

Market-mediated impacts of Brazilian sugarcane ethanol expansion

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Outline

- Policy Context – Why is our question important?
- Simulation design – How did we answer our question?
- Where does sugarcane ethanol go?
- Price linkages in sugarcane ethanol sector
- Land use story

Policy Context

- Biofuels are one of the few energy sectors that use a lot of land
- Sugarcane ethanol has superior lifecycle performance than corn ethanol. Does it maintain that advantage after we account for market mediated impacts?
- We analyze the effect of a supply shock of Brazilian sugarcane ethanol on
 - Ethanol and sugarcane markets
 - Land use changes

Simulation design

Shock

```
shock qo("ethanol2","BRAZIL") = 55.38;
```

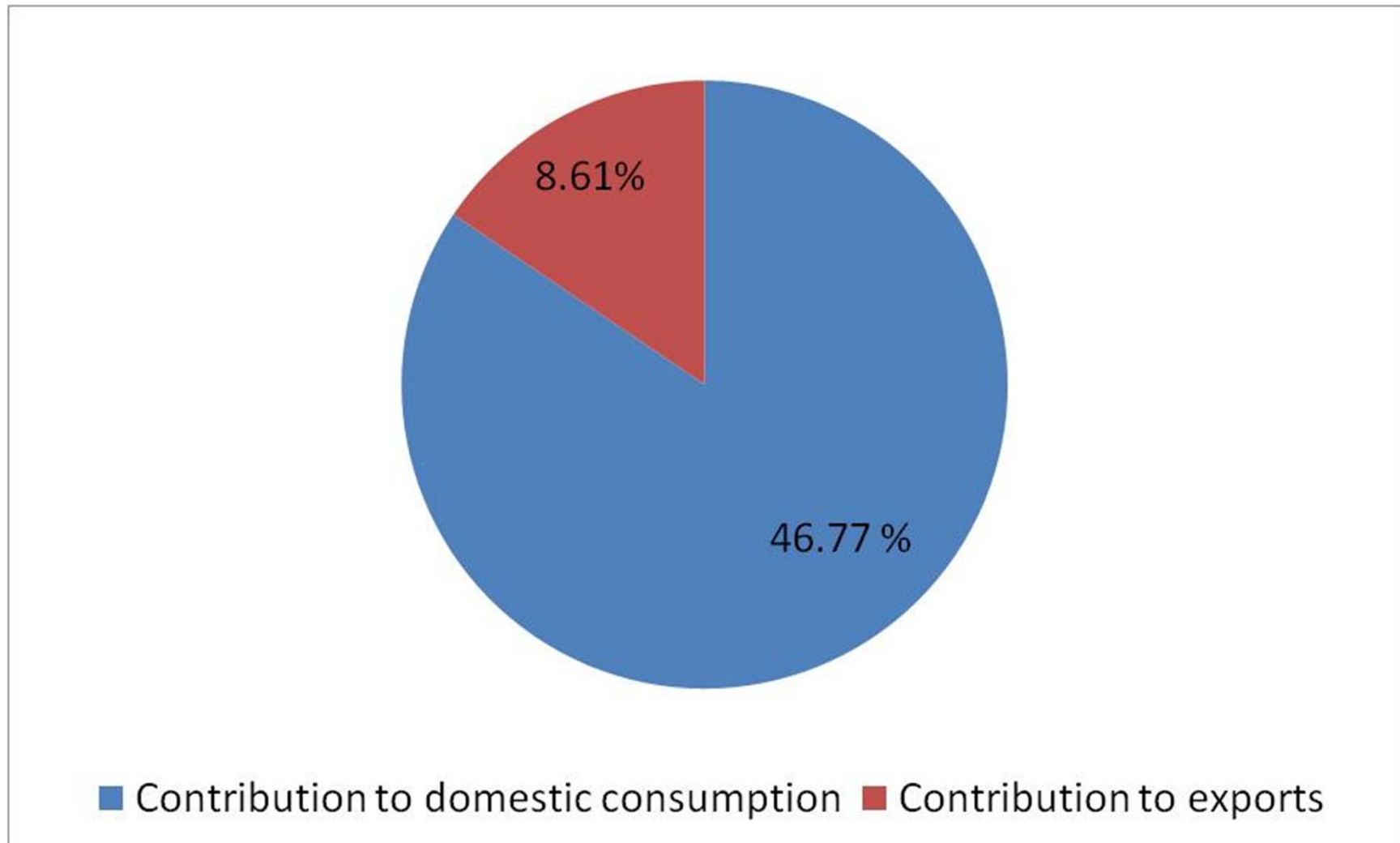
Closure

```
swap qo("ethanol2","BRAZIL") =  
to("ethanol2","BRAZIL");
```

!Keep USA production fixed

```
swap qo("ethanol1","USA") =  
tpd("ethanol1","USA");
```

Brazilian cane ethanol output increases by 55.38%



Export destinations

	Percent change in exports of sugarcane ethanol	Ethanol export flows after simulation	Percent Change in market price of Cane EtOH
1 USA	445.01	262	-41.3
2 CAN	188.046	66.6	-41.3
3 EU27	130.151	22.2	-41.3
4 BRAZIL	494.966	0	-41.3
5 JAPAN	2601.709	0	
6 CHIHKG	2606.466	0	
7 INDIA	2551.238	0	
8 LAEEX	1842.139	0	
9 RoLAC	1717.539	0	
10 EEFSUEX	2656.988	0	
11 RoE	2630.961	0	
12 MEASTNAEX	2509.89	0	
13 SSAEX	2342.028	0	
14 RoAFR	2332.888	0	
15 SASIAEEX	2409.492	0	
16 RoHIA	2567.313	0	
17 RoASIA	2628.988	0	
18 Oceania	2470.257	0	

Demand drivers in US, EU and CAN

Region	Qty expansion	Substitution	Total	Import shares of sugarcane EtOH	Elasticity of substitution between cane ethanol and other fuels
1 USA	445.006	0	445.006	1	3.2
2 CAN	188.045	0	188.045	1	2
3 EU27	130.124	0.007	130.131	1	1.5

- Since initial import share is 1, there is no substitution effect
- Quantity of sugarcane ethanol demanded is determined by the last column.
 - For Brazil itself this is 1.1 (likely to be higher if we calibrate it now due to the large influx of flex fuel vehicles)

Cane ethanol output price increase = 2.96%

Endowment	% change in endowment demand by Sugarcane ethanol sector	Change in endowment factor price
19 UnSkLab	55.971	0.087
20 SkLab	56.258	-0.059
21 Capital	55.188	0.566
22 NatRes	0.004	-6.033

Intermediate Inputs	Domestic demand increase by etoh2 for intermediates	VIFM for ethanol2 in brazil	VDFM (etoh2)	Change in factor price
4 Sugarcane	55.38	0	1387.095	10.317
15 Oil_Pcts	55.188	0.004	139.662	-0.706
16 Electricity	55.188	0	102.813	0.204
17 En_Int_Ind	55.38	0.084	114.61	0.181
18 Oth_Ind_Se	55.38	0.006	267.136	0.229

Cost of sugarcane

R035	% change in demand for land by cane in brazil	Price change (%)
1 AEZ1	29.922	96.646
2 AEZ2	25.335	97
3 AEZ3	29.155	96.704
4 AEZ4	26.714	96.892
5 AEZ5	24.814	97.041
6 AEZ6	20.794	97.364
7 AEZ7	25.221	97.009
8 AEZ8	25.221	97.009
9 AEZ9	25.221	97.009
10 AEZ10	28.687	96.74
11 AEZ11	24.897	97.034
12 AEZ12	30.088	96.633
13 AEZ13	25.221	97.009
14 AEZ14	25.221	97.009
15 AEZ15	25.221	97.009
16 AEZ16	25.221	97.009
17 AEZ17	25.221	97.009
18 AEZ18	25.221	97.009

Impacts on other Ag sectors

- $ps(\text{OthGrains}, \text{Brazil}) = 1.6\%$
- $ps(\text{Livestock}, \text{Brazil}) = 1.0\%$

- $qo(\text{OthGrains}, \text{Brazil}) = -4.0\%$
- $qo(\text{Livestock}, \text{Brazil}) = -0.9\%$

- Domestic shares close to 100% both sectors

Changes in endowment prices

pfe (i,j,r)

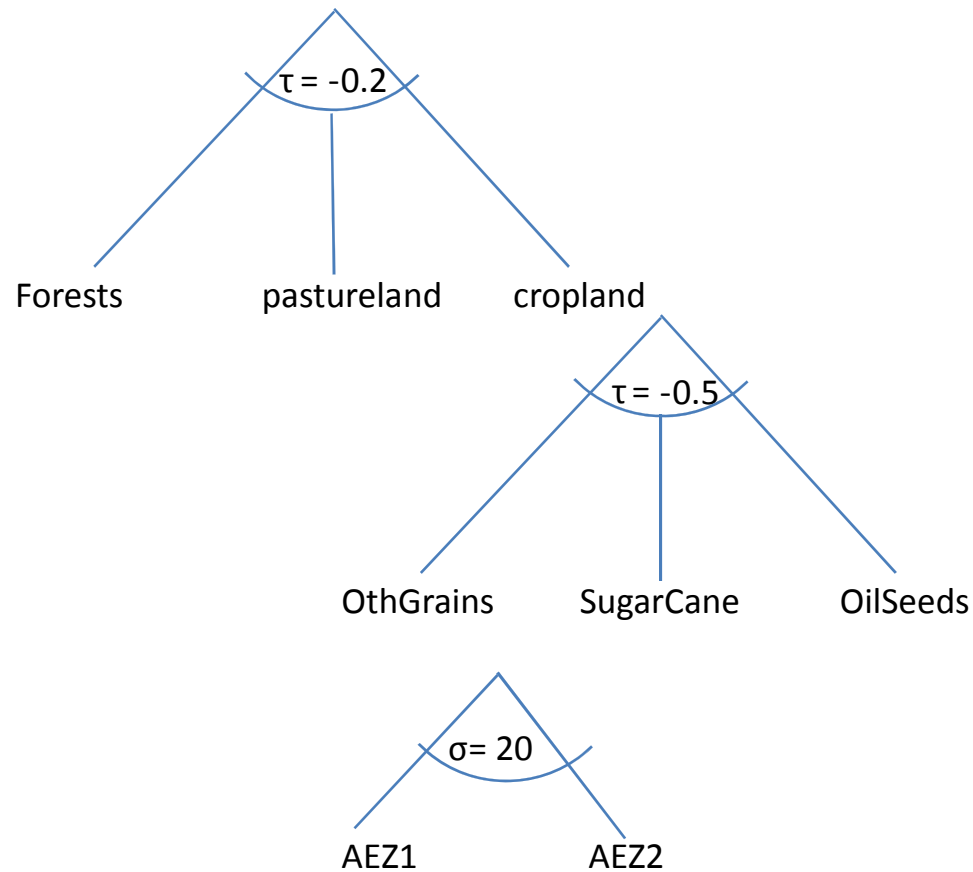
R021	1 CrGrains	2 OthGrair	3 Oilseeds	4 Sugarcan	5 Livestock	6 Forestry
1 AEZ1	16.1	10.7	14.8	96.6	8.1	9.5
2 AEZ2	16.3	10.9	15.0	97.0	8.2	9.6
3 AEZ3	16.1	10.8	14.9	96.7	8.2	9.5
4 AEZ4	16.3	10.9	15.0	96.9	8.2	9.5
5 AEZ5	16.3	11.0	15.1	97.0	8.2	9.5
6 AEZ6	16.5	11.1	15.3	97.4	8.3	9.6
9 AEZ9	16.3	10.9	15.1	97.0	8.2	9.6
10 AEZ10	16.2	10.8	14.9	96.7	8.2	9.5
11 AEZ11	16.3	11.0	15.1	97.0	8.2	9.5
12 AEZ12	16.1	10.7	14.8	96.6	8.2	9.5
18 AEZ18	16.3	10.9	15.1	97.0	8.2	9.6
19 UnSkLa	0.1	0.1	0.1	0.1	0.1	0.1
20 SkLab	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
21 Capital	0.6	0.6	0.6	0.6	0.6	0.6

Land cost shares

- $VFA(\text{land}, \text{OthGrains}) / VOA(\text{OthGrains}) * 100 = 12\%$
- $VFA(\text{land}, \text{Livestock}) / VOA(\text{Livestock}) * 100 = 6\%$

Higher cost share of land in OthGrains leads to greater transmission of high land price

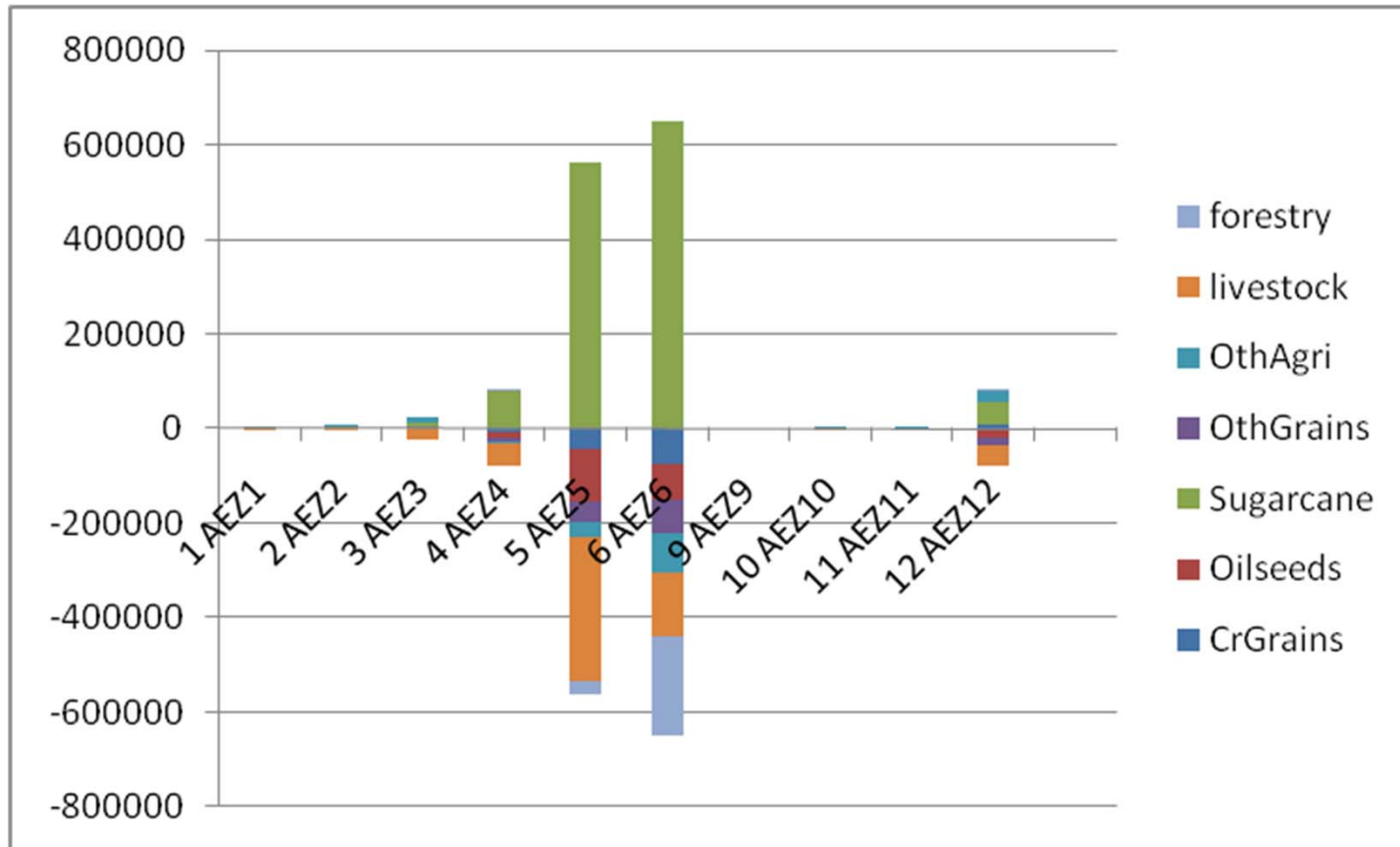
Land allocation



qf(land,Sugarcane) = 22.9%
qf(land,OthGrains) = -4.3%
qf(land,livestock) = -2.2%

pfe(land,Sugarcane) = 97%
pfe(land,OthGrains) = 11%
pfe(land,livestock) = 8%

Hvsted crop, livestock & forest land cover change (ha)



Productivity & land use change1

- Expansion in Sugarcane area = 1.36 mil. ha
- Contraction of other cropland = -0.56 mil ha
- Surplus of 0.8 million ha taken from pasture (0.56) & forestry (0.24)

$\text{cnt_yieldextreg}(j,r) = \text{sum}(i, \text{AEZ_COMM}, \text{PRODUCTSHREG}(i,j,r) * [-\text{harvstslack}(i,r)])$

- $\text{cnt_yieldextreg}(j,r) = -3.2\%$
 - -2.3% from expansion into pasture & forest land
 - -0.01% from expansion into other crop land

Productivity & land use change2

$\text{cnt_yieldintreg}(j,r) = \text{sum}(i, \text{AEZ_COMM}, \text{PRODUCTSHREG}(i,j,r)) * [\text{qo}(j,r) - \text{qf}(\text{"land"},j,r)]$

- $\text{cnt_yieldint}(j,r) = 1.6\%$
- Total yield change = $((1 + \text{int} / 100)(1 + \text{ext} / 100) - 1) * 100 = -1.7\%$

Productivity & land use change³

- If we assume productivity on new cropland from pasture and forest land is equal to that of existing land, land use changes are much more moderate.
 - Forest land reduction: 56% less
 - Pastureland reduction: 25% less
 - Cropland expansion: 35% less

Concluding remarks

- Need to modify ethanol trade flow data to get the expected consumption outside Brazil
- Irrespective of where the ethanol is consumed, big land use changes arise from the mandate.
- Land area changes very sensitive to assumed productivity of newly acquired land

Change in output of sugarcane

	Pre-Sim flows of sugarcane into all sectors in Brazil	% change in qty
Sugarcane	226.748	24.933
Sugarcane ethanol	1387.095	55.38
Processed foods	82.433	-0.826
Sugar and etc	1411.877	-2.295
Oth_Ind_Se	51.454	-0.493

All changes occur only within the domestic market
All sugarcane is used only as an intermediate inputs