On the (de)stabilisation effects of biofuels:

relative contributions of policy instruments and market forces

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ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

Issues

- Dramatic development of biofuels due to market forces (e.g. oil price) and public policies (e.g. mandates)
- Numerous numerical analyses on GHG emission and farm effects.
- Fail to recognize the uncertainty of oil prices and the risk aversion of farmers

Objectives

- Will biofuel help to smooth farm markets and incomes?
  - Larger markets but volatile as well
  - Role of biofuel policy vs Market forces
- This question is important for
  - Market projections
  - Farm policy analysis (A new safety net ?)
- Methodology
  - PE model focused on US corn-ethanol
  - (Downside) risk aversion and role of biofuel policy

Intuition

- Without biofuel:

$$Y = a + bP \qquad FD = c - dP$$

$$P = \frac{c-a}{b+d} \qquad Var\ P = \frac{Var\ c}{(b+d)^2}$$

- With biofuel: $ED = e - f(P - S)$

$$P = \frac{c+e+fS-a}{b+d+f} \qquad \operatorname{var} P = \frac{\operatorname{var} c}{(b+d+f)^2} + \frac{\operatorname{var} e}{(b+d+f)^2}$$

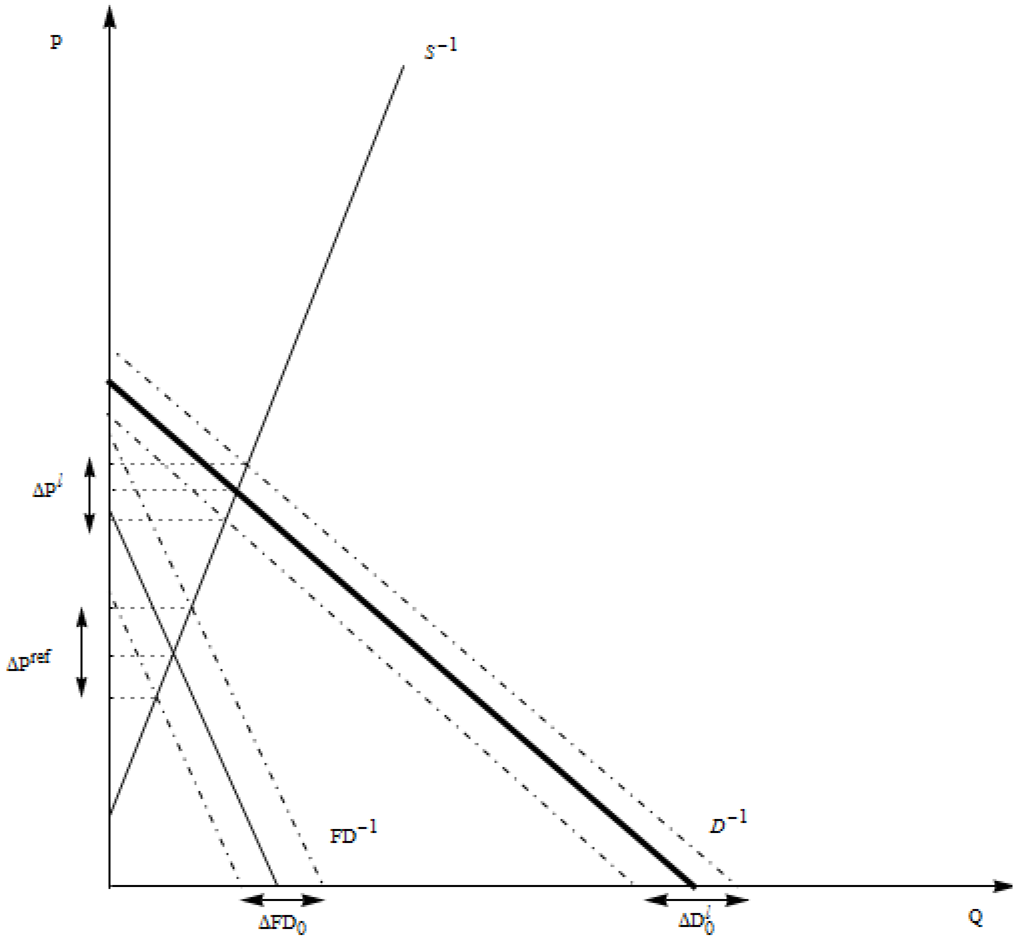

Figure 1: The higher price elasticity of corn demand outweighs the higher volatility “imported” from the energy market, leading to a smaller corn market price volatility with respect to the food-only benchmark $\Delta P^{I} < \Delta P^{ref}$

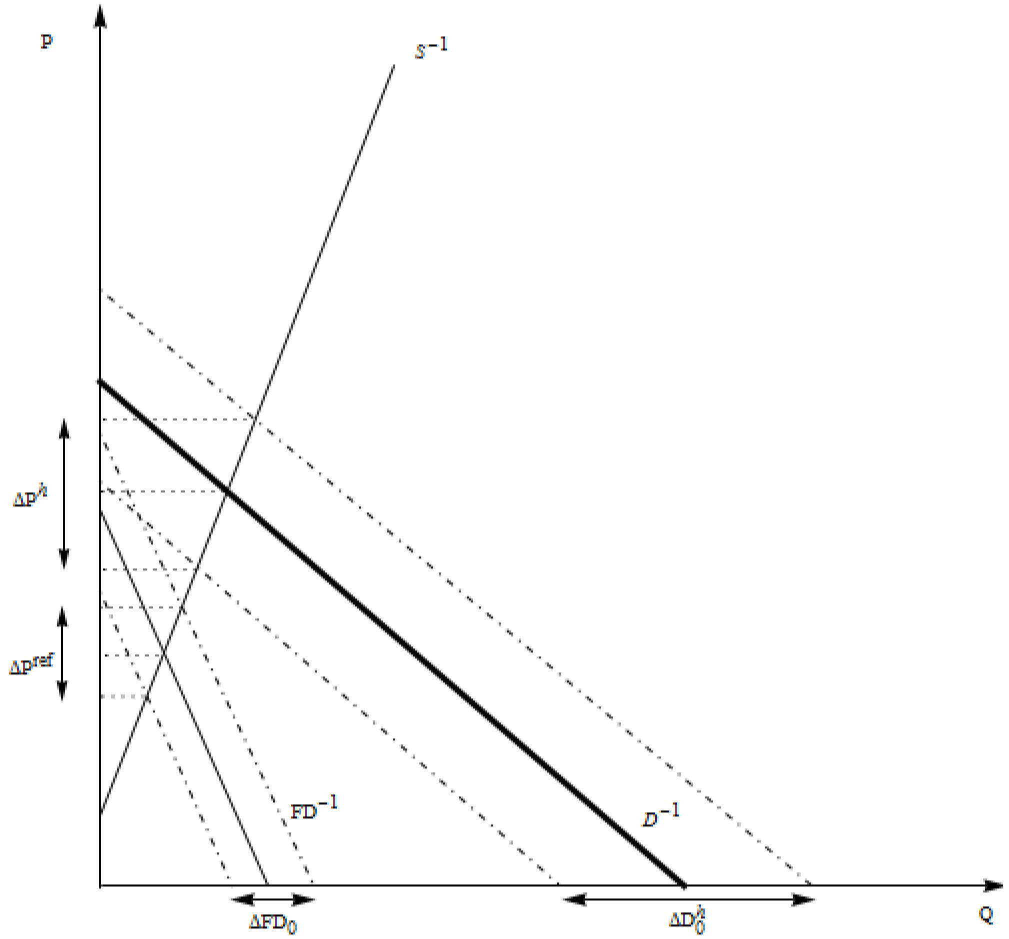

Figure 2: the higher volatility “imported” from the energy market outweighs the higher price elasticity of corn demand leading to a higher corn market price volatility with respect to the food-only benchmark $\Delta P^H > \Delta P^{ref}$

Our PE model

- Supply of US corn by a DARA producer facing only price risk and constrained by available factors
- Risk premium approximated with Arrow and Pratt expansions:

$$PR\left(W_0+\tilde{\pi}\right)\approx -\frac{1}{2}.\frac{U''\left(W_0+E\left(\tilde{\pi}\right)\right)}{U'\left(W_0+E\left(\tilde{\pi}\right)\right)}.\sigma^2\left(W_0+\tilde{\pi}\right)-\frac{1}{6}.\frac{U'''\left(W_0+E\left(\tilde{\pi}\right)\right)}{U'\left(W_0+E\left(\tilde{\pi}\right)\right)}.\sigma^3\left(W_0+\tilde{\pi}\right)$$

$$PR\left(W_0+\tilde{\pi}\right)\approx \frac{1}{2}.\frac{\rho}{W_0+E\left(\tilde{\pi}\right)}.Y^2.\sigma_{P_Y}^2-\frac{1}{6}.\frac{\rho.\left(\rho+1\right)}{\left(W_0+E\left(\tilde{\pi}\right)\right)^2}.Y^3.\sigma_{P_Y}^3$$

Farmer's program

$$\max_{Y,I,T} \quad EU\left(W_0 + \tilde{\pi}\right) = E\left(\frac{\left(W_0 + \tilde{\pi}\right)^{1-\rho}}{1-\rho}\right)$$

$$\text{s.t.} \quad \tilde{\pi} = \tilde{P}_Y.Y - P_{CI}.I - R.T + dp.T$$

$$\text{s.t.} \quad Y = \alpha_0.\left(\alpha_1.I^{\sigma-1/\sigma} + \left(1-\alpha_1\right).T^{\sigma-1/\sigma}\right)^{\sigma.\theta/\sigma-1}$$

$$\text{s.t.} \quad W_0 = WNF + \frac{R}{\tau}.TP$$

Farmer’s program (cont’d)

$$\max \quad EU\left(W_0 + \tilde{\pi}\right) \quad \Leftrightarrow \max \quad EC = E\left(W_0 + \tilde{\pi}\right) - PR\left(W_0 + \tilde{\pi}\right)$$

$$\max_{Y,I,T} \quad EC = W_0 + \mu_{P_Y}.Y - P_{CI}.I - R.T + dp.T - \frac{1}{2}.\frac{\rho}{W_0 + E\left(\tilde{\pi}\right)}.Y^2.\sigma_{P_Y}^2 + \frac{1}{6}.\frac{\rho.\left(\rho + 1\right)}{\left(W_0 + E\left(\tilde{\pi}\right)\right)^2}.Y^3.\sigma_{P_Y}^3$$

$$s.t. \quad E\left(\tilde{\pi}\right) = \mu_{P_Y}.Y - P_{CI}.I - R.T + dp.T$$

$$s.t. \quad Y = \alpha_0.\left(\alpha_1.I^{\sigma-1/\sigma} + \left(1 - \alpha_1\right).T^{\sigma-1/\sigma}\right)^{\sigma.\theta/\sigma-1}$$

→ The program is broken down into 2 steps

Hence, the optimal production is implicitly determined by:

$$\left(\mu_{P_Y} - C_Y\left(P_{CI}, R, Y\right)\right).\left(1 + \frac{1}{2}.\frac{\rho.Y^2.\sigma_{P_Y}{}^2}{\left(W_0 + E\left(\tilde{\pi}\right)\right)^2}\right) - \frac{\rho.Y.\sigma_{P_Y}^2}{W_0 + E\left(\tilde{\pi}\right)}$$

$$+\frac{\rho.\left(\rho + 1\right).Y^2.\sigma_{P_Y}^3}{\left(W_0 + E\left(\tilde{\pi}\right)\right)^2}.\left(\frac{1}{2} - \frac{\left(\mu_{P_Y} - C_Y\left(P_{CI}, R, Y\right)\right).Y}{W_0 + E\left(\tilde{\pi}\right)}\right) = 0$$

Linking corn & ethanol markets

- From the supply of corn to the demand of ethanol, the model is standard (Gardner, 2007):
  - Linear food and export demand (with uncertainties)
  - Fixed proportions in ethanol processing
  - Linear by product demand and input supply
  - Most crucial assumption: risk neutral processors

The demand for domestic ethanol and the role of biofuel policy:

$$\min_{YE,GS} \quad P_{Ethanol}.YE + (P_{GS} + tax).GS$$

$$s.t. \quad YE + GS = TGD$$

$$s.t. \quad YE \geq mr.TGD$$

Optimal demands are given by the complementarity equations:

$$P_{Ethanol} \geq P_{GS} + tax + rent \quad \perp \quad YE > 0$$

$$YE \geq mr.TGD \quad \perp \quad rent > 0$$

$$GS = TGD - YE$$

$$P_{TGD}.TGD = P_{Ethanol}.YE + \left(P_{GS} + tax\right).GS$$

Calibration of the model

- Market values based on year 2006
- Behavioral parameters: OECD, literature review
- Initial risk premium: 4.5% of total receipts and prod elasticities are 0.6, -0.07, 0.03 and 0.02
- Without biofuel, CV of corn price = 0.2
- CV of gasoline price = 0.35

Results

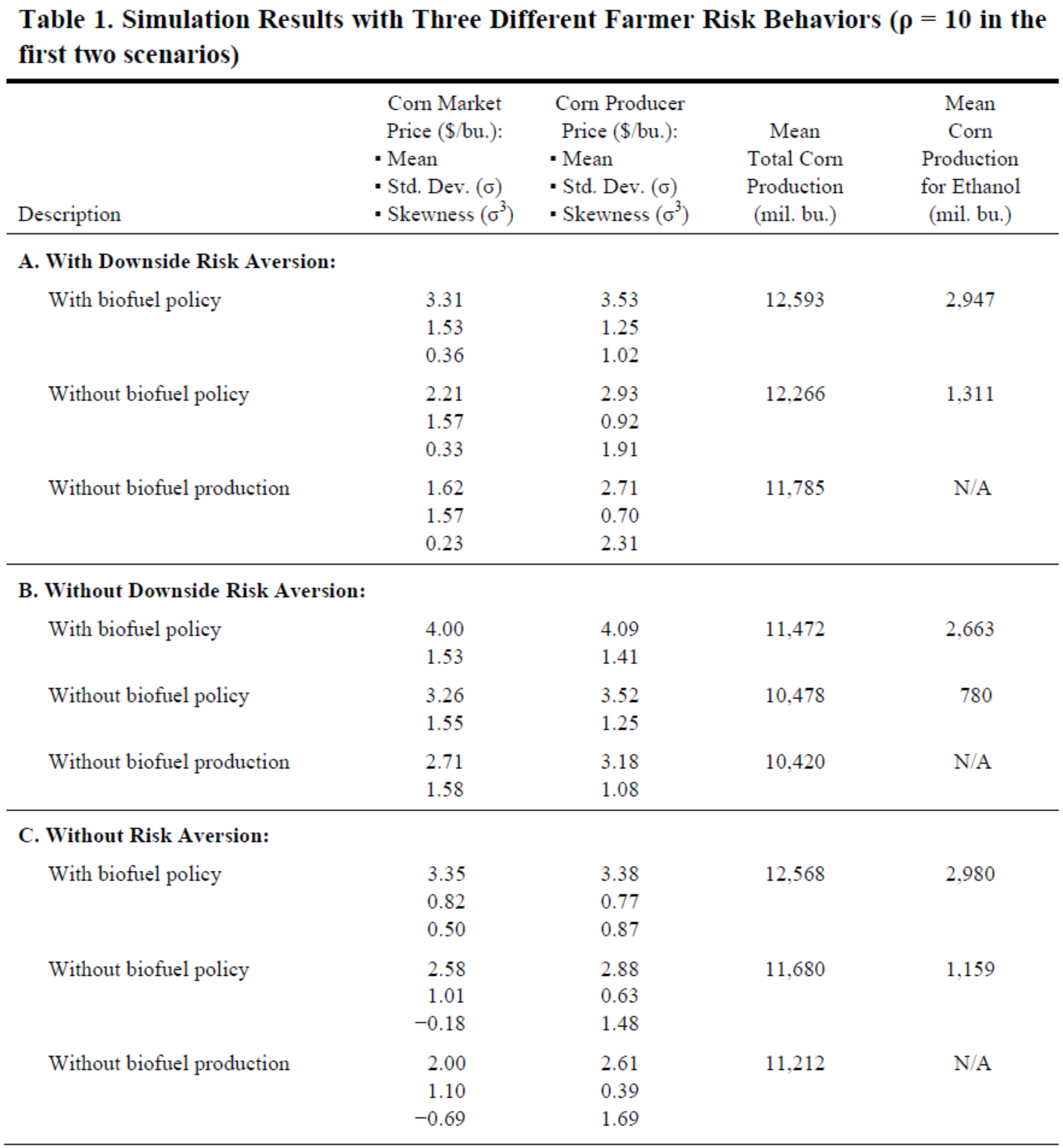

Table 1. Simulation Results with Three Different Farmer Risk Behaviors (ρ = 10 in the first two scenarios)

Description	Corn Market Price ($/bu.): ▪ Mean ▪ Std. Dev. (σ) ▪ Skewness (σ^3)	Corn Producer Price ($/bu.): ▪ Mean ▪ Std. Dev. (σ) ▪ Skewness (σ^3)	Mean Total Corn Production (mil. bu.)	Mean Corn Production for Ethanol (mil. bu.)
A. With Downside Risk Aversion:				
With biofuel policy	3.31 1.53 0.36	3.53 1.25 1.02	12,593	2,947
Without biofuel policy	2.21 1.57 0.33	2.93 0.92 1.91	12,266	1,311
Without biofuel production	1.62 1.57 0.23	2.71 0.70 2.31	11,785	N/A
B. Without Downside Risk Aversion:				
With biofuel policy	4.00 1.53	4.09 1.41	11,472	2,663
Without biofuel policy	3.26 1.55	3.52 1.25	10,478	780
Without biofuel production	2.71 1.58	3.18 1.08	10,420	N/A
C. Without Risk Aversion:				
With biofuel policy	3.35 0.82 0.50	3.38 0.77 0.87	12,568	2,980
Without biofuel policy	2.58 1.01 −0.18	2.88 0.63 1.48	11,680	1,159
Without biofuel production	2.00 1.10 −0.69	2.61 0.39 1.69	11,212	N/A

Welfare variations (in $ Millions) with respect to the no biofuel framework. ($\rho = 10$, with downside risk aversion)

	With biofuel policy	Without biofuel policy
	Producers	
Farmers	+22,096	+10,968
Non-farmers agricultural land owners	+658	+372
Producers of other agricultural inputs	+2,164	+1,259
Producers of other inputs used in ethanol production	+ 1,830	+ 666
Gasoline producers	-28,100	-11,032
	Consumers	
US Corn Consumers (Food/feed)	-13,927	-4,987
Foreign Corn consumers	-3,630	-1,074
DDGS Consumers	- 1,296	- 460
Gasoline + ethanol consumers	+27,487	+11,170
	Taxpayers	
Total payments	-6,229	-3,851
Agricultural subsidies	-9,912	-3,851
Biofuel subsidies	+ 3,684	0
	Aggregate	
Total Welfare	+13,469	+10,876

Conclusion

- Biofuel production and consumption have recently surged due to public policies and increased fossil oil prices.
- In addition to supporting corn prices through a standard demand effect on farm markets, the biofuel outlet may also pass the energy volatility to the corn market, hence destabilizing farm markets and revenues.

Conclusion (cont'd)

- By making farm policy instruments less binding, the biofuel outlet significantly affects the distribution of corn (producer and market) prices.
- Despite a greater variance and a lower asymmetry of corn producer prices, corn farmers benefit from higher expected prices.

Conclusion (cont'd)

- The new setting of agricultural and energy markets interrelatedness is bound to be a central issue in the upcoming years.
- A thorough understanding of the many impacts of the increased price volatility on all the economic agents (ethanol processors, consumers...) seems warranted.