University of Basel

Biofuels & Fossil Fuels Subsidies Reforms

7th AIEE Energy Symposium on Energy Security

Robin Argueyrolles, 15.December.2022

Overview

1	Introduction
2	Methodology
3	Results
4	Conclusion

Context

Fossil Fuel Subsidies (FFS) in 2020

- Pre-tax subsidies: $450 billion globally (Parry et al, 2021)
- WTO definition: €52 billion in the EU (EC, 2021)

Fossil Fuel Subsidy Reform (FFSR)

G20 2009 Pittsburgh Summit, EU green deal, SDG 12 target c, NDC of 15 countries

Biofuel mandates to lower GHG in the transport sector

- EU Renewable Energy Directive (RED)
- US Renewable Fuel Standard (RFS)

Biofuels penetration impacted by the price of alternative, i.e fossil fuels (Winchester & Ledvina, 2017)

DART-BIO: Model Description

Bio-economy & land-use version of the Dynamic Applied Regional Trade (DART) model

- Global recursive-dynamic model of the period 2011 to 2030
- Representative agent
- Utility maximizing consumers, Profit maximizing producers, regional gov
- Constant return to scale modeled using nested CES functions
- Linear expenditure system (LES), Armington trade elasticities
- Productivity and labor growth constant but regionally differentiated
- 21 regions, 51 sectors and 21 factors
- Heterogeneous land supply (AEZs), different land types within AEZ nested in CET function

Sectors & Products in DART-BIO

Agricultural related products (29)		**Energy products (15)**	
Crops		COL	Coal
PDR	Paddy rice	CRU	Oil
WHT	Wheat	GAS	Gas
MZE	Maize	MGAS	Motor gasoline
GRON	Other cereal grains	MDIE	Motor diesel
PLM	Oil Palm fruit	OIL	Petroleum and coal products
RSD	Rapeseed	ELY	Electricity
SOY	Soybean	ETHW	Bioethanol from wheat
OSDN	Other oil seeds	ETHM	Bioethanol from maize
C_B	Sugar cane and sugar beet	ETHG	Bioethanol from other grains
AGR	Rest of crops	ETHS	Bioethanol from sugar cane
		ETHC	Cellulosic Bioethanol from straw
Processed agricultural products			
VOLN	Other vegetable oils	Biofuels	
SGR	Sugar	BETH	Bioethanol
FOD	Rest of food	BDIE_PLM	Biodiese made from palmoill
		BDIE_OTH	Biodiesel made from other vegetable oils
PLMoil	Palm oil		
RSDoil	Rapeseed oil	**Non-energy products (3)**	
SOYoil	Soybean oil	CRPN	Other chemical rubber plastic products
OSDNoil	Oil from other oil seeds	ETS	Paper, minerals, and metals
SOYmeal	Soybean meal	OTH	Other goods and services
OSDNmeal	Meal from other oil seeds		
PLMmeal	Palm meal	**Forest and forest products (2)**	
RSDmeal	Rapeseed meal	FRS	Forestry
DDGSw	DDGS from wheat	FRI	Forest related industry
DDGSm	DDGS from maize		
DDGSg	DDGS from other cereal grains		
UCO	Used cooking oil		
STRAW	Starches, straw		
Meat and dairy products			
OLVS	Outdoor livestock and related animal products (cattle and other grazing animals, raw milk and wool)		
ILVS	Indoor livestock (swine, poultry and other animal products from indoor livestock)		
PCM	Processed animal products		

Data

Model largely calibrated on GTAP9 database (Aguiar et al., 2016)

+ Meó Consulting Team, F.O.Licht and FOASTAT data to split ‘new’ sectors

+ OECD labor productivity and regional GDP growth projections

Fossil fuel subsidies: IMF 2019 & 2021 public available dataset

=> Based on price-gap approach

- Pre-tax subsidies => Does not include: tax break, risk transfers, etc.

- Post-tax subsidies => Pigouvian tax on externalities

(Air pollution, Climate change, congestion, etc)

Policy scenario 1 – Pre-tax FFSR

- **Ref_BF:** Biofuel mandate achieved in the EU and US.

  US consumption shares calibrated based on OECD projections

  EU consumption share calibrate to reach the maximum RED target (7%)
- **Policy Sc1** (PreT_FFSR): Biofuel mandate and globally pre-tax transport FFSR

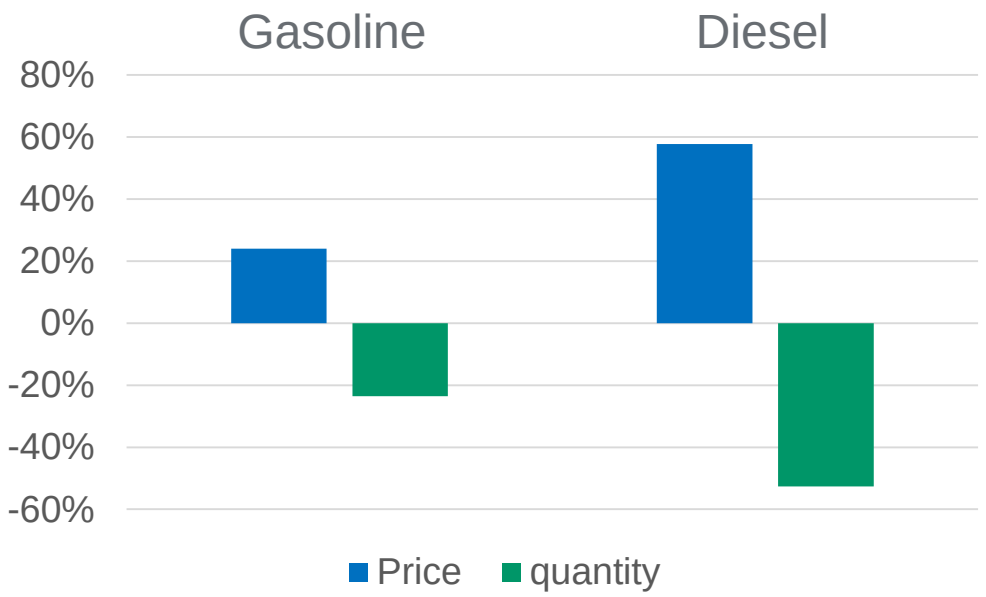
Pre-tax subsidies on liquid fossil fuels for transport in 2022

	Oceania	Russia	OPEC	PPEC	**Middle East Africa**	**Malaysia & Indonesia**	**Rest of Asia**	**Latin America**	**Rest of Former Soviet Union**
Gasoline			26%	1%	2%	4%	0.02%	1%	
Diesel	0.05%	2%	62%	9%	8%	18%	0.2%	2%	0.3%

*In bold, regions with biofuel targets

Subsidized FF – Inside reform area

Final consumption change in OPEC, 2030 - (Pre-tax subsidy reform - Sc1)



Price increases, consumption decrease

Similar magnitude with FFS (26%, 62%)

=> Downward pressure on the world price

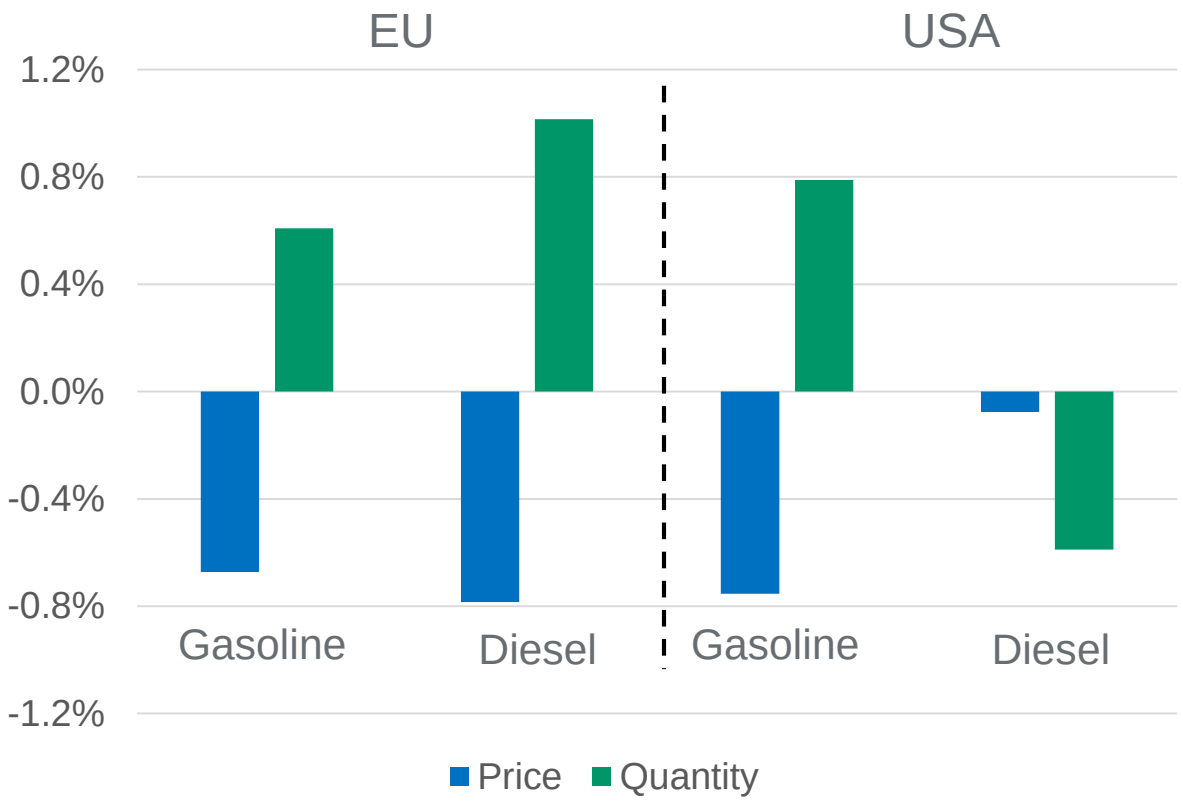
If subsidies <1% price falls while consumption rise (i.e. Rest of Asia)

=> Import price drops by more than subsidy

=> Competitive effect within/between reform region(s)

Subsidized FF – Outside reform area

Final consumption change in 2030 (Pre-tax subsidy reform - Sc1)



As import price drop consumption increase

Inter-fuel substitution => driven by price chg
(US diesel – trade effect)

Global transport fuel consumption drop
Gasoline -0.6%, Diesel -4%

Partial leakage (13.5%)

Other energy commodities

Entering gasoline and diesel production: Crude oil
=> Input demand

Gasoline and diesel input in Electricity – diesel especially (OPEC, Malaysia & Indonesia)
=> Input price

Second-order effects: Oil sector (Petroleum and coal products) produced from crude oil

Change in consumption following pre-tax FFSR, $bn (2030)

Regions	Gasoline	diesel	Crude oil	Electricity	Oil
FFSR region	-14.68	-77.15	-19.93	-10.76	45.87
RoW	6.93	2.76	6.01	0.39	16.38
Total (world)	-7.75	-74.39	-13.92	-10.37	62.25

Subsidized FF – Bilateral trade

OPEC exports in 2030, $bn (2011 price)

Ref Sc	Gasoline	Diesel	Crude oil
FFSR reg	11	18	178
RoW	16	27	1024

Diff. Sc1 & Ref	Gasoline	Diesel	Crude oil
FFSR reg	-2.4	-6.9	-3.0
RoW	-1.3	-5.8	9.6

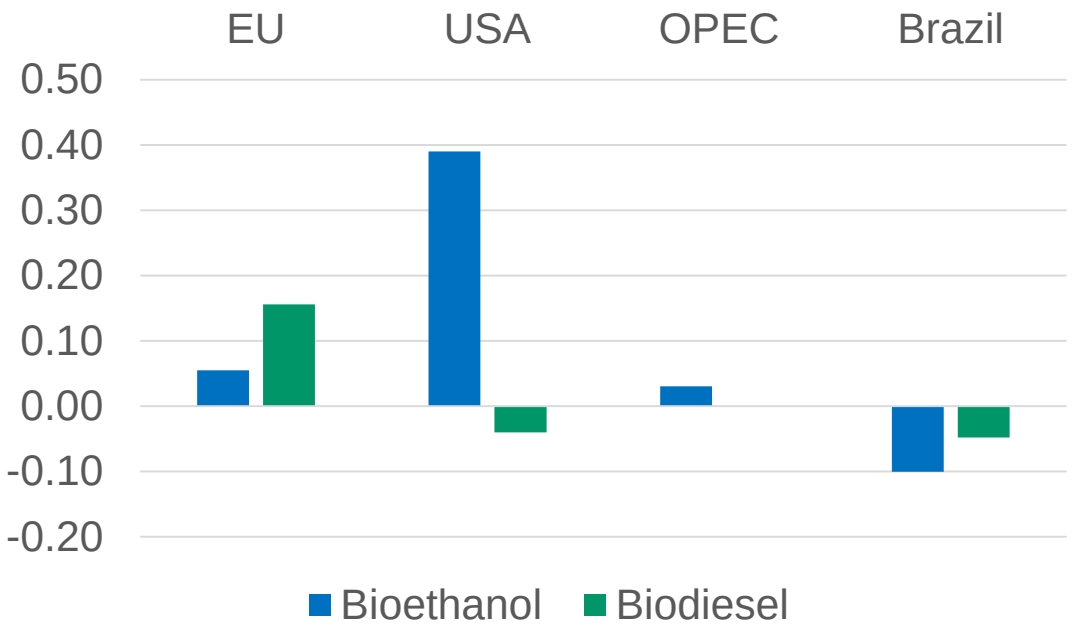
Imports in 2030 (Ref Sc), $bn (2011 price)

Ref Sc		Gasoline	Diesel	Crude oil
USA	FFSR reg	3	20	190
	RoW	12	8	71

Ref Sc		Gasoline	Diesel	Crude oil
EU	FFSR reg	1	9	229
	RoW	18	100	58

Biofuels consumption

Difference in biofuel consumption, Pre-tax subsidy reform ($ Bn, 2011 price)



	FF subsidies	Biofuel mandate
EU	No	Yes
USA	No	Yes
OPEC	Yes	No
Brazil	No	No

Biofuel mandate = target share of consumption => effect parallel to gasoline and diesel

Where subsidies are phased-out, biofuels become attractive. Small effect. Where are the subsidies?

Government Support – Pre-tax subsidies

The difference in support to biofuels to reach 2030 share target, $bn

Region	Biodiesel	Bioethanol	Total
Central Europe	0.31	0.09	0.41
Germany	0.49	0.21	0.7
Eastern Europe	0.16	0.1	0.26
Mediterranean	0.33	0.09	0.42
North-Western EU	0.09	0.07	0.15
Norway	0	0.01	0.01
USA	(0.03)	3.94	3.91

Equivalent to a 2% increase in total support in the EU and 2,7% in the US.

By 2030 when the pre-tax subsidies are fully phased-out:

Yearly avoided gov spending = 83 $BN globally (483$bn over whole phase-out period)

Policy scenario 2 – Post-tax FFSR

- **Ref_NoBF:** No biofuel mandates or FFSR
- **Policy Sc2 (**PosT_FFSR) => Post-tax FFSR in the EU and US only

  + Tax on biofuel = 65% of the post-tax subsidy on the corresponding FF

    => GHG intensity reduction set in the Renewable Energy Directive

Ad-valorem post-tax subsidies (2030)

Regions	Bioethanol	Biodiesel	Gasoline	Diesel
Central Europe	12%	12%	19%	19%
Germany	2%	17%	3%	27%
Eastern Europe	3%	5%	5%	8%
Mediterranean	6%	12%	9%	18%
North-Western EU	15%	9%	24%	13%
Norway	21%	17%	32%	26%
US	48%	78%	73%	121%

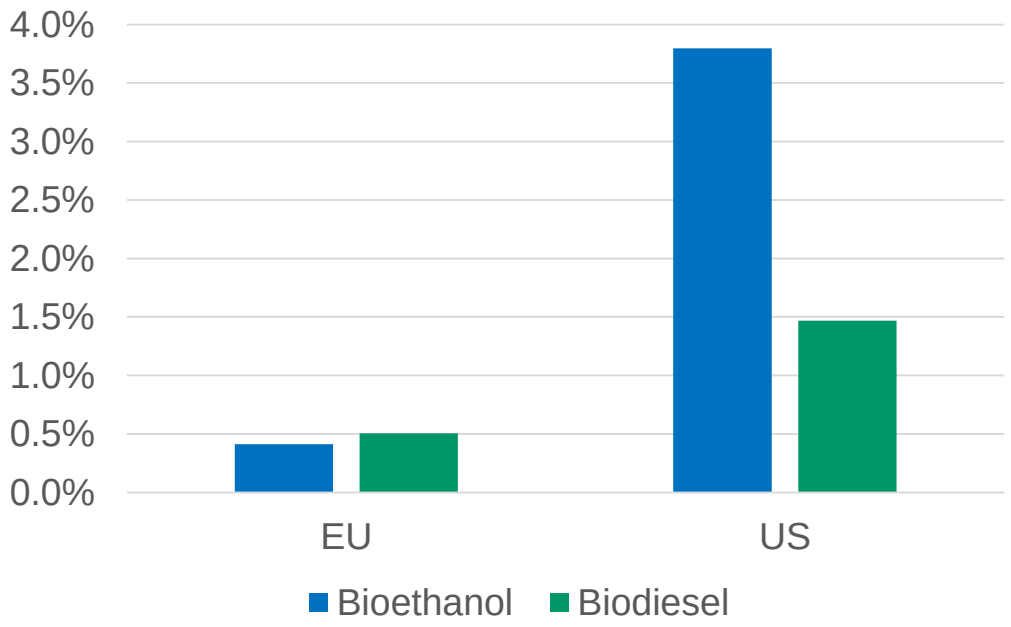
Biofuel Shares – Post-tax subsidies (Pigouvian tax)

By large, same mechanism as pre-tax.

FF: Price increases, consumption falls.

BF: Price increase BUT relatively less => Share increase

Change in the share of biofuel in transport fuel (2030)



US: Close more than half the gap between baseline and target

EU: Still 5% away from its target

Government Support – Post-tax subsidies (Pigouvian tax)

Difference in the consumption of transport fuel in the EU, 2030 ($bn)

Regions	Bioethanol	Biodiesel
Central Europe	0.18	0.41
Germany	-0.11	0.16
Eastern Europe	-0.03	-0.18
Mediterranean	-0.01	0.13
North-Western EU	0.27	0.04
Norway	0.00	-0.02

This is driven by the subsidy, relatively high subsidies mean a rise in consumption

The relative price of biofuel drops by less than the country you trade with.

Conclusion

- Where implemented FF consumption drop, biofuel consumption increase

  $\Rightarrow$ Positive additive effect when both implemented in the same region

  $\Rightarrow$ Potential to achieve biofuel target without support

- In the rest of the world, FF consumption increases while biofuel drops

  $\Rightarrow$ Increase support for biofuel

- Competitive effect between regions with subsidies + complex trade effects

  $\Rightarrow$ Single country focus can miss interpret a reform

- Strong factor linkages in the energy sector

  $\Rightarrow$ Leakage not just in fuel no longer subsidies (i.e. oil)

Coming next

Current project

Calibrate global biofuel quota & consumption up to 2022 instead of 2030 targets

Re-design phase-out scenarios (based on where a biofuel quota exists only)

Calibrate all energy commodities (natural gas – importance for the US)

Next project(s)

Include GHG emissions and climate policy (NDC target)

Consideration over market power and natural resources (inter-temporal optimization?)

University of Basel

Thank you
for your attention.