

Price Analysis of Biotech Seed Markets: Bundling, Integration, Patenting, Efficiency, and Market Power

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1. Motivations for our work

- Bundling, Integration and the exercise of market power
 - Price discrimination opportunities.
 - Optimal bundle strategy (including pricing) depends on
 - Independently valued, complements, or substitutes
 - Heterogeneity in consumers
 - Cost structure (e.g. economies of scope)
 - Power profile

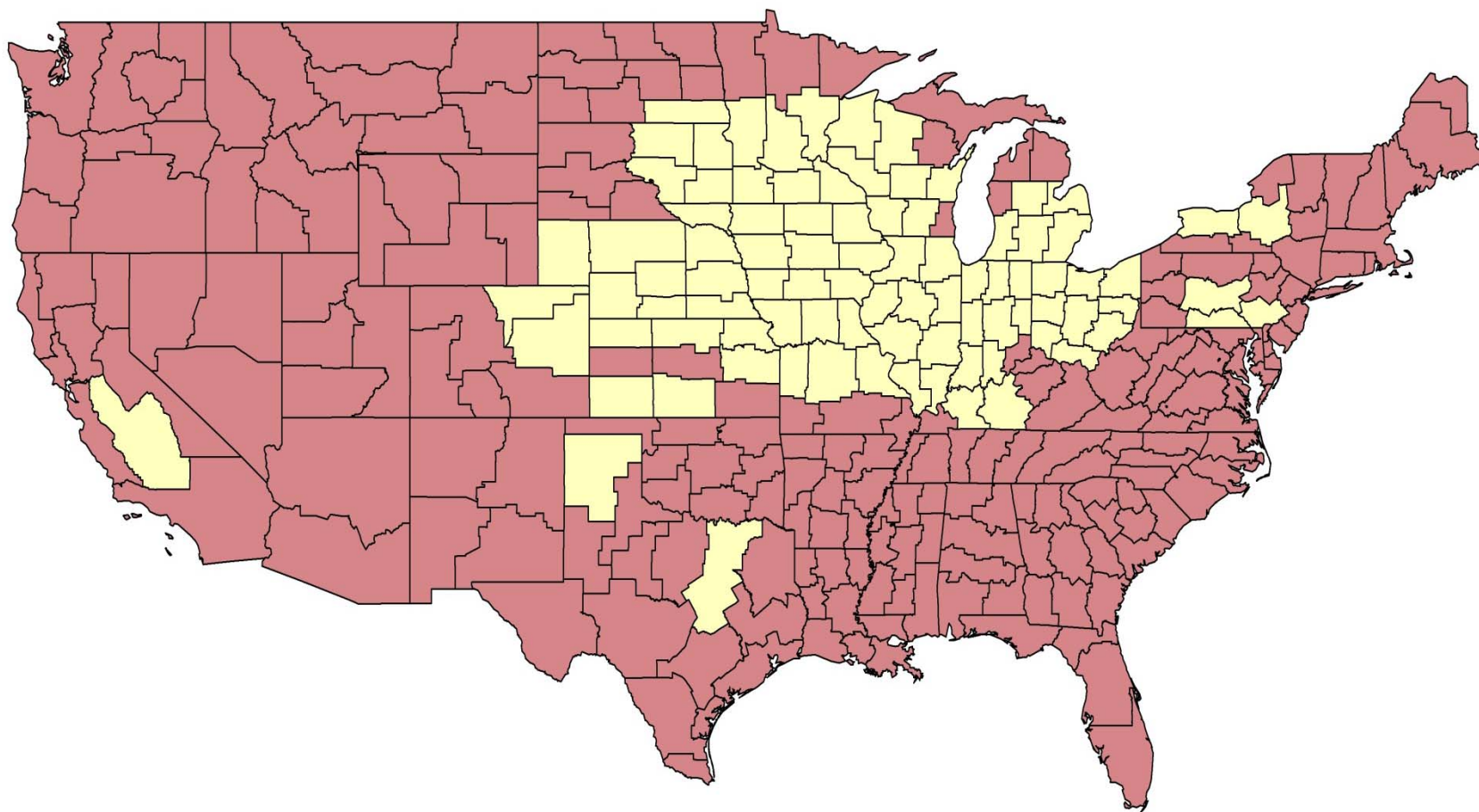
Seed markets?

- Increasing concentration in the seed industry associated with
 - Biotechnology revolution
 - Intellectual Property Protection revolution
 - Mergers
- Genetically modified (GM) seed as a bundle of basic seed and biotech traits
 - Single trait, double/triple/quadruple stacking...

3. Data

- Survey data of corn, cotton and soy farmers across the US over the period 2000 to 2007.
- Stratified random sample
 - Weighting scheme constructed using the census data
 - Our analysis focuses on crop reporting districts (CRD) reporting at least 10 farms sampled over the 8 years.

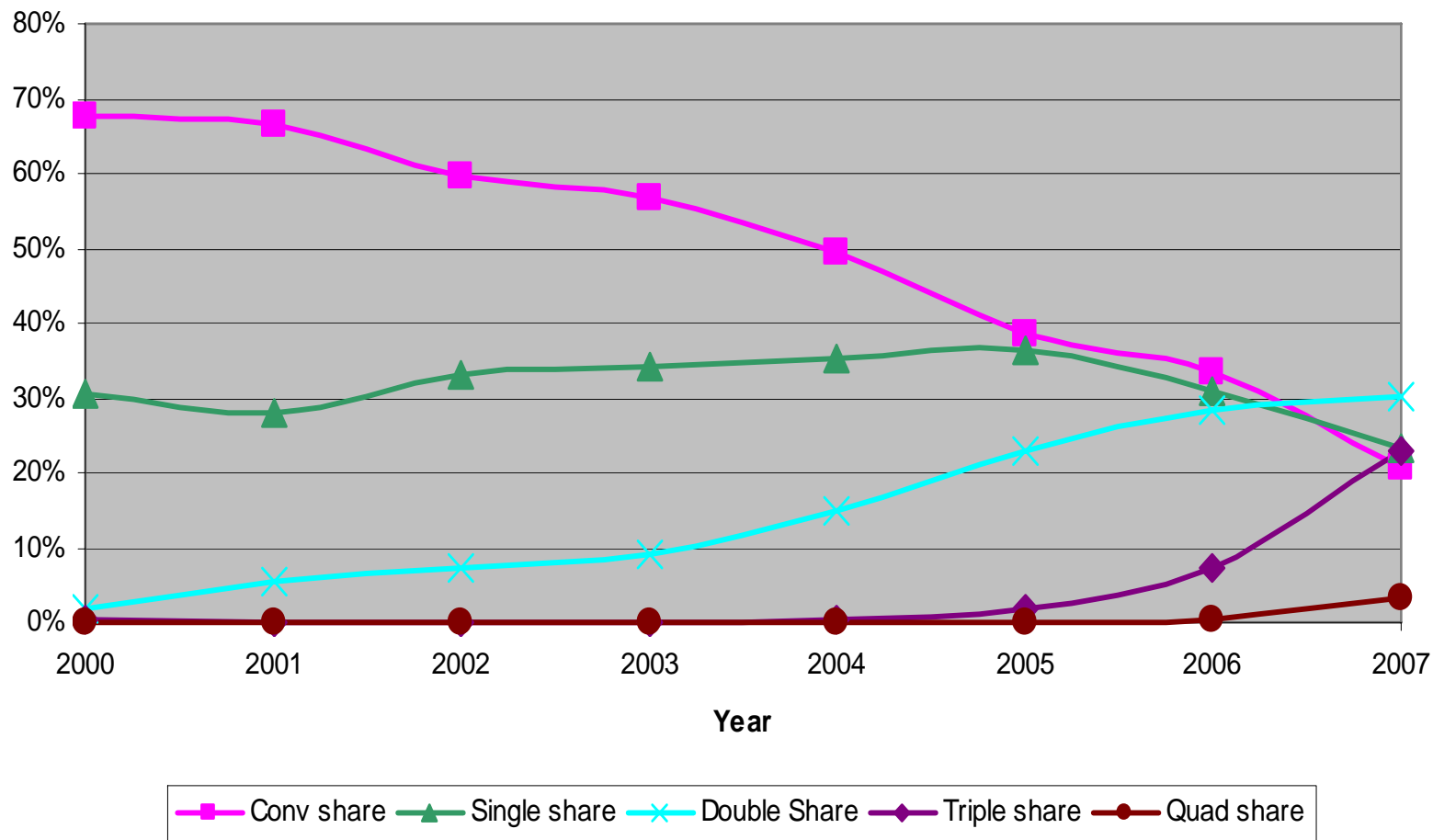
Corn Planting areas in our data, 2000-2007



Corn Seed portfolio

- Over 300 seed companies
- 5 (or 6) biotech companies
 - Monsanto, Syngenta, Dow/DuPont, Bayer, and BASF
- Spatially differentiated
 - Local market defined at the CRD level
- Biotech traits
 - Insect resistance traits
 - Bt for European Corn Borer (2)
 - Bt for Rootworm (3)
 - Herbicide tolerance traits
 - Roundup Ready/Glyphosate tolerance
 - Liberty Link
 - Clearfield
 - 2, 3 and 4 stacking systems

Figure 1. Corn seed adoption rates in the US, acreage share, 2000 – 2007



Dependant Var: Net Price (\$/bag)	Coefficient	Robust z statistics
<i>Market concentration effects</i>		
$H_{11}K_1$	13.13***	5.94
$H_{22}K_2$	-2.97	-1.02
$H_{33}K_3$	7.58	0.50
$H_{44}K_4$	20.11***	5.02
HH_{12}	17.22	1.52
HH_{13}	-58.19	-1.57
HH_{14}	35.55**	2.55
HH_{23}	-6.85***	-3.54
HH_{24}	6.68***	3.56
HH_{34}	6.82***	3.27

Conclusions

- Strong evidence against component pricing of biotech trait in corn seed market.
- Strong evidence of traditional market power-concentration in conventional and HT markets.
- Strong evidence of cross product market power effects.
- Evidence of cross product efficiency gains.
- Much evidence of spatial price discrimination.

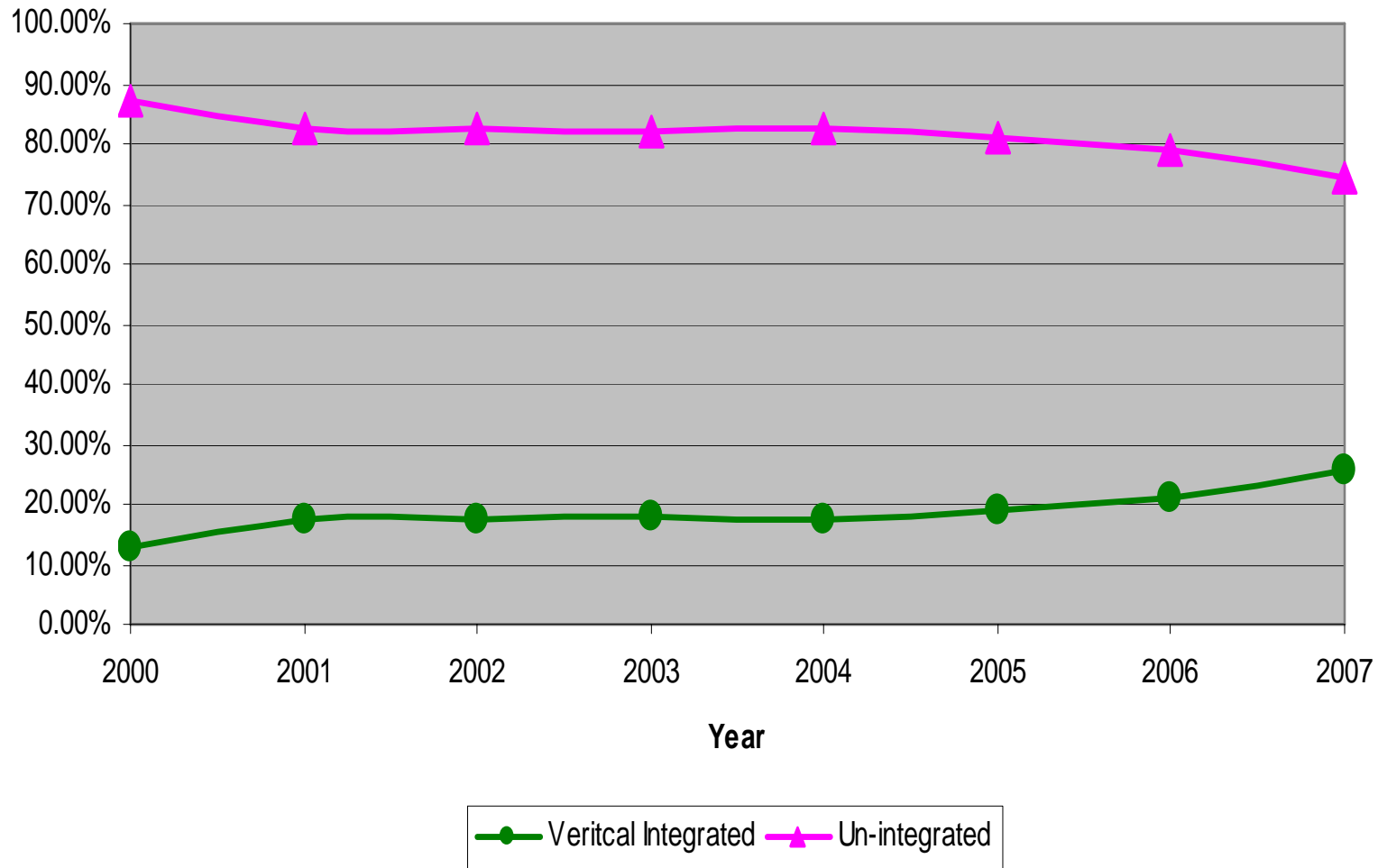
Estimated Lerner indexes

	Lerner Index (100 $\times L$)	Standard Error	t-ratio
K_1 (Conventional)	2.25*	1.236	1.818
K_2 (Bt-ECB)	-2.06	2.840	-0.724
K_3 (Bt-RW)	2.05	7.573	0.271
K_4 (HT1)	21.14***	2.539	8.325
K_{23}	2.88	5.755	0.500
K_{24}	14.39***	3.273	4.396
K_{34}	17.62**	7.614	2.314
K_{234}	15.32**	6.113	2.506

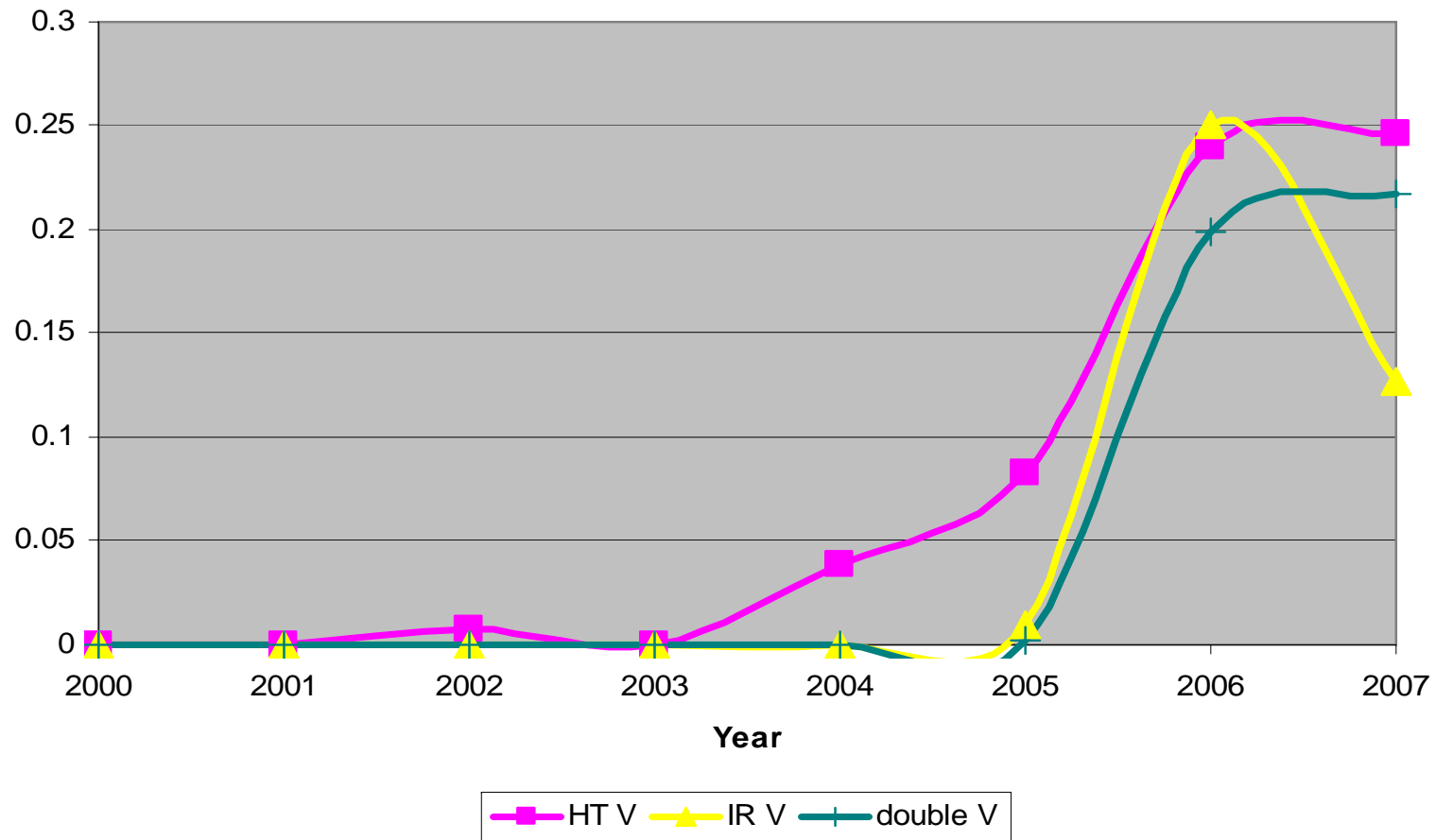
Cotton/Soy Study: Motivation

- Vertical organization vs. exercise of market power
 - Efficiency driven (Chicago School)
 - Market foreclosure (e.g. Whinston 2006)
 - Differentiated products?
 - Limited, mostly assume perfect substitutes and/or monopolist
- Vertical organization and optimal bundling?

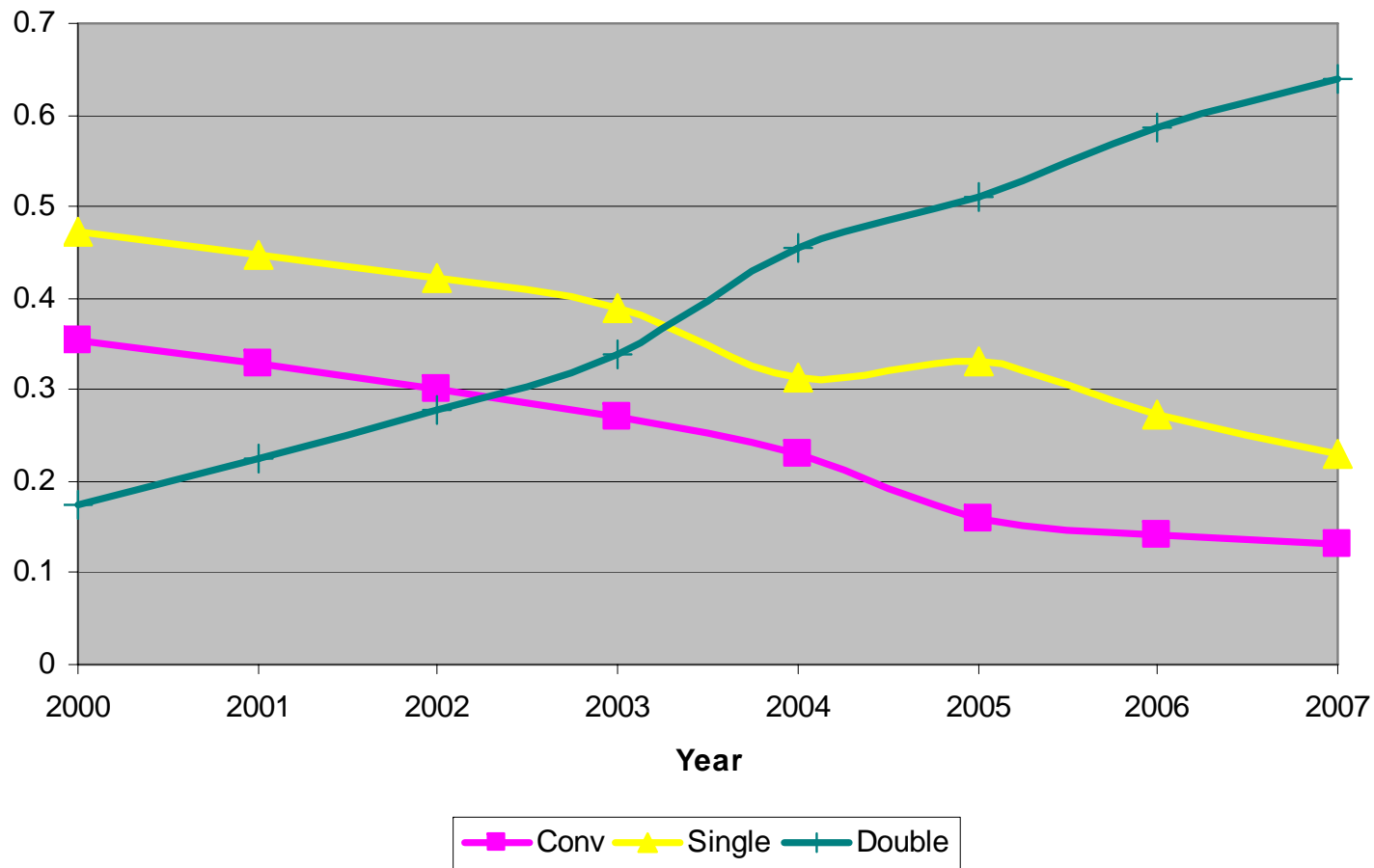
Vertical integrated vs. licensed **single trait soybean** seeds, acreage share 2000-2007.



Vertical integrated **cotton** seeds, acreage (relative) share 2000-2007.



Cotton seed adoption rates in the US, acreage share, 2000 – 2007



Cotton Estimation Results

<i>Seed type effects, benchmark is T_1: Conventional Seed</i>		
T_2D_ℓ (HT under licensing)	85.24***	11.71
T_2D_v (HT under vertical integration)	79.95***	7.37
T_3D_ℓ (IR under licensing)	75.13***	4.95
T_3D_v (IR under vertical integration)	130.32***	11.46
T_4D_ℓ (stacked seed under licensing)	120.20***	18.81
T_4D_v (stacked seed under vertical integration)	162.88***	25.09

Market Concentration

Own: $H_{11,\ell\ell} Y_{1\ell}$ (on conventional seed)	0.198***	4.41
$H_{21,\ell\ell} Y_{2\ell}$ (on conventional seed), and $H_{12,\ell\ell} Y_{1\ell}$ (on HT1 under licensing)	-0.075	-1.04
$H_{21,\ell v} Y_{2v}$ (on conventional seed), and $H_{12,\ell v} Y_{1\ell}$ (on HT1 under vertical integration)	-0.715***	-3.61
$H_{31,\ell\ell} Y_{3\ell}$ (on conventional seed), and $H_{13,\ell\ell} Y_{1\ell}$ (on IR1 under licensing)	-0.636**	-2.03
$H_{41,\ell\ell} Y_{4\ell}$ (on conventional seed), and $H_{14,\ell\ell} Y_{1\ell}$ (on stacked seed under licensing)	-0.180*	-1.90
$H_{22,\ell v} Y_{2\ell}$ (on HT under vertical integration)	4.249***	3.01
Own: $H_{22,\ell v} Y_{2v}$ (on HT under vertical integration)	4.482***	5.09
$H_{32,\ell v} Y_{3\ell}$ (on HT under vertical integration), and $H_{23,\ell v} Y_{2v}$ (on IR under licensing)	6.824***	3.10

$H_{42,lv} Y_{4l}$ (on HT under vertical integration), and $H_{24,vl} T_4 D_l Y_{2v}$ (on stacked seed under licensing)	-5.735***	-3.36
Own: $H_{22,ll} Y_{2l}$ (on HT under licensing)	0.061	0.39
$H_{22,vl} Y_{2v}$ (on HT under licensing)	1.643***	2.64
$H_{32,ll} Y_{3l}$ (on HT under licensing), and $H_{23,ll} Y_{2l}$ (on IR under licensing)	0.937	0.91
$H_{42,ll} Y_{4l}$ (on HT under licensing), and $H_{24,ll} Y_{2l}$ (on stacked seed under licensing)	-0.495**	-2.45
Own: $H_{33,ll} Y_{3l}$ (on IR under licensing)	7.573*	1.74
$H_{43,ll} Y_{4l}$ (on IR under licensing), and $H_{34,ll} Y_{3l}$ (on stacked seed under licensing)	-2.665***	-3.01
Own: $H_{44,ll} Y_{4l}$ (on stacked under licensing)	1.248***	5.37

Major Findings

- Sub-additivity in stacked seed prices.
- Own-Hs ($H_{11,\ell\ell}$, $H_{22,vv}$, $H_{22,\ell\ell}$, $H_{33,\ell\ell}$, and $H_{44,\ell\ell}$): trad. market power is pres.
- Cross Hs involving conv. seed ($H_{21,\ell\ell}$, $H_{21,v\ell}$, $H_{31,\ell\ell}$, $H_{41,\ell\ell}$): complementarities
- HT market cross effects ($H_{22,\ell v}$, $H_{22,v\ell}$) support substitution, with much stronger effects emanating from vertical int. market.

	Scenario I: from 2002 to 2004		Scenario II: from 2005 to 2006	
	Estimated Effect	Standard Error	Estimated Effect	Standard Error
<i>Conventional Seed, T₁</i>				
Total Effect	-4.34***	1.53	-1.70***	0.53
H Effect	0.71	0.98	2.32***	0.50
Y Effect	-5.04***	1.02	-4.02***	0.82
<i>Licensed HT Biotech Seed, T_{2ℓ} Nothing Significant</i>				
<i>Vertically Integrated HT Biotech Seed, T_{2v}</i>				
Total Effect	-23.33***	7.30	39.80***	7.67
H Effect	11.14	10.41	52.28***	16.53
Y Effect	-34.47**	16.92	-12.47	11.20
<i>Licensed IR Biotech Seed, T_{3ℓ} Nothing Significant</i>				
<i>Licensed HT/IR Stacked Biotech Seed, T_{4ℓ}</i>				
Total Effect	12.51	10.20	18.56***	3.09
H Effect	15.69***	5.78	12.99***	5.16
Y Effect	-3.18	6.67	5.57	5.24

Simulations Major Findings

- Subadditivity in stacked market
- Vertical Integration in HT market strongly linked to market power.
- Licensed single trait cottonseed products not a source of market power
- Entry from 2002-2004 had procompetitive effect. Merger in 2005 had anticompetitive effect.
- Y-effects important