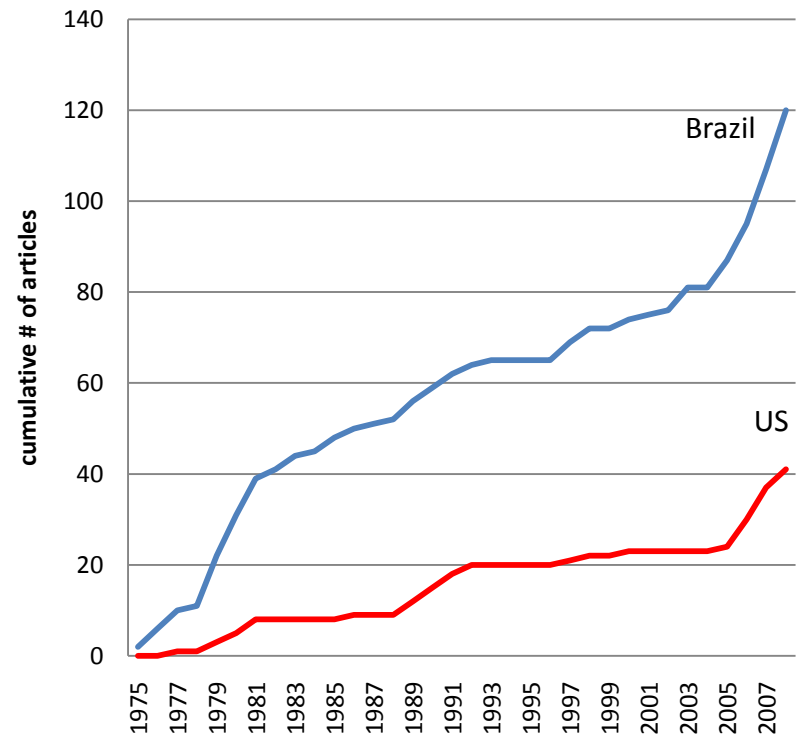
F1 - Entrepreneurship

$r = 0.93$ ($\alpha = 0.05$)



F2 - Knowledge Creation

$r = 0.93$ ($\alpha = 0.05$)

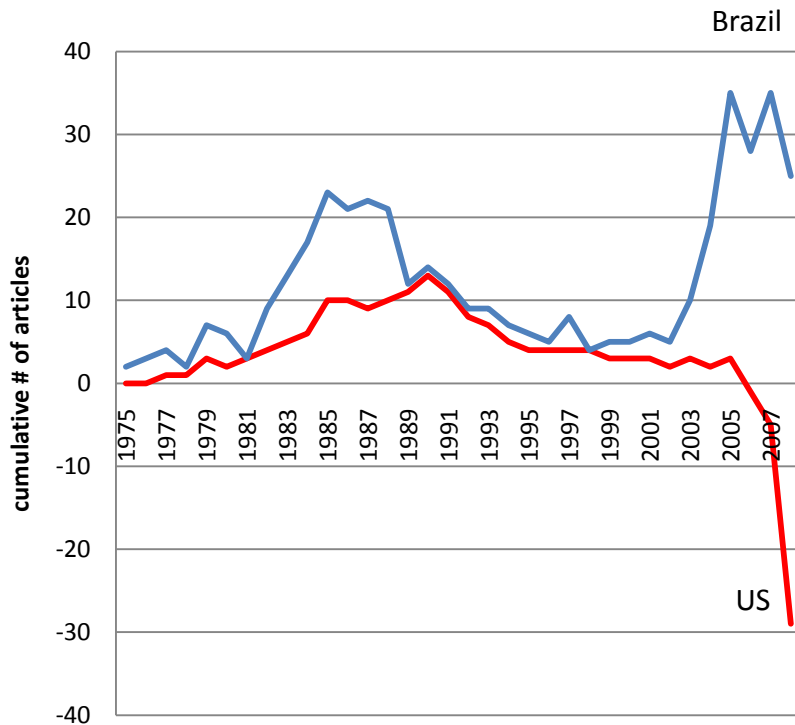


Functions by country, by year

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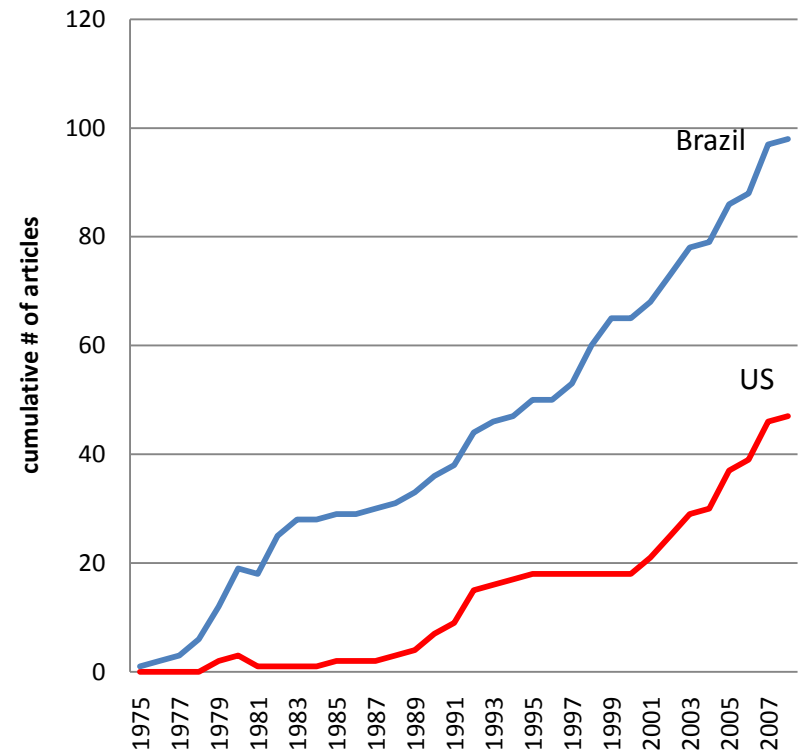
F4 - Guidance of Research

$r = -0.70$ ($\alpha = 0.05$)



F5 - Market Formation

$r = 0.86$ ($\alpha = 0.05$)

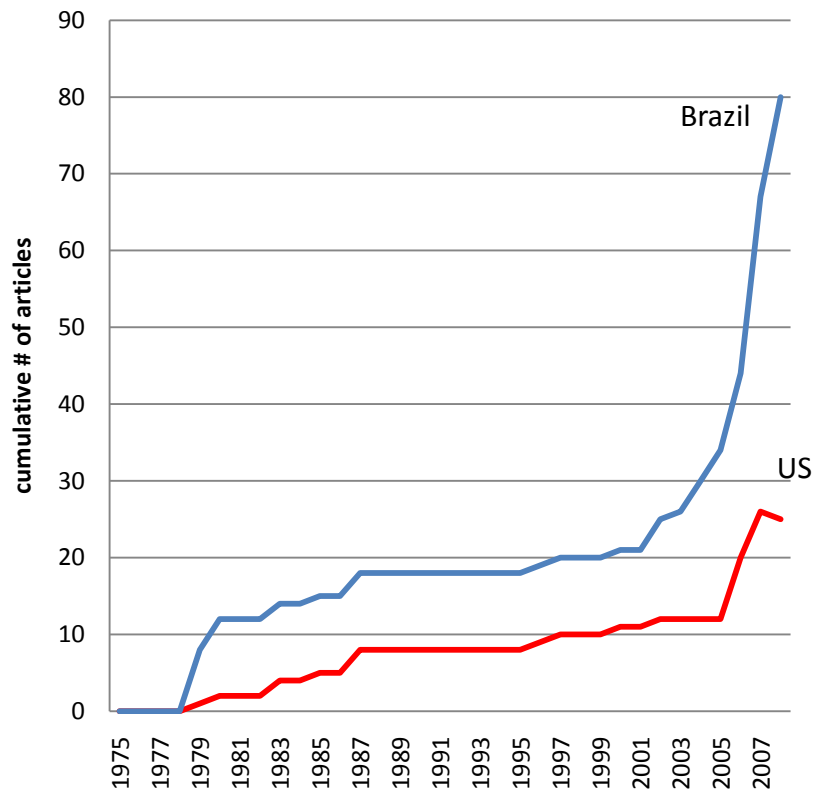


Functions by country, by year

Pearson correlation test

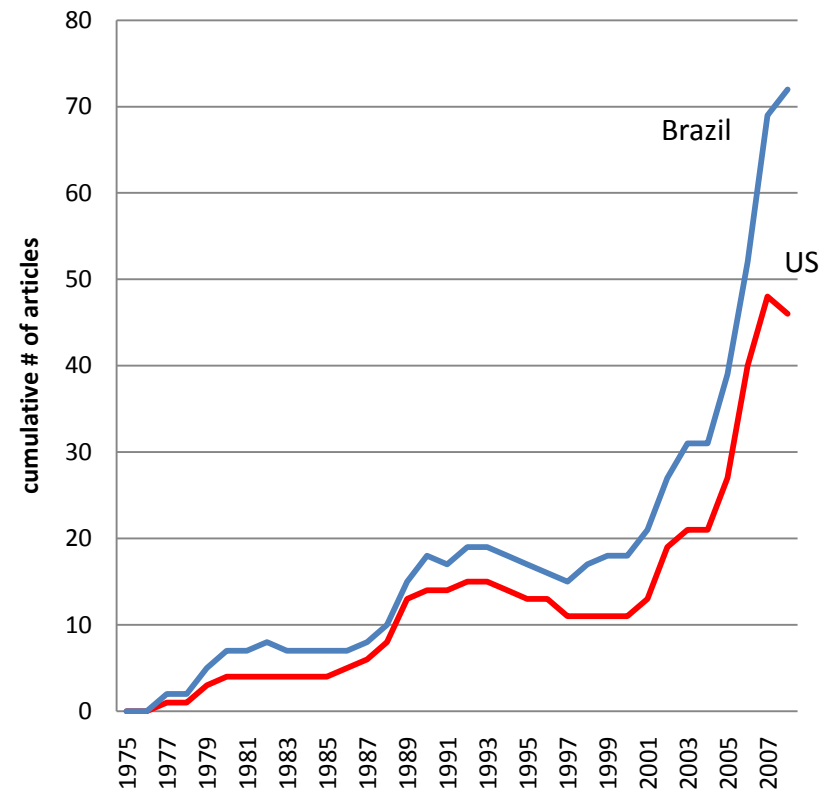
F6 - Resource Mobilization

$r = 0.85$ ($\alpha = 0.05$)



F7 - Legitimation

$r = 0.92$ ($\alpha = 0.05$)

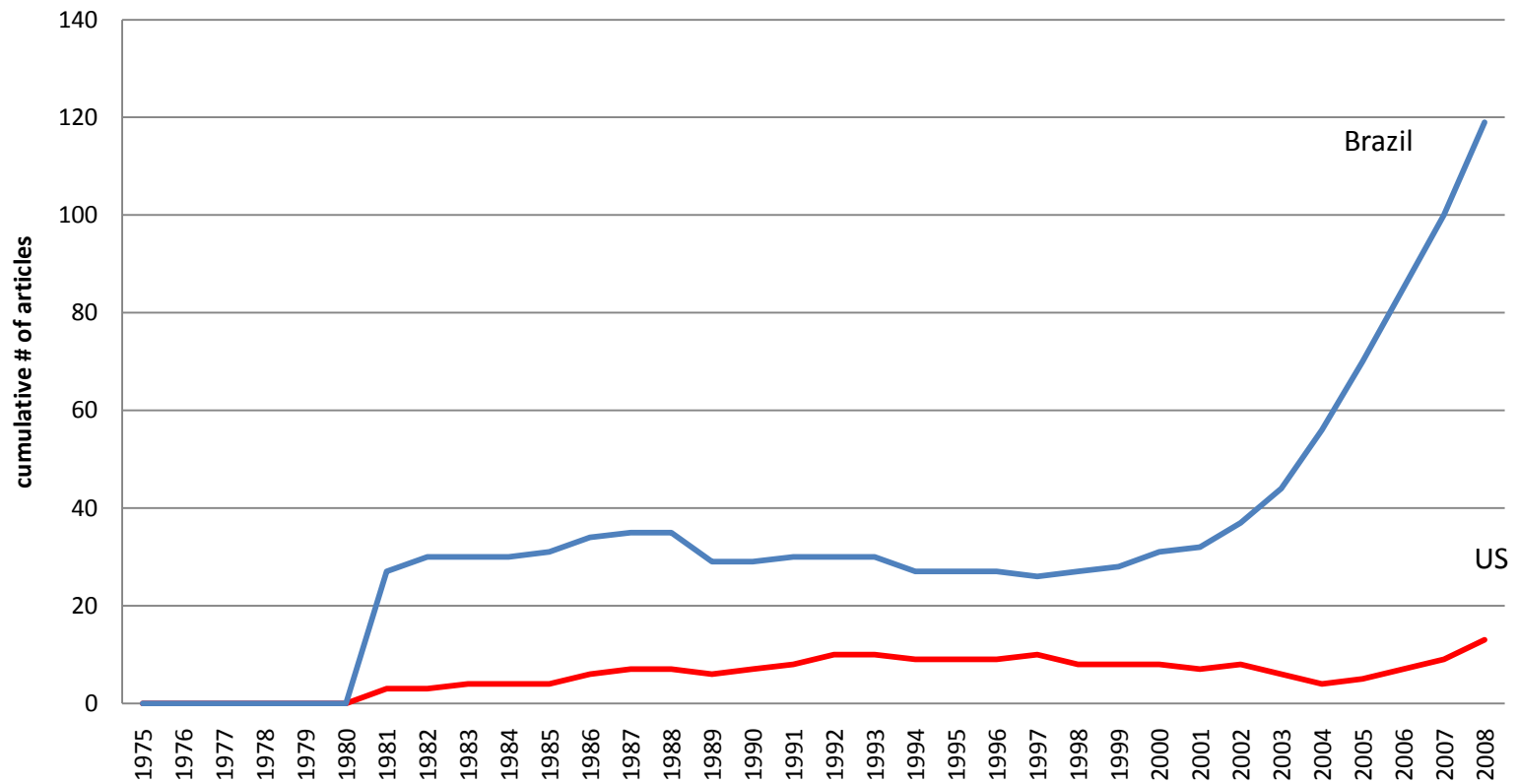


Functions by country, by year

Pearson correlation test

F8 - Capabilities in the Downstream Market

$r = 0.19$ ($\alpha = 0.05$)



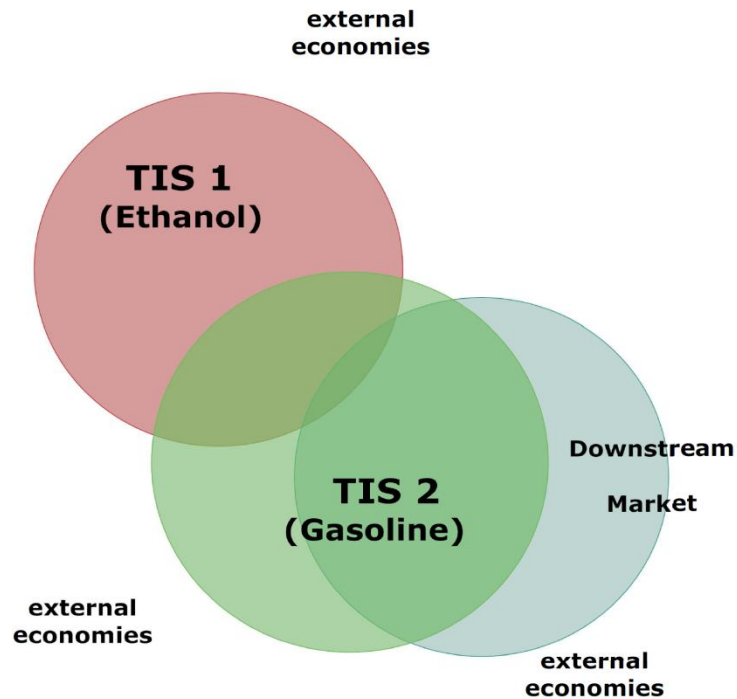
Conclusions

- Guidance of Research and Downstream Market are inducers and can be detrimental to innovation
- Guidance of Research (F4)
 - U.S.: low expectation about sustainability and long term market prospects of corn ethanol
 - Brazil: ups and downs until 2000 and FFVs
- Downstream market (F8)
 - U.S. facing threat of “blend wall”
 - Brazil stronger than U.S.: hydrated ethanol (40% market gasoline), FFVs tuned to run on ethanol

Downstream market (F8)

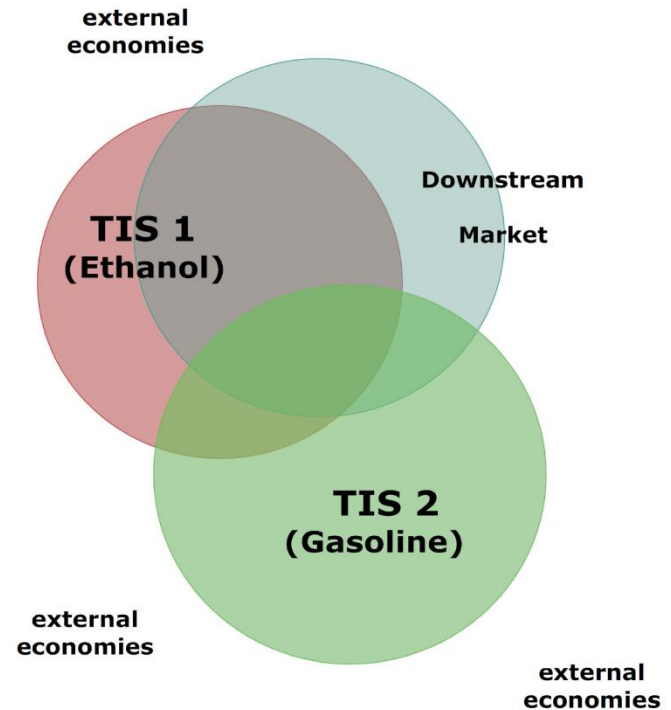
U.S.

Competing TIS



Brazil

Competing TIS



Policy Implications

- Guidance of research (F4):
 - clear policy goals decrease risks of innovation
 - negative expectations about 1st generation technology undermines potential synergy between 1st and 2nd generation technologies.
- Downstream market (F8):
 - Policy makers should provide incentives to automakers and distributors (oil companies) join ethanol TIS

- Georgia Tech
- School of Public Policy
- Technology Policy Assessment Center - TPAC
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