A Broader Look at Risk Management: Eat Well, Sleep Well

Nicholas E. Piggott

Associate Professor and Extension Specialist

Dept. of Agricultural and Resource Economics

North Carolina State University

nick_piggott@ncsu.edu

Energy in Agriculture: Managing the Risk

June 27, 2006

Kansas City, Missouri

Eat Well, Sleep Well

- An adage pertaining to the risk/return trade-off is that the type of security an investor chooses depends on whether he or she wants to eat well or sleep well.
- Investing in high-risk, high-reward securities will offer you the potential to eat well, but the risky nature of these securities might prevent you from sleeping at night. By contrast, investing safely means that you will sleep well, but the low rate of return may keep you from eating well.

Source: http://financial-dictionary.thefreedictionary.com/

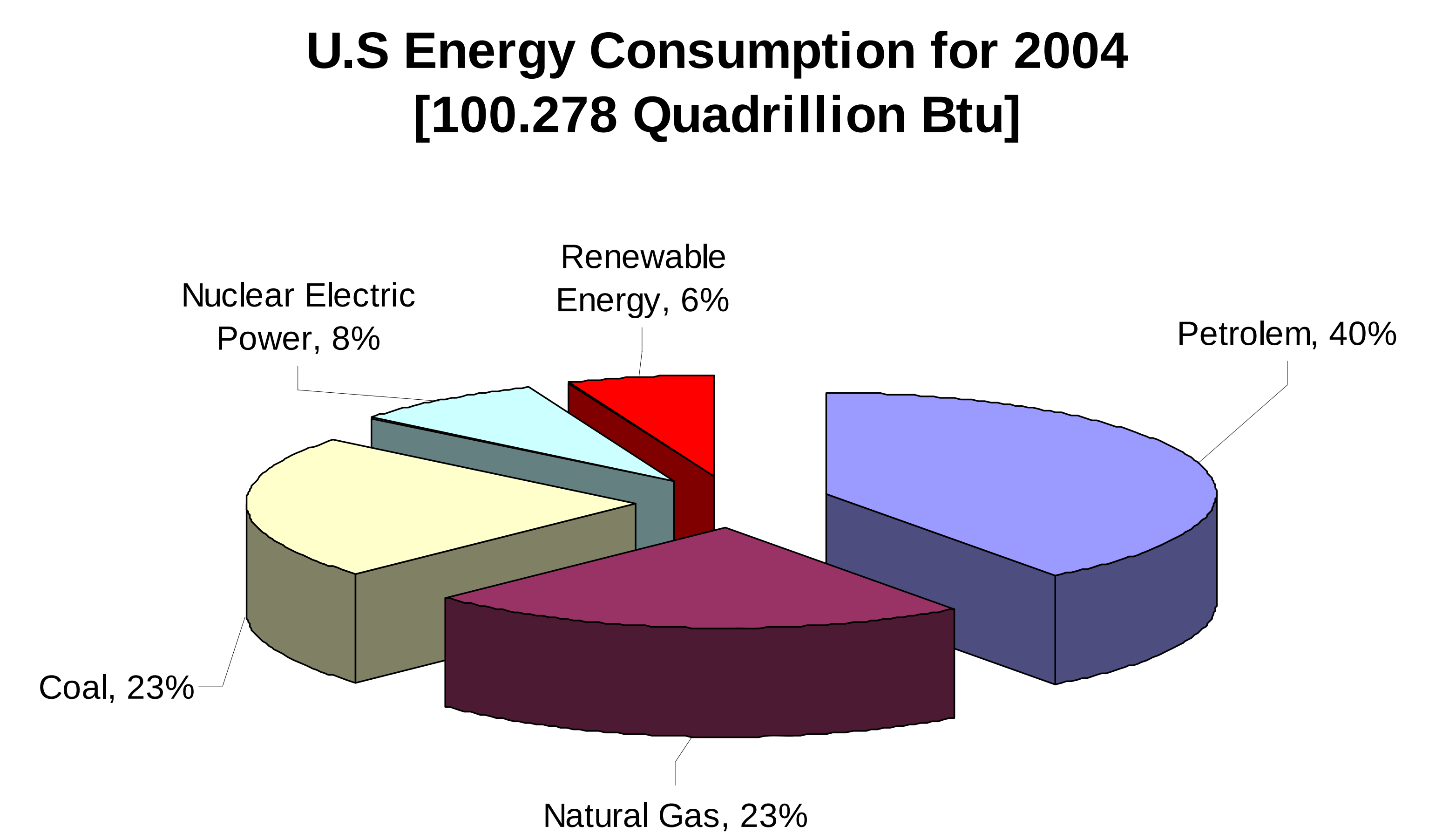
Basics of Energy

- Prices of basic energy (gasoline, electricity, natural gas, heating oil) are generally more volatile than other commodities
  - consumers are limited in their ability to substitute between fuels
  - demand is inelastic
  - increased reliance on foreign sources

Energy in U.S. Agriculture

- **Two important factors for agriculture:**
  - **Energy is a <u>crucial input</u> into agriculture**
    - **volatility in energy prices can impact the bottom line of agricultural production**
  - **Agriculture has the potential to <u>supply renewable energy</u> supplementing existing sources**
    - **potentially leading to a reduction in the volatility of fuel prices**

U.S. Energy Consumption



Source: Energy Information Administration (www.eia.doe.gov)

Nicholas E. Piggott ©

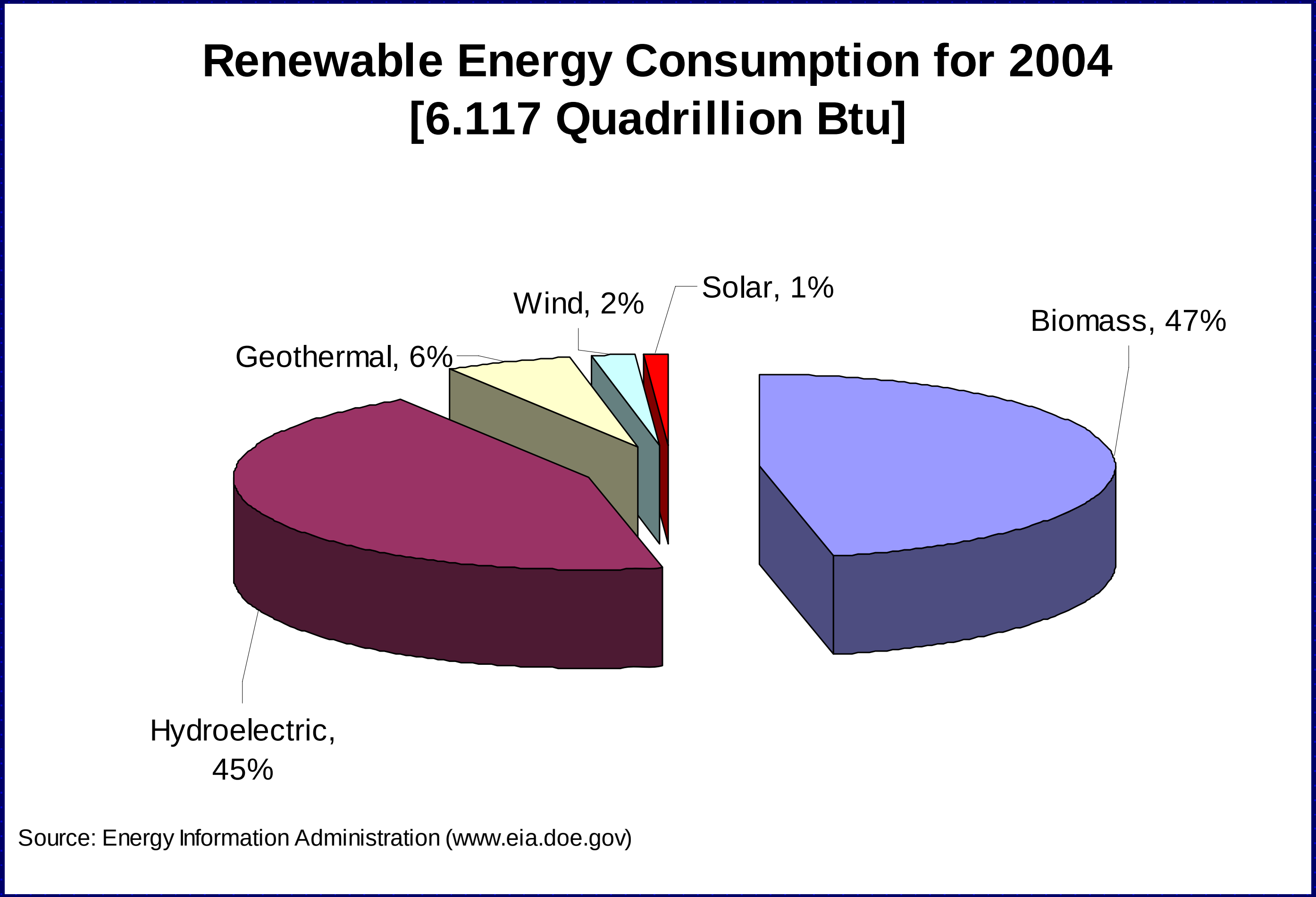
U.S. Energy Consumption….

- US energy consumption continues to grow
  - increased demand met mostly by increases in nuclear and petroleum
  - consumption is outpacing current renewal growth

Energy Source	% Change 2003 to 2004
Coal	0.90%
Natural Gas	-0.30%
Petroleum	2.77%
Nuclear Electric Power	3.43%
Renewable Energy	0.58%
Total	**1.58%**

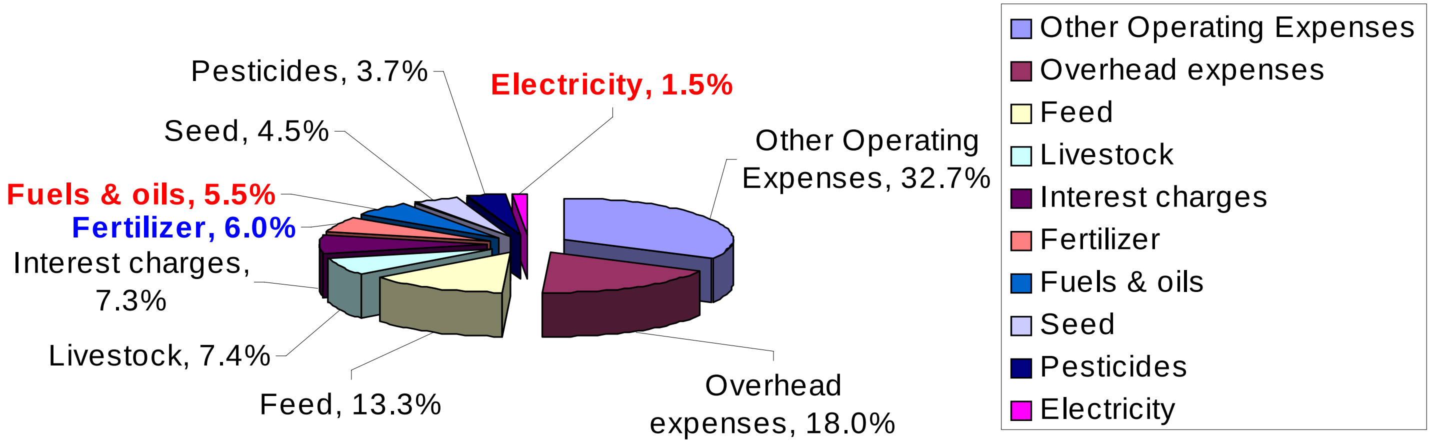
Source: Energy Information Administration (www.eia.doe.gov)

U.S. Renewable Energy Consumption



Energy Costs in US Farm Sector

Production Expenses U.S. Farm Sector 2006F [$229.2 billion]



Source: ERS-USDA

Energy & U.S. Agriculture

– **Energy is a <u>crucial input</u> into agricultural production making up about 13% of the $229.2 billion in production costs**

2006F	\$ Bill.	% of Total
Direct (Fuel + Electricity)	16.05	7.0%
Indirect (Fertilizers & lime)	13.78	6.0%
Total	29.83	13.0%

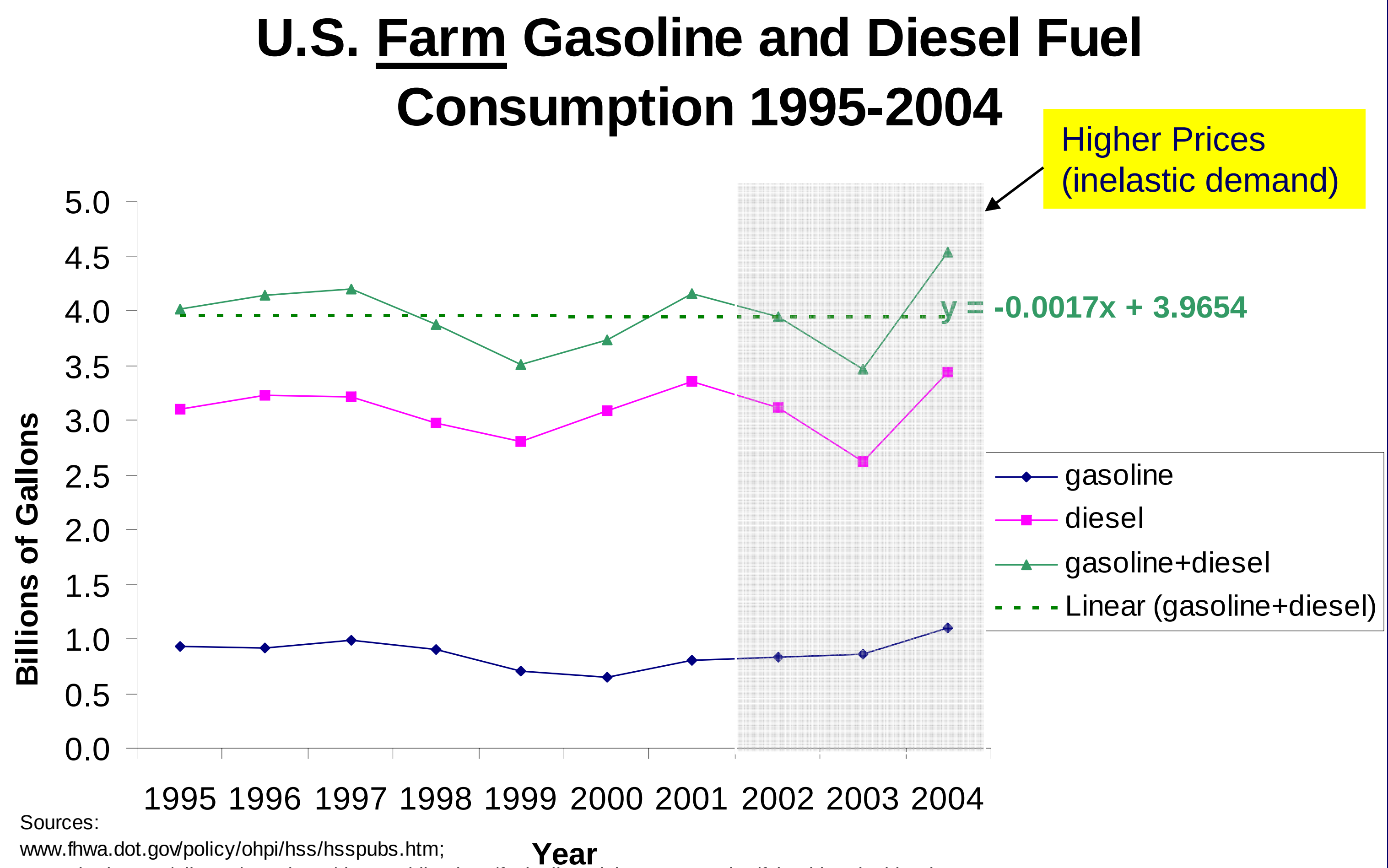
Energy & U.S. Agriculture….

– Agriculture has the potential to supply renewable energy, supplementing existing sources

- Renewable energy makes up 6% of total energy
  – about 47% comes from biomass

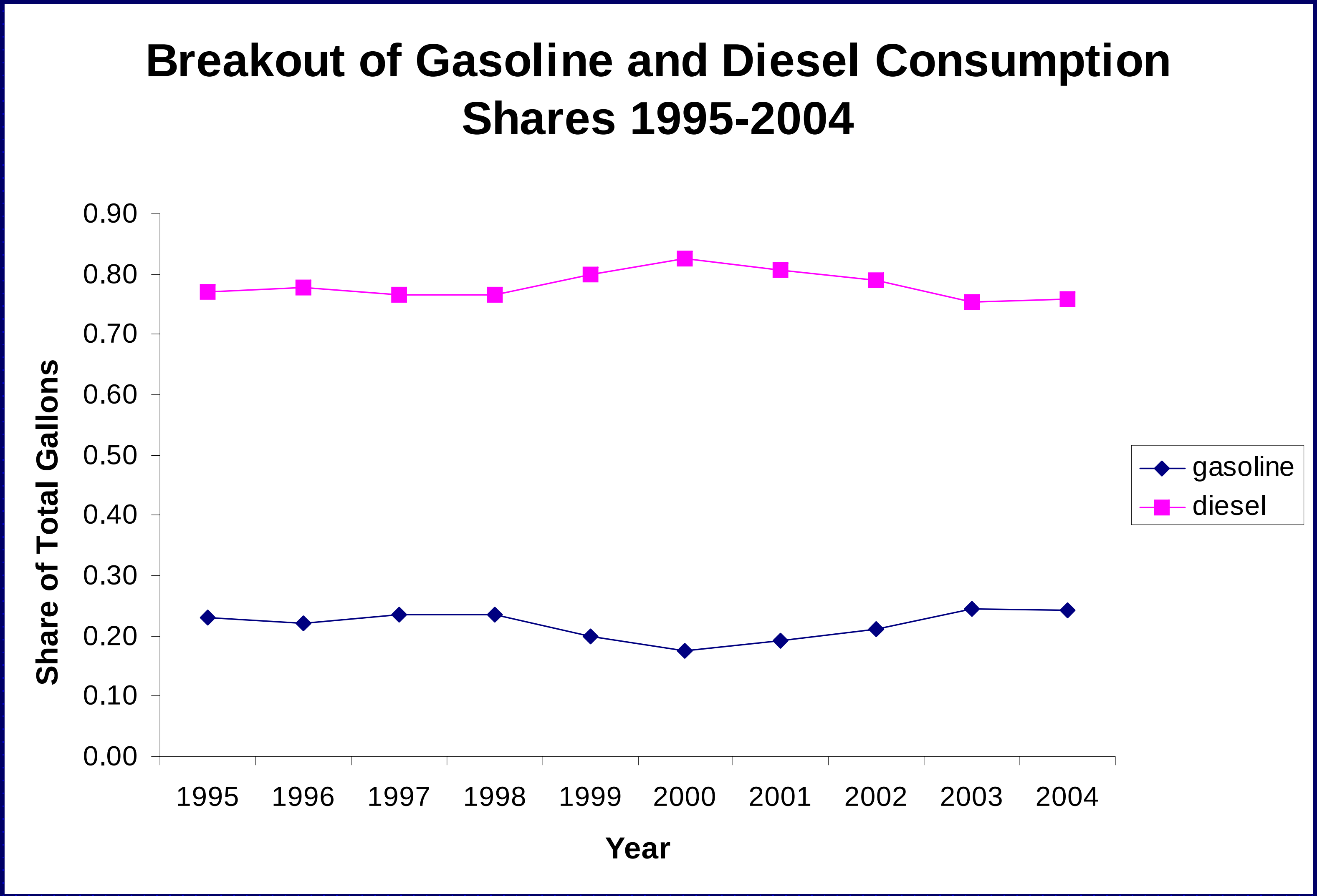
- This opportunity involves significant challenges in managing the risks involved

U.S. Farm Fuel Consumption



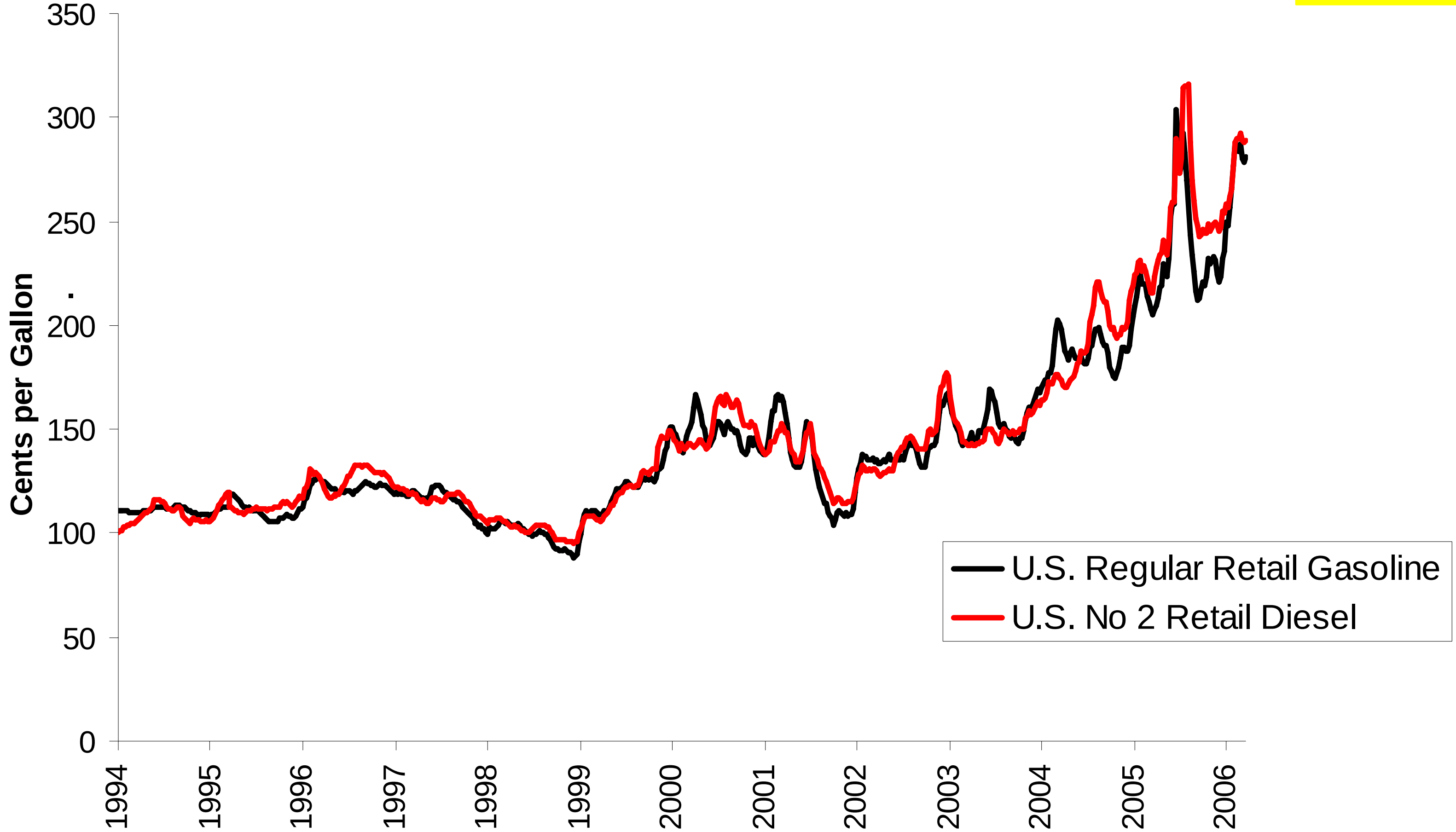
Sources:
www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm;
www.eia.doe.gov/oil_gas/petroleum/data_publications/fuel_oil_and_kerosene_sales/foks_historical.html;

U.S. Farm Fuel Consumption….



Weekly Retail Regular Gas and Diesel Prices
3/21/1994-6/5/2006

$\rho_{G,D}$=0.98



Source: http://eia.doe.gov/

Summary Statistics

Product: U.S. Retail Gasoline Prices & No 2 Diesel Sales

Periodicity: Weekly

Time Period: 3/21/1994-6/5/2006 (639 observations)

	Gasoline [a]	Diesel [b]	Difference [b]-[a]
	Cents Per Gallon		
Average	141.7	144.3	**2.7**
Std	41.7	45.3	**3.5**
CV	0.29	0.31	**0.02**
Min	88.5	95.3	6.8
Max	303.7	315.7	12.0
Range	215.2	220.4	5.2
Median	126.0	130.2	4.2
Skewness	1.56	1.68	0.1

Source:

U.S. Department of Energy, Energy Information Administration

http://eia.doe.gov/

Filenames: "PSWRGVWNUS.xls", "PSW18VWALL.xls"

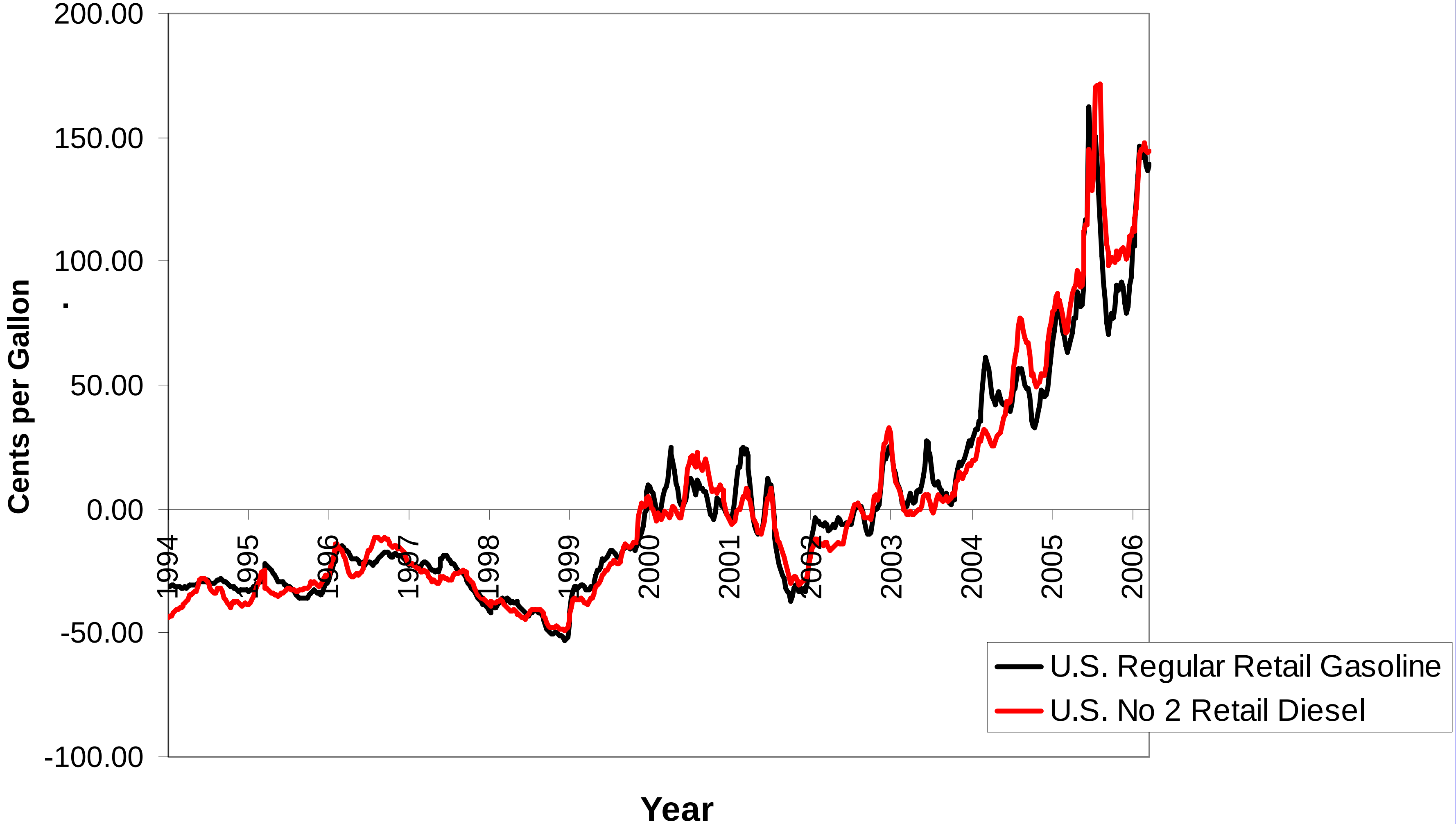
Coefficient of Variation (CV)

- **A measure of the degree of risk. Useful in comparing the relative riskiness of two series.**

$$CV = \frac{Std.\ Dev.}{Mean} = \frac{\sigma}{\mu}$$

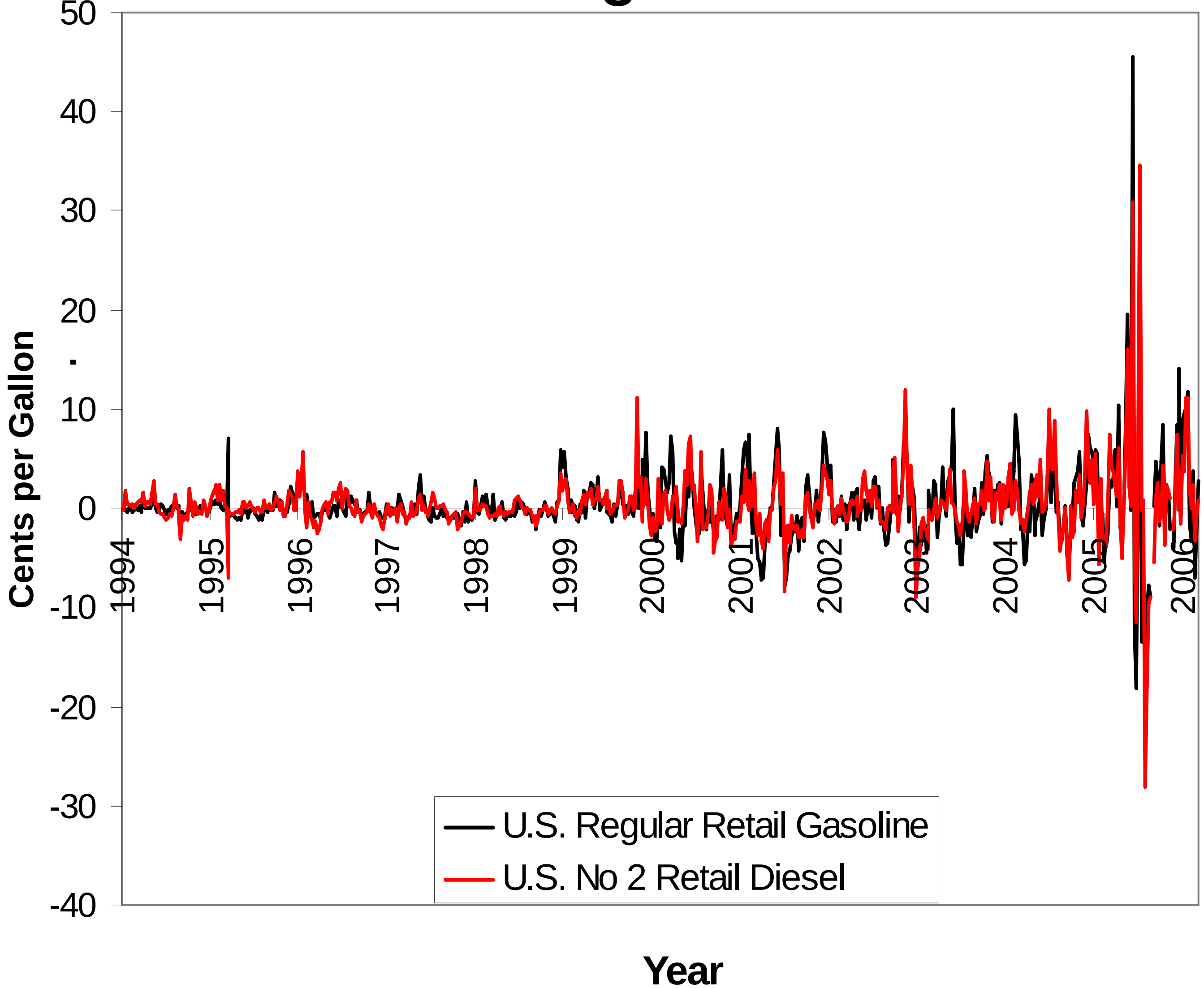
- **The CV is a <u>dimensionless number</u> that allows comparison of the variation of populations that have significantly different mean values. It is often reported as a percentage (%) by multiplying the above calculation by 100.**

Weekly Retail Regular Gas and Diesel Prices Deviations from Mean 3/21/1994-6/5/2006



Nicholas E. Piggott ©

Weekly Retail Regular Regular Gas and Diesel Price Changes 3/21/1994-6/5/2006



Nicholas E. Piggott ©

Asymmetric Price Changes

- A larger number of price **declines** for **gasoline** but more price **increases** for **diesel**

Weekly Prices Changes

Time Period:	3/21/1994-6/5/2006 (639 observations)				
	Gasoline [a]	%	Diesel [b]	%	[b]-[a]
Price Increase	282	44.2%	**314**	49.2%	32
Price Decrease	**337**	52.8%	301	47.2%	-36
Price Unchanged	19	3.0%	23	3.6%	4
Total	638	100.0%	638	100.0%	

Asymmetric Price Changes…

- **The magnitude of the average price increases is consistently <u>higher</u> for both gasoline and diesel**

Weekly Prices Changes
Time Period: 3/21/1994-6/5/2006 (639 observations)

	Gasoline Price [a]		Diesel Price [b]	
	Increase	Decrease	Increase	Decrease
Average	**2.67**	**-1.72**	**2.08**	**-1.54**
Std	3.79	2.30	3.27	2.43
CV	1.42	-1.33	1.57	-1.58
Min	0.10	-18.20	0.10	-28.10
Max	45.60	-0.10	34.60	-0.10
Range	45.50	18.10	34.50	28.00
Median	1.60	-0.90	1.10	-0.80

Fuel Costs Higher and More Volatile Post 2001

- **Significantly higher and more volatile gasoline and diesel prices post 2001**

	Gasoline 1994-2001 [a]	Diesel 1994-2001 [a]	Gasoline 2002-2006 [b]	Diesel 2002-2006 [b]	Gasoline [b]-[a]	Diesel [b]-[a]	Gasoline %	Diesel %
	Cents Per Gallon							
Average	119.93	121.40	179.97	184.77	**60.04**	**63.37**	**50.1%**	**52.2%**
Std	16.68	16.70	45.04	51.16	**28.36**	**34.46**	**170.1%**	**206.4%**
CV	0.14	0.14	0.25	0.28	**0.11**	**0.14**	**80.0%**	**101.3%**
Min	88.50	95.30	108.10	114.00	19.60	18.70	**22.1%**	**19.6%**
Max	166.40	167.00	303.70	315.70	137.30	148.70	**82.5%**	**89.0%**
Range	77.90	71.70	195.60	201.70	117.70	130.00	**151.1%**	**181.3%**
Median	116.90	117.05	169.80	170.00	52.90	52.95	**45.3%**	**45.2%**
Skewness	0.81	0.78	0.74	0.71	-0.08	-0.06	**-9.4%**	**-8.2%**

Post 2001 Fuel Prices

- Two important factors for agriculture
  - diesel usage makes up 78% of fuel usage
  - the CV for petroleum diesel has <u>doubled</u> from 0.14 to 0.28 from 1994-2001 to 2002-2006
  - weighted average CV for all fuels has increased from 0.14 to 0.27
- With fuel and oil making up 5.5% of production costs raises the risks of farming

Post 2002 Energy Prices….

- Because of
  - the increased variability of diesel prices
  - the dominant share of diesel usage
  - the limited substitutability between diesel and gasoline

these recent price phenomena potentially impact U.S. farmers more severely than more gasoline-dependent enterprises

What Can be Done to Manage the Price Risk?

1. Traditional hedging using current instruments
2. Development of an insurance product that provides a ceiling on the costs of energy
3. Further development and production of renewable energy technologies and supplementing traditional fossil fuels with ethanol and biodiesel
   - the portfolio effect and its impact on risk reduction (more details to follow)

Traditional Hedging

- Traditional hedging using current instruments?
  - there is no futures or options contracts for diesel fuel
  - to hedge diesel costs farmers must cross-hedge with heating oil futures or options
  - lumpy process as contracts are in 42,000 gallons increments
  - typically low participation rates from farmers
  - not a very attractive proposition overall

Insurance Product

- Development of an FCIC insurance product that insures energy costs?
  - currently there is no insurance product in the RMA portfolio that covers the cost of energy
  - a product that established a price ceiling by paying an indemnity when prices reach some trigger level would offset the price-risk
  - the recent increased volatility in energy costs could be sufficient to make it worthwhile now to develop such a product
  - a possibility deserving further consideration and investigation

Renewal Fuels

- **An UNAPPRECIATED aspect of renewable fuels…….**

Further development and production of renewable energy technology and supplementing traditional fossil fuels with ethanol and biodiesel blends have the potential to reduce price volatility

The Portfolio Effect on Renewable Energy Policy

- When developing and evaluating the economic viability of renewable energy, the focus has been on comparison of price differences between renewable energy and petroleum fuels

Price of ethanol vs. Price of gasoline

&

Price of biodiesel vs. Price petroleum diesel

The Portfolio Effect on Renewable Energy Policy..

- Not much attention has been given to <u>price volatility</u> of renewable fuels versus petroleum fuels
  - Notable exceptions include
    - Vedenov, Duffield, Wetzstein (2006) [*JARE*] with respect to conventional gasoline and ethanol
    - Tareen, Wetzstein, Duffield (2000) [*JAAE*] with respect to petroleum diesel and biodiesel

The Portfolio Effect on Renewable Energy Policy…

- The main results from their research
  - –switching to blends can be a sound economic decision if vehicle performance is not inhibited—more stable fuel prices
  - –increased volatility in gasoline and diesel markets may speed up adoption of less volatile renewable energy
  - –implications for existing incentives in how the volatility impacts trigger prices for adoption
  - –hinges on individuals degree of risk aversion

What is the Portfolio Effect for Fuel Blends?

- Blending petroleum fuels with renewable fuels can result in a more stable blended fuel price
- Two factors contribute to this……
  - –renewable fuels tend to have lower volatilities (a smaller standard deviation)
  - –the diversification effect if the prices of the two fuels are not perfectly correlated

Illustrative Example with Petroleum Diesel and Soy-B20

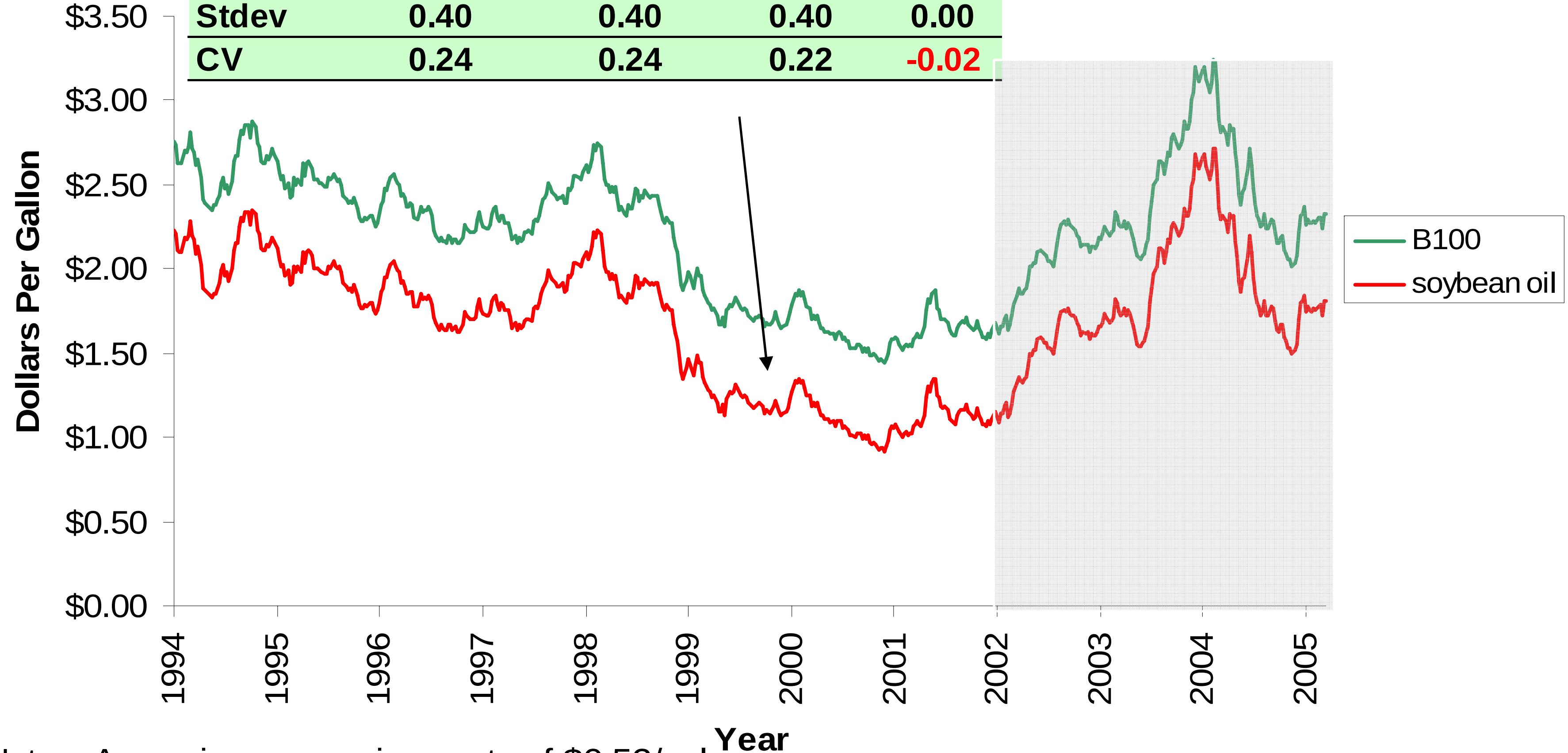
- Assumptions
  - –soybean oil as the feedstock for B20
  - –convert soybean oil price in $/lb to $/gallon by multiplying by 7.6 (1 gal. of soy oil is about 7.6 lbs)
  - –an additional $0.52 per gallon processing costs (Tareen, Wetzstein, Duffield (2000); Wither and Noordam (1996))
    - + $0.58/gal. transesterifcation cost
    - + $0.33/gal. overhead cost
    - - <u>$0.39/gal.</u> value of co-product glycerol

      <u>$0.52/gal.</u> processing cost

Weekly Soybean Oil and Projected Soy-B100 Prices for 1994-2005

$\rho_{B100,SO} = 1.0$

Soybean Oil ($/gal.)	1994-2005	1994-2001	2002-2005	π
Average	1.68	1.64	1.78	0.14
Stdev	0.40	0.40	0.40	0.00
CV	0.24	0.24	0.22	-0.02

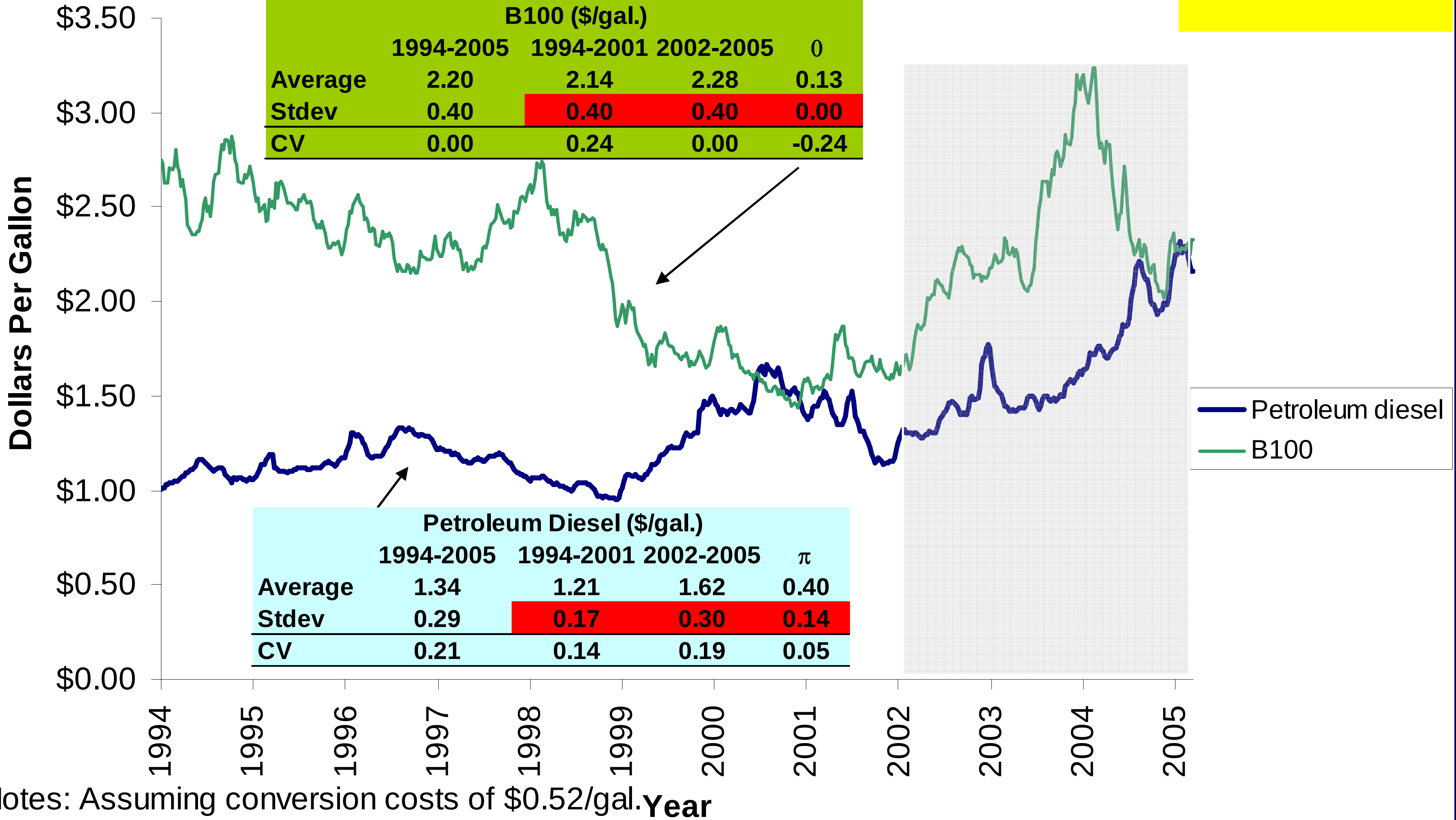


Notes: Assuming conversion costs of $0.52/gal.

Nicholas E. Piggott ©

Weekly Soy-B100 and Petroleum Diesel Prices for 1994-2005

$\pi_{B100,PD}$ = -0.09

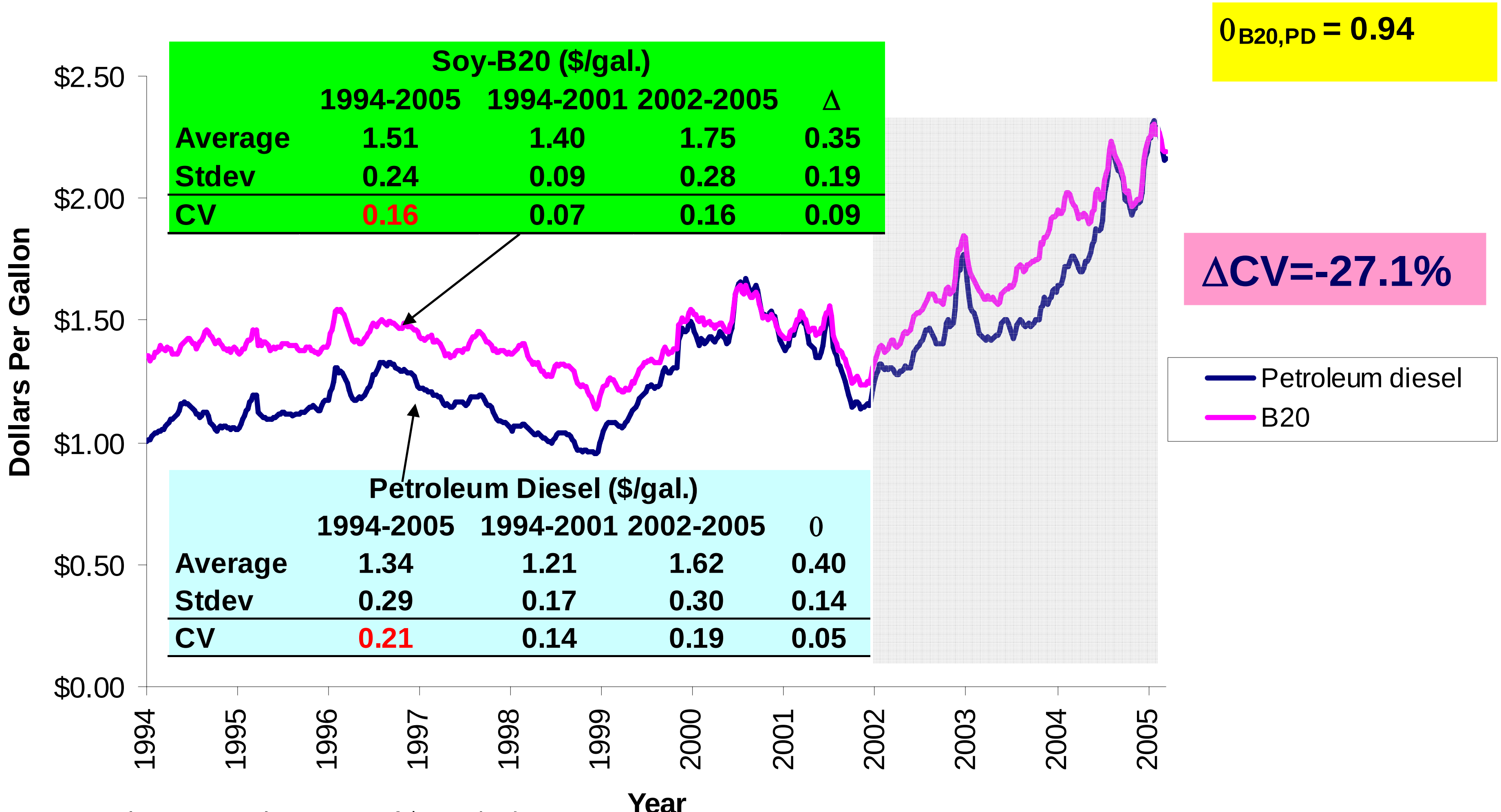


B100 ($/gal.)				
	1994-2005	1994-2001	2002-2005	0
Average	2.20	2.14	2.28	0.13
Stdev	0.40	0.40	0.40	0.00
CV	0.00	0.24	0.00	-0.24

Petroleum Diesel ($/gal.)				
	1994-2005	1994-2001	2002-2005	π
Average	1.34	1.21	1.62	0.40
Stdev	0.29	0.17	0.30	0.14
CV	0.21	0.14	0.19	0.05

Notes: Assuming conversion costs of $0.52/gal.

Weekly Soy-B20 and Petroleum Diesel Prices for 1994-2005

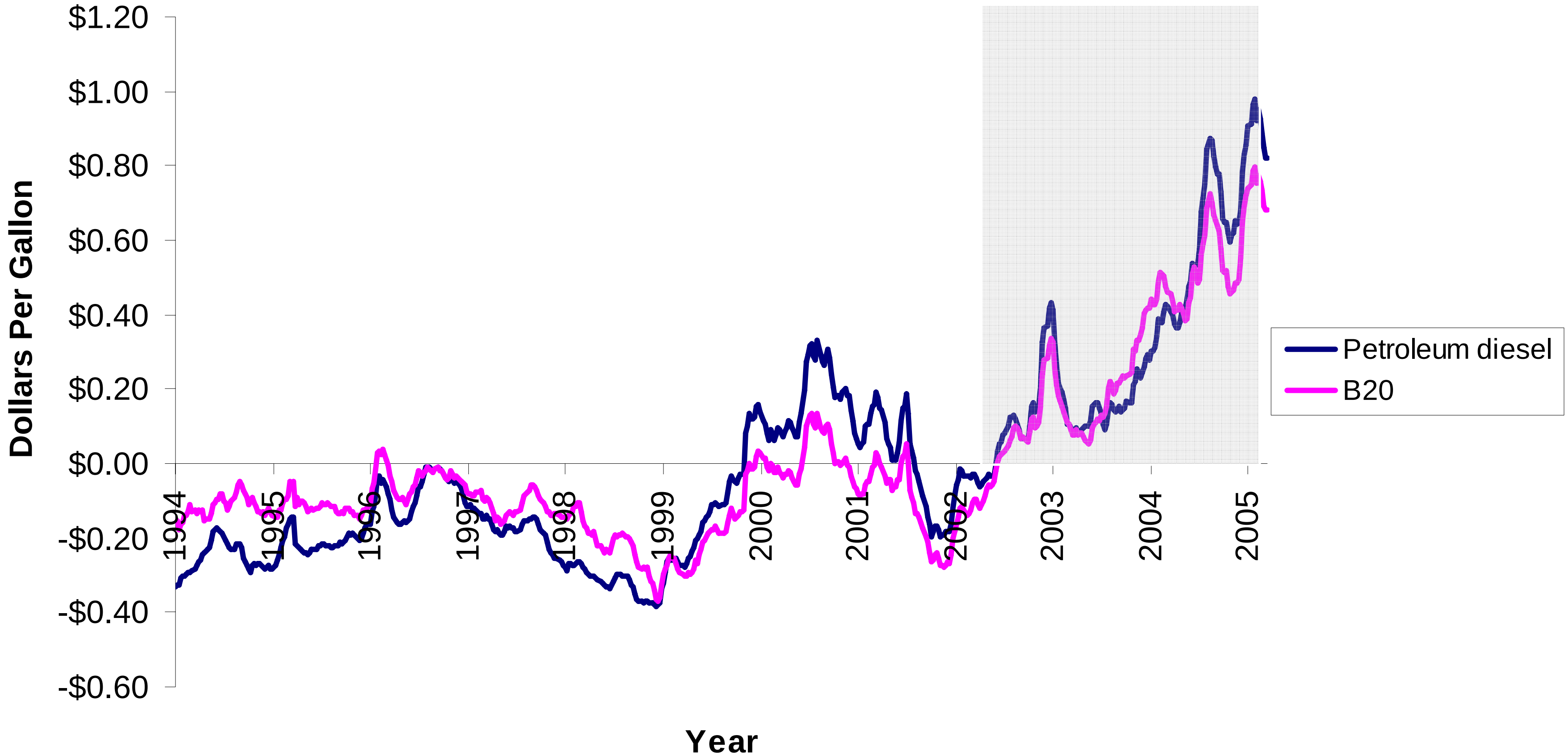


Soy-B20 ($/gal.)				
	1994-2005	1994-2001	2002-2005	Δ
Average	1.51	1.40	1.75	0.35
Stdev	0.24	0.09	0.28	0.19
CV	0.16	0.07	0.16	0.09

Petroleum Diesel ($/gal.)				
	1994-2005	1994-2001	2002-2005	0
Average	1.34	1.21	1.62	0.40
Stdev	0.29	0.17	0.30	0.14
CV	0.21	0.14	0.19	0.05

Notes: Assuming conversion costs of $0.52/gal.

Weekly Deviations from Mean Price Levels for Soy-B20 and Petroleum Diesel for 1994-2005



Notes: Assuming conversion costs of $0.52/gal.

The Risk-Return Trade-off With Diesel Blends: Eat Well, Sleep Well

Summary Statistics for Weekly Estimates 1994-2005					
			Biodiesel Blends		
	B100	Petroleum Diesel	B5	B10	B20
		$/gal			
Average	2.20	1.34	1.38	1.42	1.51
Std. Dev	0.40	0.29	0.27	0.26	0.24
CV	**0.18**	**0.21**	**0.20**	**0.18**	**0.16**

ΔCV=-27.1%

Summary

- US energy demand continues to grow
  - –outpacing increases in renewable energy with an increased reliance on foreign sources

- Post 2001 has seen dramatic increases in levels and volatility of gasoline and diesel prices
  - –these market conditions present further increased risk to agriculture for which energy is a crucial input

Summary…

- These market conditions also represent an opportunity for agriculture through the production of renewable energy

- This reduction in price volatility is just another potential benefit from the pursuit of more economically feasible renewable fuels

- An unappreciated aspect of renewable fuels is that they can help to stabilize fuel prices by blending petroleum fuels with renewable fuels
  – ethanol with gasoline (eg. E15)
  – biodiesel with petroleum diesel (B20)

Some Final Remarks for Agriculture

- **Renewable energy is a win-win for agriculture if feedstocks are agriculturally based by**
  - **increasing demand for agricultural products**
  - **without offsetting increases in supply there will be a positive price response**
  - **lowering the volatility of energy costs for all users involved as well as their own**

Some Final Remarks for Agriculture…..

- The production of agriculturally based alternative fuels brings more risk management challenges
  - –value-added initiatives magnify the need for effective risk management
- North Carolina has several initiatives and is strategically well situated from the demand side but with challenges on the supply side
  - biodiesel (soybeans)
  - ethanol (corn)
  - biggest challenge for producer owned co-ops is the magnified financial risk

Some Final Remarks for Agriculture….

- Risks for biomass based fuel production:
  - –the additional price and margin risk involved
    - biodiesel production involves the transformation from no longer selling soybeans into selling meal and biodiesel
  - –optimal plant location taking account of both input supply and output demand issues
  - –incentive compatible contracts to secure sufficient feedstock
    - feedstock prices will most likely increase in the region and you want to avoid contract defaults
  - –sufficient cash reserves to ride-out the inevitable market troughs

The Risk-Return Trade-off with Fuel Blends

- Not surprisingly, we have shown with an empirical example that with some effective risk management strategies involving fuel blends some balance can be struck between risk-return trade-off, meaning it may be possible to

Eat Better ~~Well~~ , Sleep Better ~~Well~~

THANK YOU

- Electronic version available at

www.ag-econ.ncsu.edu/faculty/piggott/piggott.html