Sustainability in Biofuel and Bioenergy Sectors: The Role of Public Policy

Hayri Önal

University of Illinois at Urbana-Champaign

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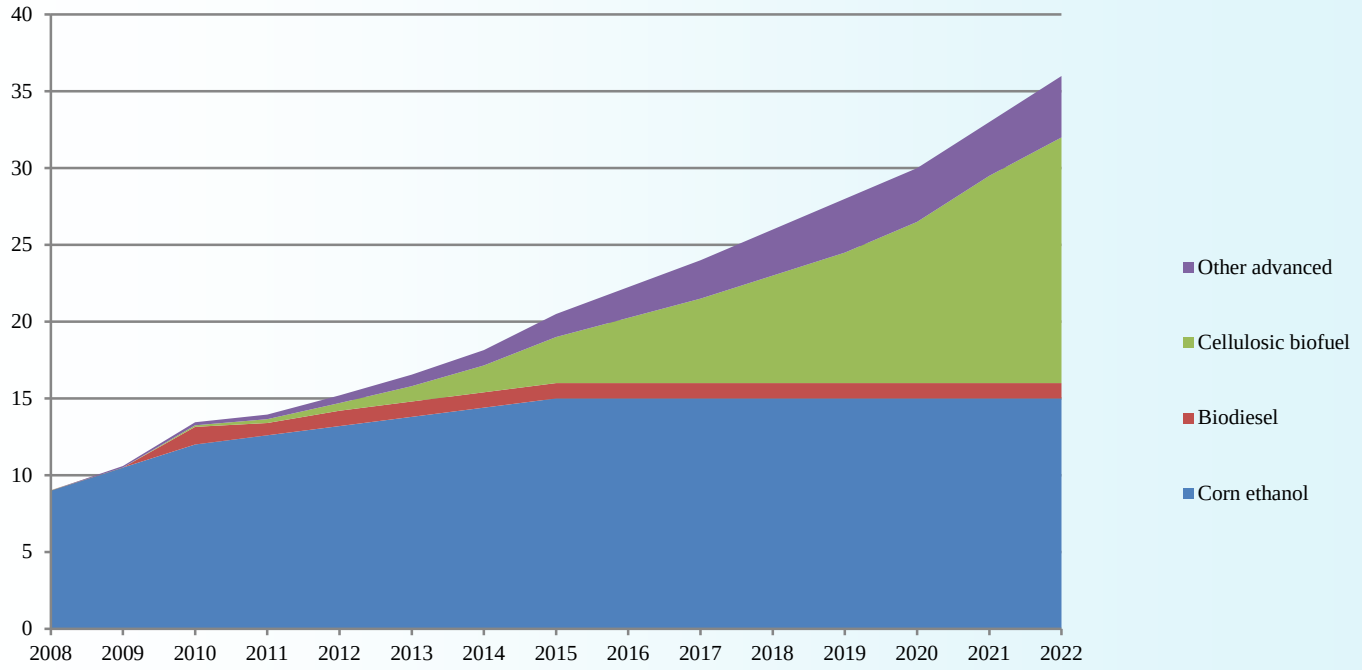
Recent Situation in Three Major Biofuel Markets

- **EU**: The Renewable Energy Directive requires that by 2020 the share of biofuels to be >10% of the conventional fuel consumption. Biofuels must reduce GHG eemissions by at least 35% relative to the replaced fossil fuel. In 2013, the EU parliament proposed a cap that restricts bifouels from food crops to be <7% of the mandate.
- **US**: RFS mandates blending **136** blt of renewable biofuels with oil-based fuels by 2022. Up to **56** blt can be corn-based ethanol, >**80** blt must be advanced biofuels, of which **61** blt must be cellulosic biofuels.

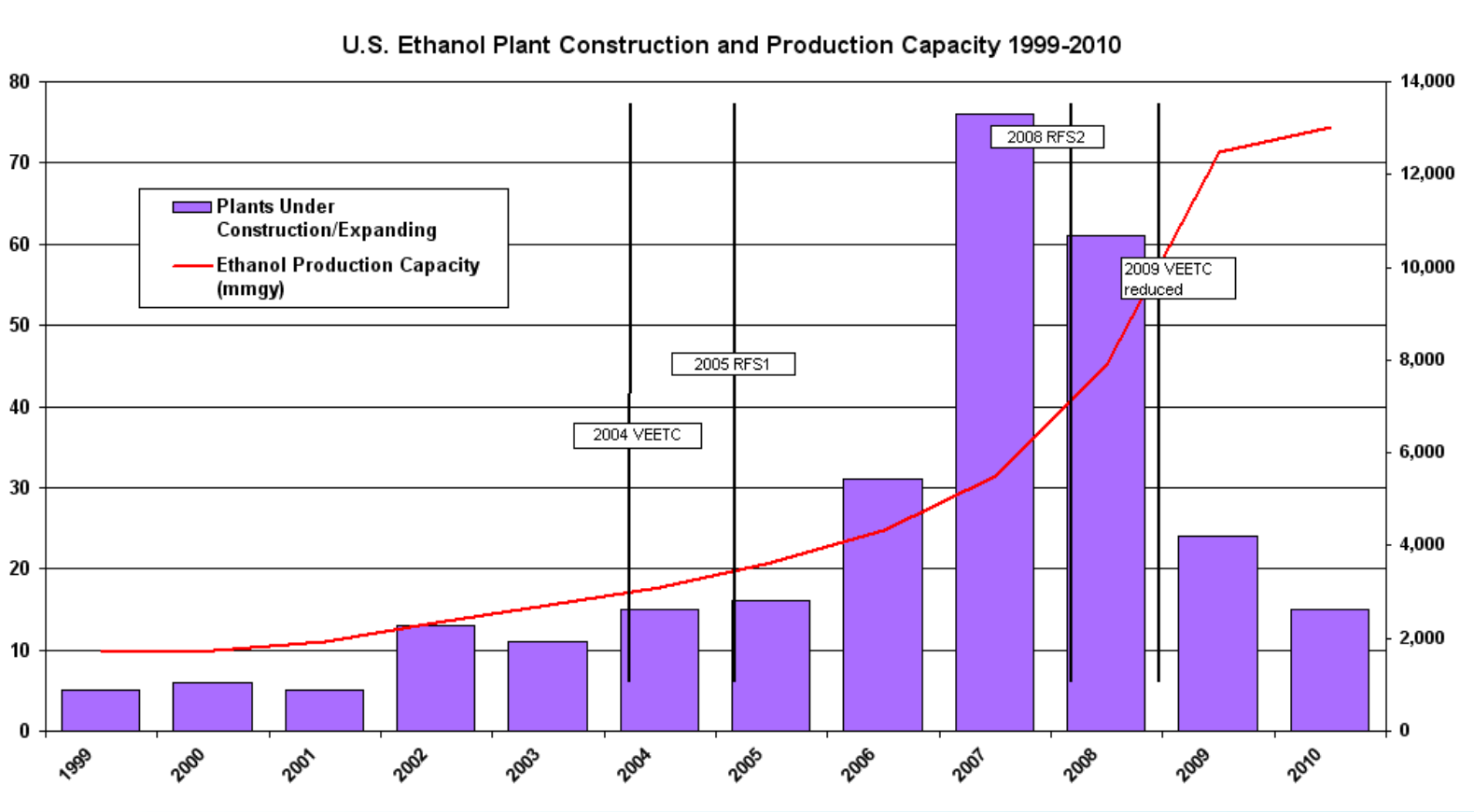
RFS Biofuel Blending Mandates (BGY, 2008-2022)



Where We Are Now

- Corn ethanol production tripled from **14.7** blt in 2005 to about **53.2** blt in 2011. Current production capacity is about **55.6** blt ≈ maximum capacity envisioned by RFS.
- Cellulosic biofuel mandates could not be met since the inception of the RFS;
- At present, there is no biorefinery producing cellulosic biofuel at commercial scale, some small scale test production has occurred in the past few years, first commercial production is scheduled for 2014 (?).

Progress in US Ethanol Plant Construction and Production Capacity



US Corn Production and Use for Ethanol

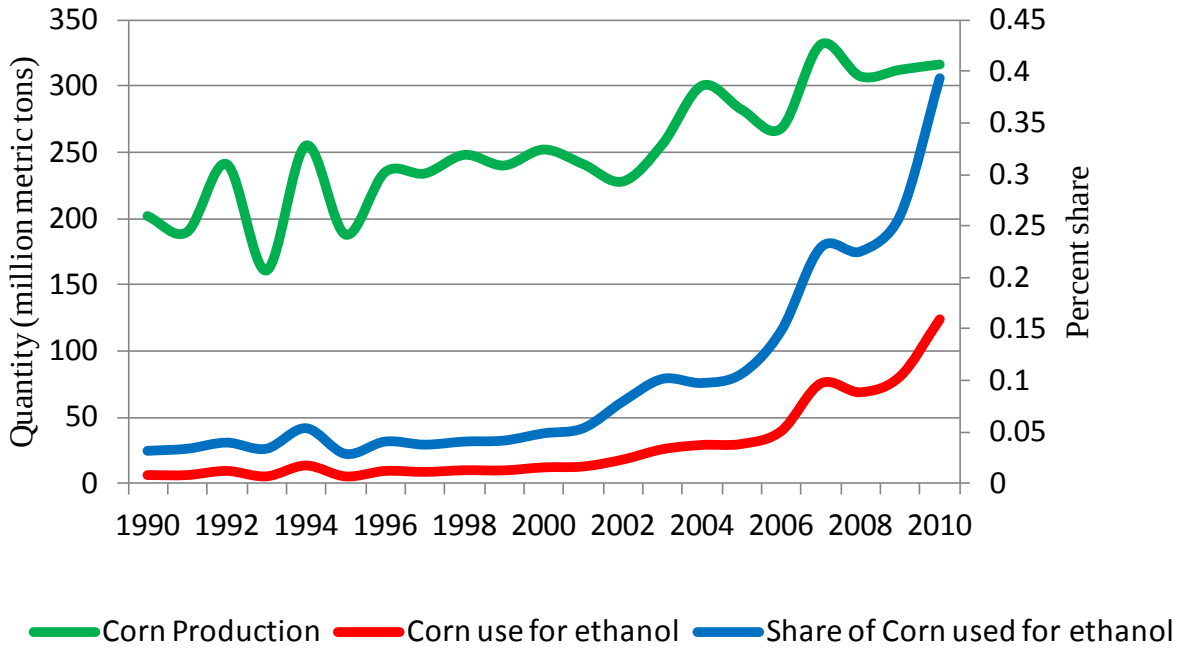


Figure 1: Corn production in US and corn use for fuel ethanol, 1990-2010.
Source: USDA

Crop Price Trends and Volatility in US

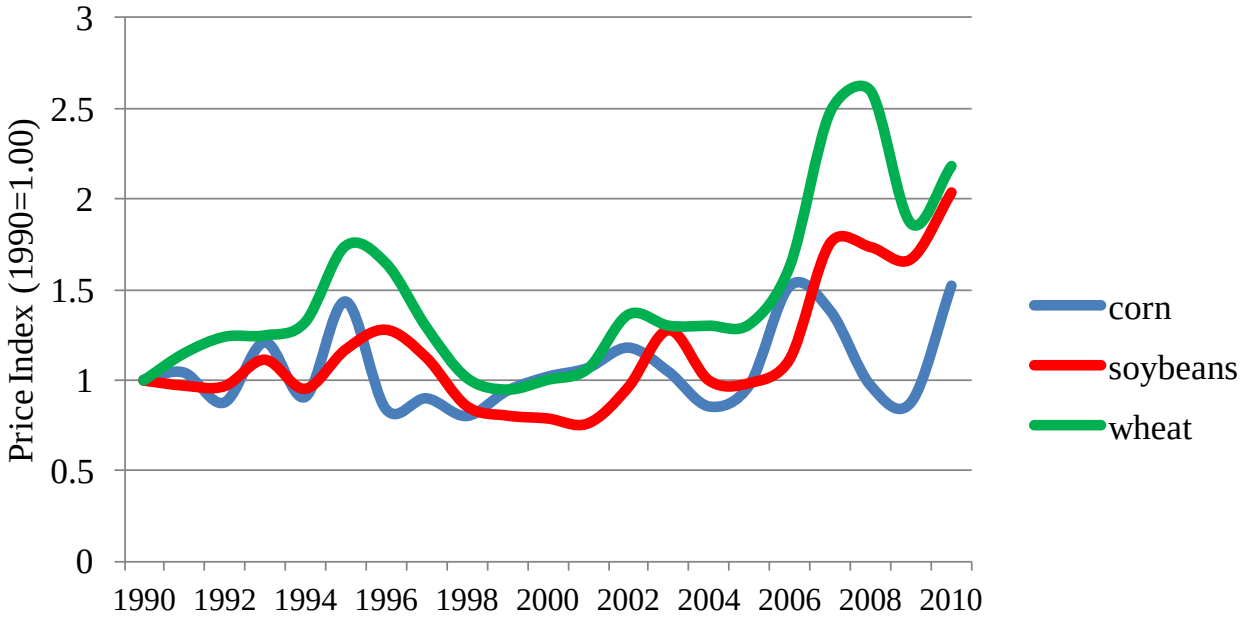
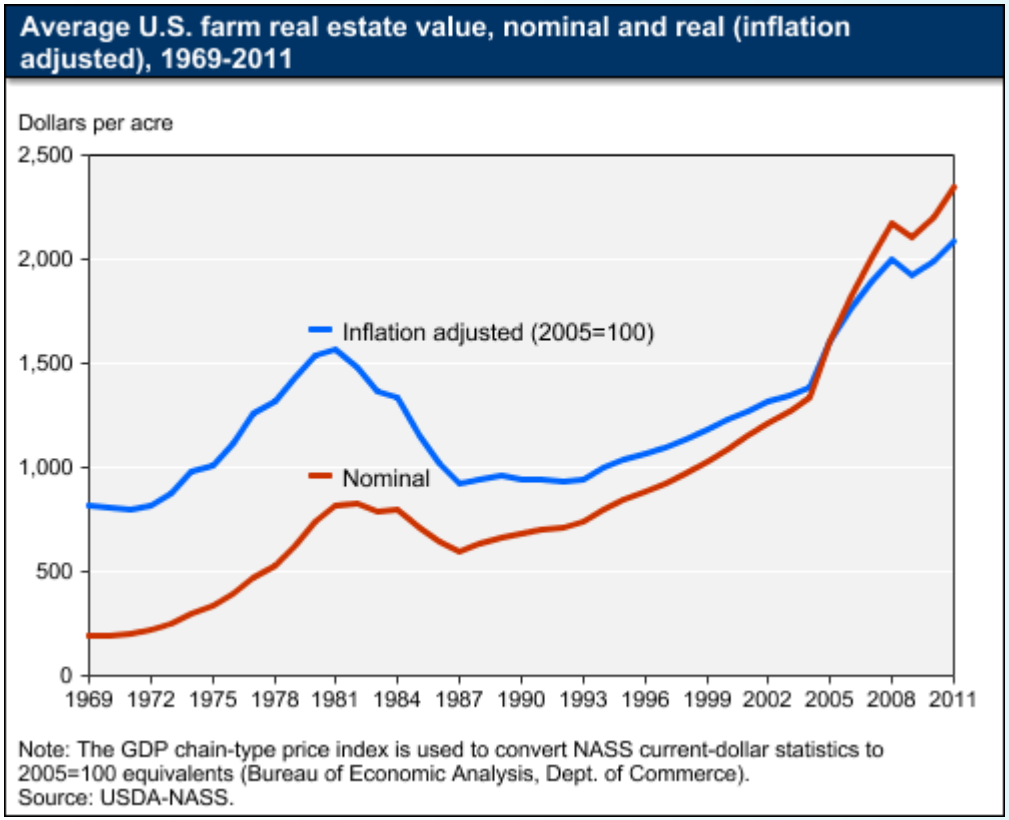


Figure 2: Crop price trends and volatility in the US, 1990-2010. Source: USDA

Trends in Farm Real Estate Value



Implementation of the RFS

Each year EPA revises the mandated volumes of biofuels. Since 2008, the annual cellulosic biofuel blending targets have been waived or adjusted drastically.

Year	Target (mg)	Revised (mg)
2010	100	6.0
2011	250	6.6
2012	500	8.65
2013	1,000	6.0 (down from 14)
2014	1,750	17 (?)

Cellulosic Biofuel Plants Under Construction & Planned Production Capacity (mg/year)

Facility	Fuel	Year	Cap
Abengoa, KS	Ethanol	2013	25
Fiberight, IA	Ethanol	2013	6
Ineos Bio, FL	Ethanol	2013	8
DuPont, IA	Ethanol	2014	30
Fulcrum, NV	Biodiesel	2013	10
Mascoma, MI	Ethanol	2014	20
Kior ,MS	Eth/Diesel	2013	11
POET, IA	Ethanol	2013	25
BP, FL	Ethanol		(36, cancelled)

Responses to Policy Changes

Corn prices during 2006 through the 2012 were supported by a rapidly growing domestic ethanol industry. Relatively poor corn yields in 2010, 2011, and 2012 kept corn supplies very tight.

Recently, EPA proposed to reduce the 2014 blending mandates for both the advanced and corn-based components (41 and 16%, respectively).

Commodity Price Changes in US, 2005-2013

Ratio of farm commodity prices relative to corn (Pi/Pc)

	2005	Avg. of 2006-12	2013
soybeans	2.83	2.28	2.92
wheat	1.71	1.34	1.54
soymeal	2.44	2.06	3.02

Effects of Biofuel Policies on Fuel Consumption, Fuel Mix and GHG Emissions

Scenarios	BAU	Carbon tax	RFS	LCFS
Cumulative Fuel Consumption, 2007-2030 (Billion gallons)				
US gas consumption	3155.1	3056.0	2898.6	3024.3
		(-3.1)[1]	*(-8.1)*	*(-4.1)*
US gasoline imports	2031.2	1949.6	1821.5	1923.3
		(-4.0)	*(-10.3)*	*(-5.3)*
US petro diesel consumption	989.2	954.7	969.3	980.1
		(-3.5)	*(-2.0)*	*(-0.9)*
ROW gas consumption	4421.0	4467.5	4532.9	4477.8
		(1.1)	*(2.5)*	*(1.3)*
First generation biofuels[2]	115.7	117.5	384.7	82.4
Cellulosic Ethanol			160.4	253.9
BTL diesel[3]				5.8
Reduction in Cumulative GHG Emissions relative to Baseline, 2007-2030 (Billion tons)				
US GHG emissions		-2.4	-2.4	-2.4
		(-4.2)	*(-4.2)*	*(-4.2)*
Global GHG emissions		-1.8	-0.2	-1.4
		(-3.1)	*(-0.4)*	*(-2.6)*

Welfare Effects of Biofuel Policies

Scenarios	Carbon Tax	RFS	LCFS
US fuel consumers (a)	-1377.9	42.7	89.6
US fuel producers (b)	-164.9	-203.5	-87.3
US agricultural consumers (c)	-12.9	-124.0	3.7
US agricultural producers (d)	19.6	296.6	10.9
US government (e)	1669.8	35.0	16.4
Reduction in US externality costs (f)[2]	75.1	63.4	58.5
US economic surplus (Δ=a+b+c+d+e)	133.7	46.7	33.4
US social welfare (Δ+f)	208.9	110.1	91.9
	(0.8)	(0.4)	(0.3)

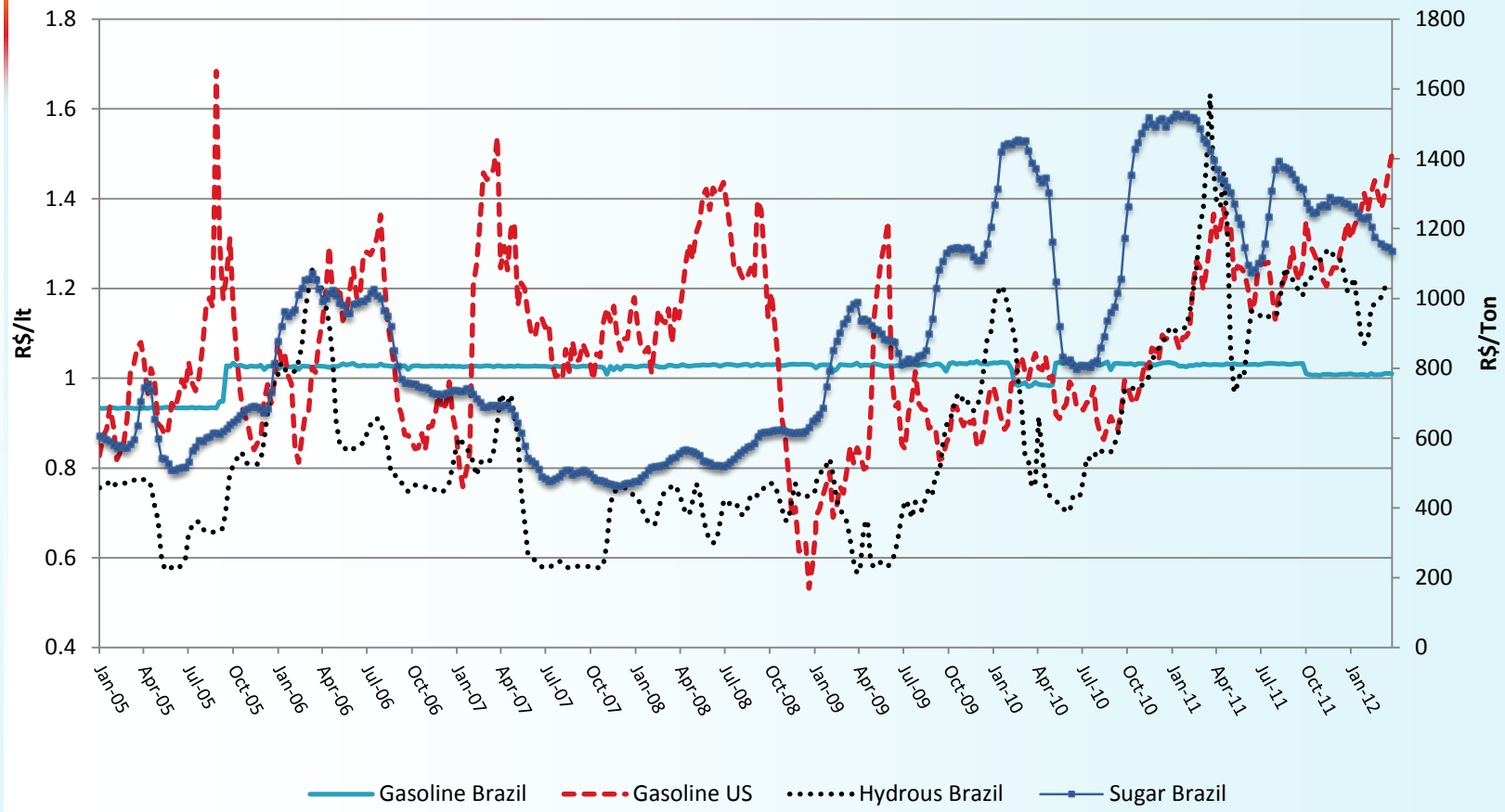
Biofuel Policies in Brazil

- Blending rate: in the past decade varied within 18- 25% range. Due to supply shortages, in 2011 the rate was reduced from 25% to 20%, in May 2013 it was raised back to 25%.
- Tax rates : >100% for gasoline, <40% for ethanol until 2011. In 2011, gasoline tax was 80%, in 2012 it was reduced to 53% and then totally eliminated. Ethanol tax is also eliminated in May 2013.
- Price controls: PETROBRAS regulates gasoline & diesel prices. In the past decade gasoline price was almost fixed at a level 19% lower than the world price. In 2013, to reduce losses from subsidized sales the price was raised by 11%.

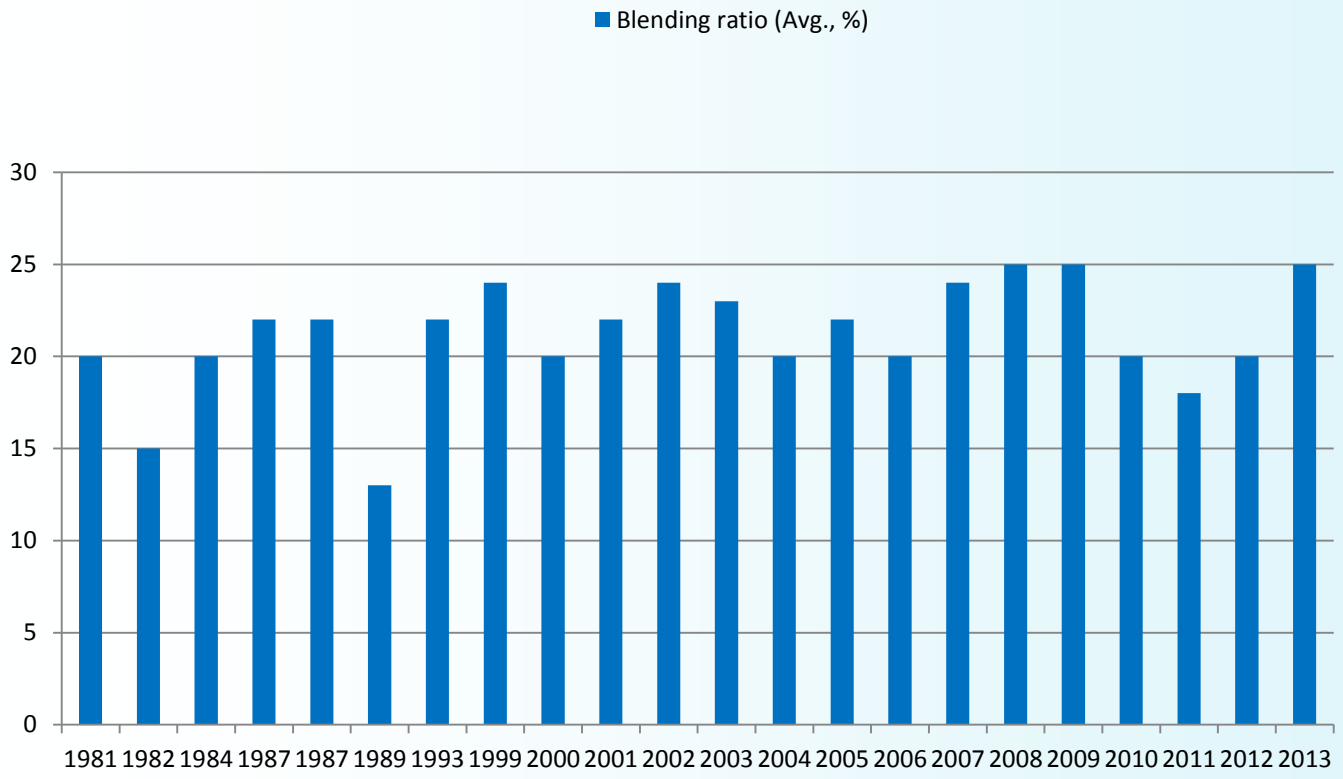
Ethanol Market

- Ethanol price is not regulated and fluctuates depending on the fuel blending ratio, tax rate and sugarcane/sugar prices.
- Despite the tax incentives provided to ethanol consumers, low gasoline prices in recent years weakened the competitiveness of ethanol and reduced the share of ethanol in the total fuel consumption from 56% in 2009 to 39% by volume in 2012. Currently it is about 50%.

Trends in Fuel and Sugar Prices



Ethanol Blending Ratio in Brazil



Simulation Results Under Different Market Conditions and Policy Scenarios - 2022

- Benchmark Case: Strong ethanol and strong sugar demand in global markets, average sugarcane yield, 25% blending rate, and base year fuel tax rates
- Four market conditions are considered by coupling two demand and two supply conditions
  - Strong vs Weak demand for ethanol and sugar
  - Historical average sugarcane yield vs low yield
- Each case is run assuming blending mandates ranging over 15-25% and tax rate reductions ranging over 0-100%

Percent Changes wrt Benchmark	Strong Ethanol Demand + Strong Sugar Demand					Weak Ethanol Demand+ Average Sugar Demand				
Sugarcane Yield	Average		Low			Average		Low		
Blending Rate	15%	15%	25%	25%	15%	15%	15%	25%	25%	15%
Tax Rate	bt	nt	bt	nt	bt	bt	nt	bt	nt	bt
Vehicle Km Traveled	-0.4	5.0	-0.3	5.1	-0.6	0.3	5.1	0.2	5.4	-0.2
Eth Consumption Total	22.2	-77.2	-4.0	-62.0	-2.9	29.5	-77.2	6.0	-61.9	24.8
Gas Consumption Total	-22.9	88.9	3.5	72.8	2.2	-28.9	89.1	-5.7	73.4	99.0
E100 Consumption by FFV	44.8	-100.0	-6.1	-100.0	8.6	55.0	-100.0	9.4	-100.0	48.5
Gas Consumption by FFV	-39.9	130.2	5.4	110.5	-1.2	-49.1	130.5	-8.7	111.3	-43.3
E100 Consumer Price	6.6	6.6	2.3	11.0	4.6	1.3	-4.0	-1.4	-3.0	4.8
Gasohol Consumer Price	7.5	-32.3	0.5	-35.3	8.6	6.8	-33.0	-0.3	-37.2	7.4
Ethanol Exports	-4.3	10.1	-29.1	-13.9	-29.2	-96.6	-67.7	-100.0	-95.0	-100.0
Sugarcane Area	3.8	-15.9	-6.6	-15.5	-6.4	-40.0	-55.0	-42.9	-60.2	-37.7
GHG Emissions	-4.8	**18.9**	-0.8	**14.5**	-1.1	-12.0	**14.4**	-7.1	**10.1**	-11.2
Ethanol Producers' Surplus	20.0	-81.5	-4.2	-73.3	-6.9	29.6	-76.1	11.1	-58.8	27.4
Government Tax Revenue	-1.9	-68.2	0.6	-69.7	4.4	-2.3	-68.2	-1.0	-69.6	-2.1
Social Surplus	-0.7	**1.0**	-0.7	**0.8**	-1.2	-5.2	**-3.1**	-4.5	**-3.5**	-5.1

Highlights from Model Results

- Fuel taxes seem to be the most important policy instrument in Brazil's biofuel economy. Removing the taxes makes gasohol a more appealing fuel than ethanol. The total consumption of ethanol goes down, driving goes up, GHG emission goes up, tax revenue goes down, yet social surplus goes up wrt the corresponding scenario with higher taxes.

Highlights from Model Results (continued)

- Impacts of a reduced blending mandate on the fuels sector and social welfare vary across the scenarios
- Impact on VKT demand insignificant, but
- Composition of the fuel mix changes significantly, more ethanol is consumed by FFVs switching from gasohol to ethanol because gasohol becomes more expensive since it has a more of an expensive fuel (gasoline) in its mix.

An Unintuitive Result

- A smaller blending rate increases the GHG emissions from transportation fuels since this increases the amount of gasoline in the fuel consumption by CVs. BUT, a simultaneous effect is the possibility of switching from gasohol to E100 by FFVs. The net effect is ambiguous.
- The simulation results show that under the same market conditions the adverse effect of a more gasoline-intensive mix on GHG emissions is dominated by the emission reduction effect of increased ethanol consumption resulting from FFVs' switching to E100. Thus, reducing the blending mandate w/o tax rate change would decrease the GHG emissions!

Concluding Remarks

- Lowering the blending rate temporarily to cope with a short supply of ethanol may be a sound policy in the short run, but if continued in the long run it is not a good policy
- Lowering the tax rate on gasoline may reduce some of the adverse effect on consumers, but it is harmful for the environment.
- Sound policies: invest in agriculture (e.g. livestock intensification) and invest in infrastructure development (e.g. ethanol pipelines, roads, rail, irrigation).

Concluding Remarks (Continued)

- Under a lower blending rate CVs will be driven less, while FFVs and EDVs will not be affected much. Reducing the blending rate alone reduces consumers' surplus, increases producers' surplus.
- Fuel taxes are strong and effective policy instruments. Lowering the tax rates reduces competitiveness of ethanol against gasoline blends. Low fuel taxes are beneficial for consumers, but lower producers' surplus.
- A reduced tax policy may have dramatic environmental impacts by increasing GHG emissions from transportation fuels.

Current State of The Biofuels Policy World

THANK YOU!