I want to address three specific aspects of agricultural risk management:

▶ Recent developments in price volatility and yield risk
▶ The role of policy:
  ▶ Subsidized crop insurance with examples from the massive US program ($115 billion in liability in 2011)
  ▶ The 2012 US Farm Bill, which is currently being debated in Congress (with disturbing developments)
▶ Very briefly review recent research on developments in the empirical modeling of risk with a focus on revenue insurance (combining aspects of dependent yield and price risks)
Corn Yields Continue to Advance
Tremendous Gains Made Over Last Ten Years

Source: USDA NASS

Goodwin (NCSU): June 29, 2012
Adoption of Biotech Crops in the US

Growth in adoption of genetically engineered crops continues in the U.S.

Percent of planted acres

Data for each crop category include varieties with both HT and Bt (stacked) traits.
Recent Price Volatilities

Average Weekly Nearby Futures Prices for US Corn, Soybeans, and Wheat 1/8/1960-6/6/2011

Post 2007 Harvest involved unprecedented price levels and price volatility in corn, soybean, and wheat prices.
What’s Driving Price Volatilities?

US ethanol policy has some relevance
## Some Perspective

### Net Cash Income in 2011F

#### Income Statement U.S. Farm Sector 2007-2011F

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Receipts</th>
<th>Crops</th>
<th>Livestock</th>
<th>Direct Govt. Pay</th>
<th>Gross Cash Income</th>
<th>Cash Expenses</th>
<th>NET CASH INCOME</th>
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<tbody>
<tr>
<td>2007</td>
<td>288.5</td>
<td>150.1</td>
<td>138.5</td>
<td>11.9</td>
<td>318.0</td>
<td>240.6</td>
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<td>2008</td>
<td>316.7</td>
<td>175.0</td>
<td>141.6</td>
<td>12.2</td>
<td>350.4</td>
<td>261.8</td>
<td>88.6</td>
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<tr>
<td>2009</td>
<td>288.6</td>
<td>168.3</td>
<td>120.3</td>
<td>12.2</td>
<td>322.8</td>
<td>248.4</td>
<td>74.4</td>
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<tr>
<td>2010</td>
<td>314.4</td>
<td>172.9</td>
<td>141.4</td>
<td>12.4</td>
<td>345.0</td>
<td>252.7</td>
<td>92.3</td>
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<tr>
<td>2011</td>
<td>365.9</td>
<td>220.6</td>
<td>165.4</td>
<td>10.6</td>
<td>396.1</td>
<td>286.2</td>
<td>109.9</td>
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<tbody>
<tr>
<td>Cash Receipts</td>
<td>9.8%</td>
<td>-8.9%</td>
<td>8.9%</td>
<td>16.4%</td>
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<tr>
<td>Crops</td>
<td>16.6%</td>
<td>-3.8%</td>
<td>2.7%</td>
<td>27.6%</td>
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<tr>
<td>Livestock</td>
<td>2.2%</td>
<td>-15.0%</td>
<td>17.5%</td>
<td>17.0%</td>
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<tr>
<td>Direct Govt. Pay</td>
<td>2.5%</td>
<td>0.0%</td>
<td>1.6%</td>
<td>-14.5%</td>
</tr>
<tr>
<td>Gross Cash Income</td>
<td>10.2%</td>
<td>-7.9%</td>
<td>6.9%</td>
<td>14.8%</td>
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<tr>
<td>Cash Expenses</td>
<td>8.8%</td>
<td>-5.1%</td>
<td>1.7%</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

NET CASH INCOME: 109.9%

Source: [http://ers.usda.gov/Briefing/Farmincome/Data/nf_t2.htm](http://ers.usda.gov/Briefing/Farmincome/Data/nf_t2.htm)
Farm Household Income

Household Incomes; Source: USDA-ERS Farm Household Economics and Well-Being Briefing Room;
(http://www.ers.usda.gov/Briefing/WellBeing/farmhouseincome.htm)
Farm Household Wealth

Cumulative distribution of wealth among households, 2007


Household Wealth Distribution; Source: USDA-ERS Farm Household Economics and Well-Being Briefing Room

(Mary Aheam); (http://www.ers.usda.gov/Briefing/WellBeing/farmhouseincome.htm)
US Senate passes 2012 Farm Bill
Important Points

- Price levels and volatilities have increased tremendously, appearing to have reached a new equilibrium.
- This fact is shaping the direction of US policies:
  - US farm income at record high levels.
  - Support levels that are tied to revenues (prices and/or yields) are ratcheting the guarantee each year (currently only ACRE).
  - Outside of crop insurance, which is growing more costly every day, current policies are not delivering the transfers that farmers want (prices are too high).
  - Crop insurance is expanding significantly, both in the US and around the world.
  - Subsidized crop insurance is currently the most costly of US agricultural policies—approximately $9 billion each year.
- One of the great mysteries of agricultural policy—
  - Theory predicts risk averse agents will always take actuarially fair insurance.
  - Yet, crop insurance nearly always requires significant subsidies to get farmers to participate.

Goodwin (NCSU): June 29, 2012
Revenue Risk

So, we have two recent factors driving farm revenues
- High price levels and high volatility
- Upward trending yields with diminishing yield risk

This suggests a focus on revenue risk rather than just yield risk or price risk

The proper forecast and measurement of yield risk depends on the dependence of multiple sources of risk
- Price and yield (negative dependence)
- Yields for alternative crops (usually positive dependence)
- In the US (and elsewhere), this has corresponded to a significant shift toward revenue protection
  - Revenue protection accounts for about 75% of total liability in the federal program
  - Revenue guarantees play a major role in 2012 Farm Bill discussions
Salient facts about the US federal crop insurance program

- $115 billion in liability in 2011
- Total premium in 2011 was $12 billion
- Premium subsidy $7.42 billion
- Implies 62% subsidy
- Subsidy paid as a percentage of premium such that rising prices (which we have seen in recent years) imply much larger costs to taxpayers
- Touted as a “public–private” partnership (beware!)
- Latest CBO score $91 billion over 10 years
- Governed by complex (and favorable to companies) reinsurance agreement
- Recent calls for Congress to raise guarantee to 90% (“shallow losses”) of expected revenue
Premium Subsidies and Loss-Cost

1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009

- Subsidy
- Loss-Cost
US Crop Insurance Statistics: Participation

Source: Smith (2012)

**Graph Description:**
- **Total Acres Insured** (in Millions) and **Percentage of Planted Acres Insured** over the years 1981 to 2009.
- **Total Acres Insured** shows a steady increase from approximately 50 million in 1981 to around 300 million in 2009.
- **Percentage of Planted Acres Insured** starts around 20% in 1981 and increases to nearly 120% by 2009.

**Source:**
Data on insured acres were obtained from the US Department of Agriculture (USDA) Risk Management Agency (RMA); data on annual acres planted to crops were obtained from the USDA National Agricultural Statistical Service.

**Reference:**
Goodwin (NCSU): June 29, 2012
Source: Smith (2012)
Loss Ratios

Agricultural Markets and Risk Management Tools
Key Policy Questions

- Has the market failed to provide private crop insurance?
  - Systemic risk too much for private reinsurance?
  - CDG swap market (a form of reinsurance) has trillions in capacity
  - Difficulties in measuring “all risks” for MPCI coverage.

- Or, has the private market been crowded out by subsidies? (No private market can compete with 60% premium subsidy and A&O subsidy)

- A fundamental principle of the US program is that no subsidized plan should displace a private plan already in market. And yet . . .

- Private mechanisms for managing revenue risk have long been in use:
  - Options
  - Forward contracts
  - Private specific peril insurance
Key Research Issues

Things that Fabian and I will be working on—

- Demand for insurance
- Why do we always see large subsidies being needed for participation?
- Adverse selection and distortions in participation
- Moral hazard—do subsidies induce distortions?
- First principles—risk subsidies induce more risk
- Heterogeneity in benefits may cause distortions
- Revenue insurance has ratcheting support level—WTO implications? Distortions?
- What is the role for private crop insurance?
- The utility of index insurance
- How does one address tail risk with multiple (dependent) sources of risk?
Spatial Heterogeneity of Loss Ratios

2000-2010 Average Loss-Ratio Based on Farmer-Paid Premium
Indemnities/(Total Premium - Premium Subsidy)
The 2012 Farm Bill and “Shallow Losses”

- Current crop insurance limited to 85% coverage (expected yield/revenue)
- US Senate passed 2012 Farm Bill June 21, 2012 (now goes to House)
  - Will cost almost $1 trillion over 10 years
  - Eliminates direct payments ($5 billion/year)
  - Eliminates CCP and ACRE
  - Introduces “shallow loss coverage” to cover part of the 15% deductible
  - Predicted to save $23 billion
  - However, that estimate is based on current price trends
  - We have shown that prices at levels recently seen would raise spending significantly
  - Most certainly would be challenged in WTO
  - Coupled support—60/75% of acreage is basis for payments
  - Last minute amendment restored conservation compliance as requirement for insurance subsidies
Lessons from the 2008-2012 ACRE Program

Illinois Corn Yield and National Corn Price
Five-Year Olympic Yield Average and Two-Year Price Average

Year

Price
3.0 3.5 4.0

Yield
120 140 160

Goodwin (NCSU): June 29, 2012
Agricultural Markets and Risk Management Tools
Lessons from the 2008-2012 ACRE Program

Illinois ACRE State Revenue Guarantee
90% of Product of Five-Year Olympic Yield Average and Two-Year Price Average

Year


Revenue

200 300 400 500 600
Issues in Revenue Coverage—Dependence

- Correlation relationships play very important role in pricing revenue coverage
- Livestock margin plans have $1.1 billion in liability
- Recently introduced livestock margin plans involve multiple overlapping options contracts
- Margin plans:
  - Cover margin between input prices and output price (e.g., cattle prices, hog prices, milk prices, corn prices, soybean meal prices)
  - Structured as Asian option
  - Requires estimation of a large number of different correlation relationships
  - Little attention has been paid to how these dependent relationships should be modeled
- Remember that price insurance is readily available in the private markets (options markets) but without taxpayer subsidies
State Dependence in Spatial Correlation (Goodwin 2001):

Figure 2. Pearson correlation coefficients vs. distance: normal yield years

Figure 3. Pearson correlation coefficients vs. distance: extreme yield years
Revenue Rate and Correlation

Effect of Different Correlation Values on Revenue Insurance Premium

![Graph showing the effect of different correlation values on revenue insurance premium.]
A copula is a function that joins the marginal distribution functions to form the multivariate distribution function.

For an m-variate function $F$, the copula associated with $F$ is a distribution function $C : [0, 1]^m \to [0, 1]$ that satisfies

$$F(y_1, \ldots, y_m) = C(F_1(y_1), \ldots, F_m(y_m)),$$
Our Approach

- Use common methods (with Gaussian copula as benchmark) to estimate joint distributions for yields and prices.
- Illustrative example considers a portfolio comprised of an equivalent number of acres of corn and soybeans for four prominent Illinois counties.
- Consider a much broader approach to estimating the joint distribution—Vine Copulas.
- Use model selection criteria to evaluate alternatives and to choose relevant copulas at each point in the vine.
- Data-driven process to select from a range of 17 different copulas: Gaussian, Student t, Clayton, Gumbel, Frank, Joe, Clayton-Gumbel, Joe-Gumbel, Joe-Clayton, Joe-Frank, (With rotated versions of all).
- Estimate by standard ML procedures.
### Table 6: Simulated Revenue Insurance Premium Rates

<table>
<thead>
<tr>
<th>Insurance Instrument</th>
<th>Clayton</th>
<th>Gumbel</th>
<th>Gaussian</th>
<th>t</th>
<th>Canonical Vine</th>
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<tr>
<td></td>
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<td></td>
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<tr>
<td>75% Revenue Guarantee</td>
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<tr>
<td>Corn Revenue County 1</td>
<td>0.0142</td>
<td>0.0113</td>
<td>0.0017</td>
<td>0.0020</td>
<td>0.0042</td>
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<td>Corn Revenue County 2</td>
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<td>0.0111</td>
<td>0.0014</td>
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<td>Corn Revenue County 3</td>
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<td>0.0118</td>
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<td>Soybean Revenue County 1</td>
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<td>Soybean Revenue County 2</td>
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<td>0.0024</td>
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<td>Corn Revenue Total</td>
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<td>Soybean Revenue Total</td>
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<td>0.0012</td>
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<td>0.0028</td>
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<td>Total Revenue</td>
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<td>0.0015</td>
<td>0.0003</td>
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<td>95% Revenue Guarantee</td>
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<td>Corn Revenue County 1</td>
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<td>0.0365</td>
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<td>Corn Revenue County 2</td>
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<td>0.0347</td>
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<td>Corn Revenue County 3</td>
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<td>Soybean Revenue Total</td>
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<td>Total Revenue</td>
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<td>0.0392</td>
<td>0.0288</td>
<td>0.0297</td>
<td>0.0375</td>
</tr>
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</table>
Summary and Conclusions

- US Congress shows little intent to significantly cut subsidies
- Though cuts in food stamps are being proposed
- Seems to be little concern about WTO obligations
- Shallow loss coverage appears to be an attempt to remove nearly all risk from agriculture
- Does anyone know of another small business sector that is treated this way?
- Ever expanding crop insurance raises concerns about distortions in behavior
- Subsidies for ACRE, ARC, revenue insurance, most certainly tied to the market price (WTO implications?)
- A very rich research agenda
  - Great data sets
  - A place where econometrics and policy intersect and have real-world implications
  - Still much we don’t understand about risk attitudes and subsidized insurance