The Net Emissions Effects of Fuel Taxes

- *VERY PRELIMINARY VERSION. Do not quote without permission please.*

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GGKP Conference

Fiscal Policies and the Green Economy

Venezia 29-30.1.2014

The most efficient pol Instrument?

- Kyoto
- ETS
- Agricultural / Forestry policy
- Energy Saving regulations etc
- R&D – solar, wind….
- Chinese ”One Child” policy

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- **Gasoline Taxes!**

	$/ton CO2
EU ETS	10
Swed C tax	150
EU gas taxes	375
Oil Price fall	200

Ancilliary benefits ...

..or Additional reasons for reducing emissions

- Local Pollution
- Energy Security
- Congestion effects

Growth and Environment 2020

- Can we increase income 50% **&** reduce fossil emissions 50% ?
- Take the transport sector: A simple model for fuel demand is **$Q = Y^a P^b$**
- Elasticities 1 for income Y, –0.8 for price P

Just raise fuel price by 300%*

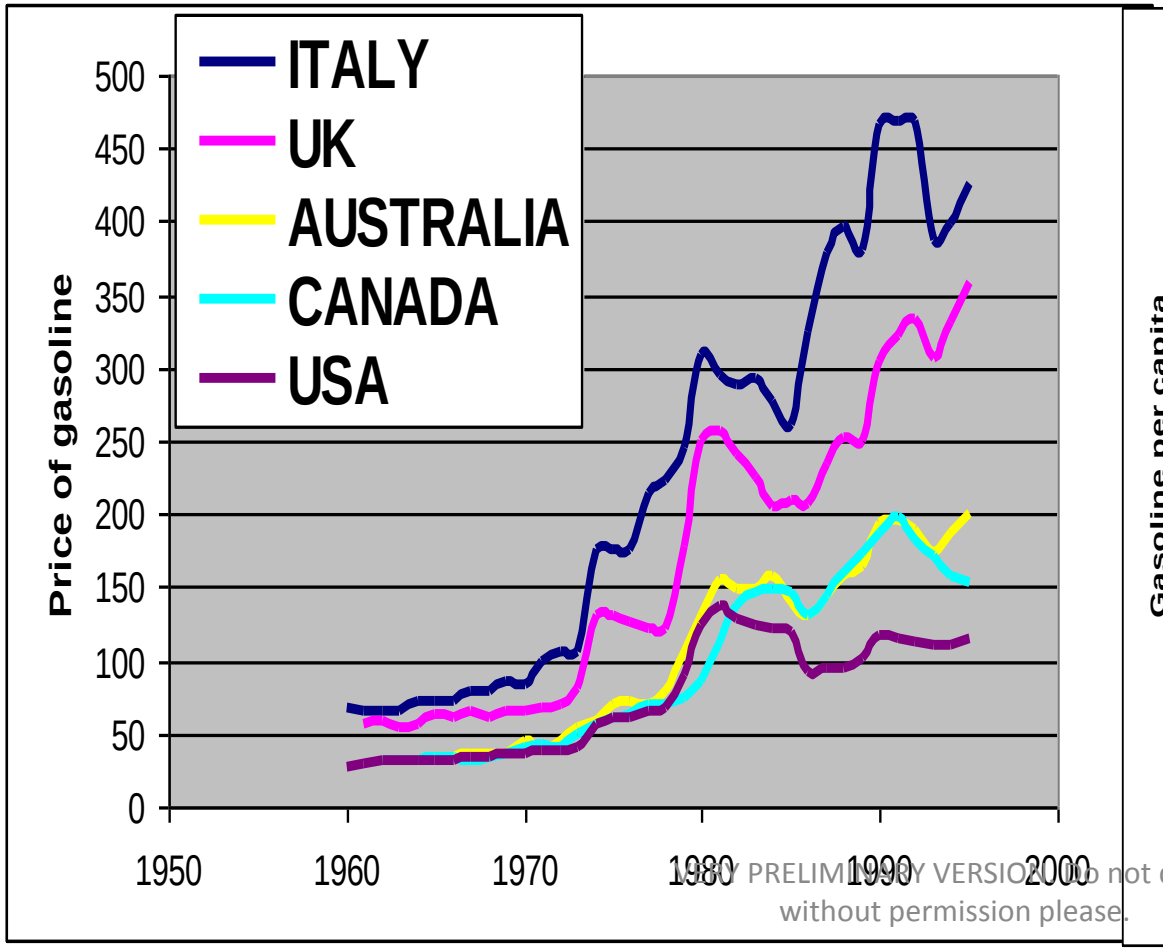
If you want to cut by 3% year and growth is 2% Increase fuel price 6%/year!

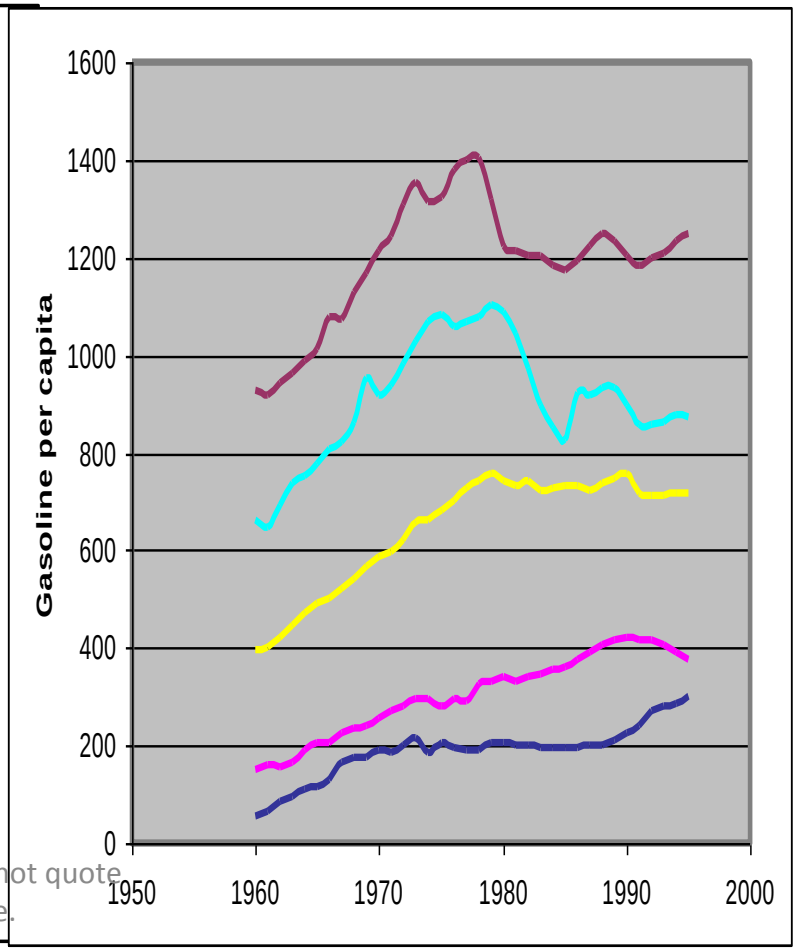
- * Because $P = (0.5/1.5)^{-1/0.8} = 3.95$

Petrol

prices

Consumption/cap





Transport Fuel Use in OECD
Gtons fuel (and ~C*(12/14))

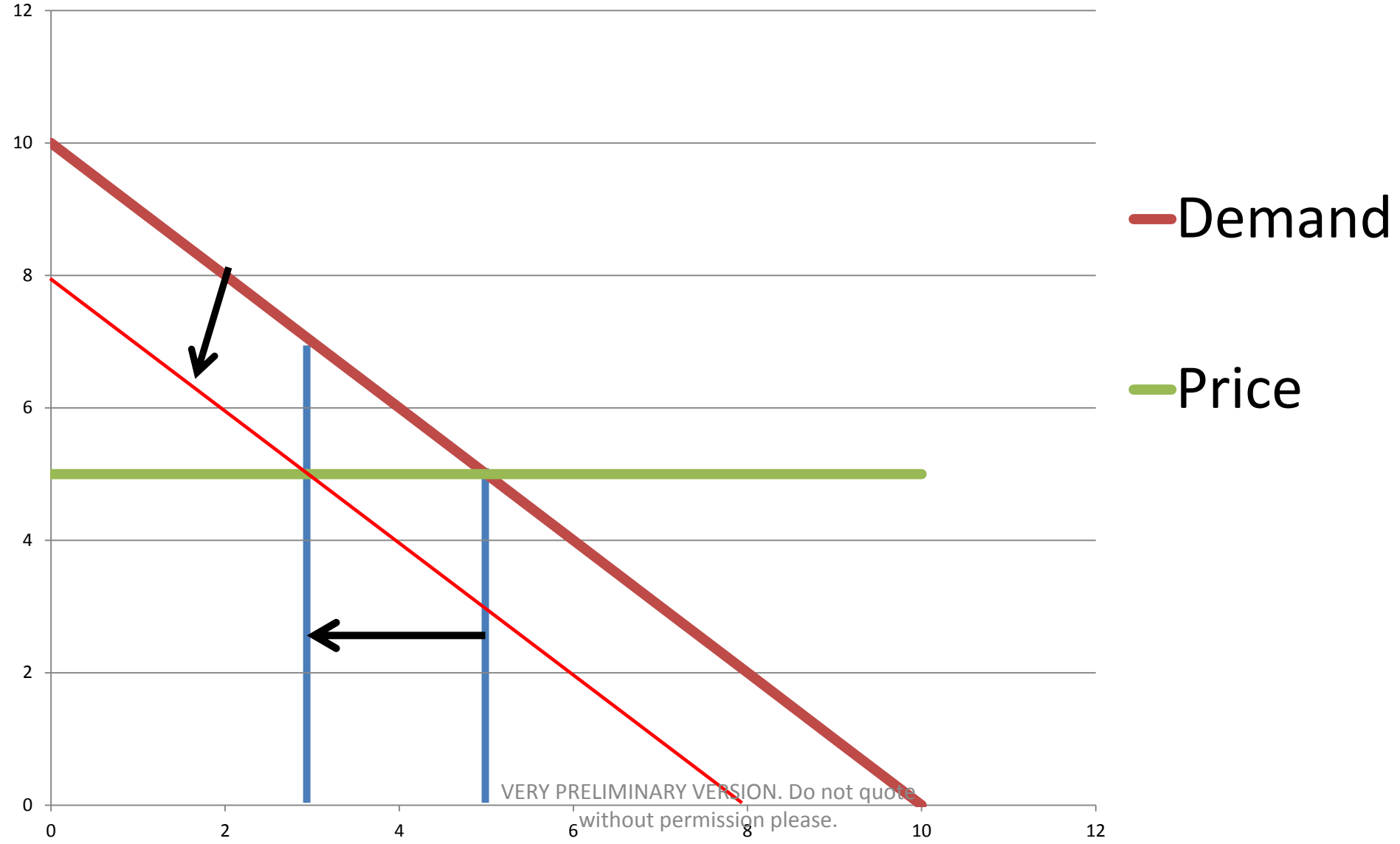
	Real	UK prices	US prices
Fuel use	**1,13**	0,72	1,47
		-36%	+30%

What are the **Global** Effects

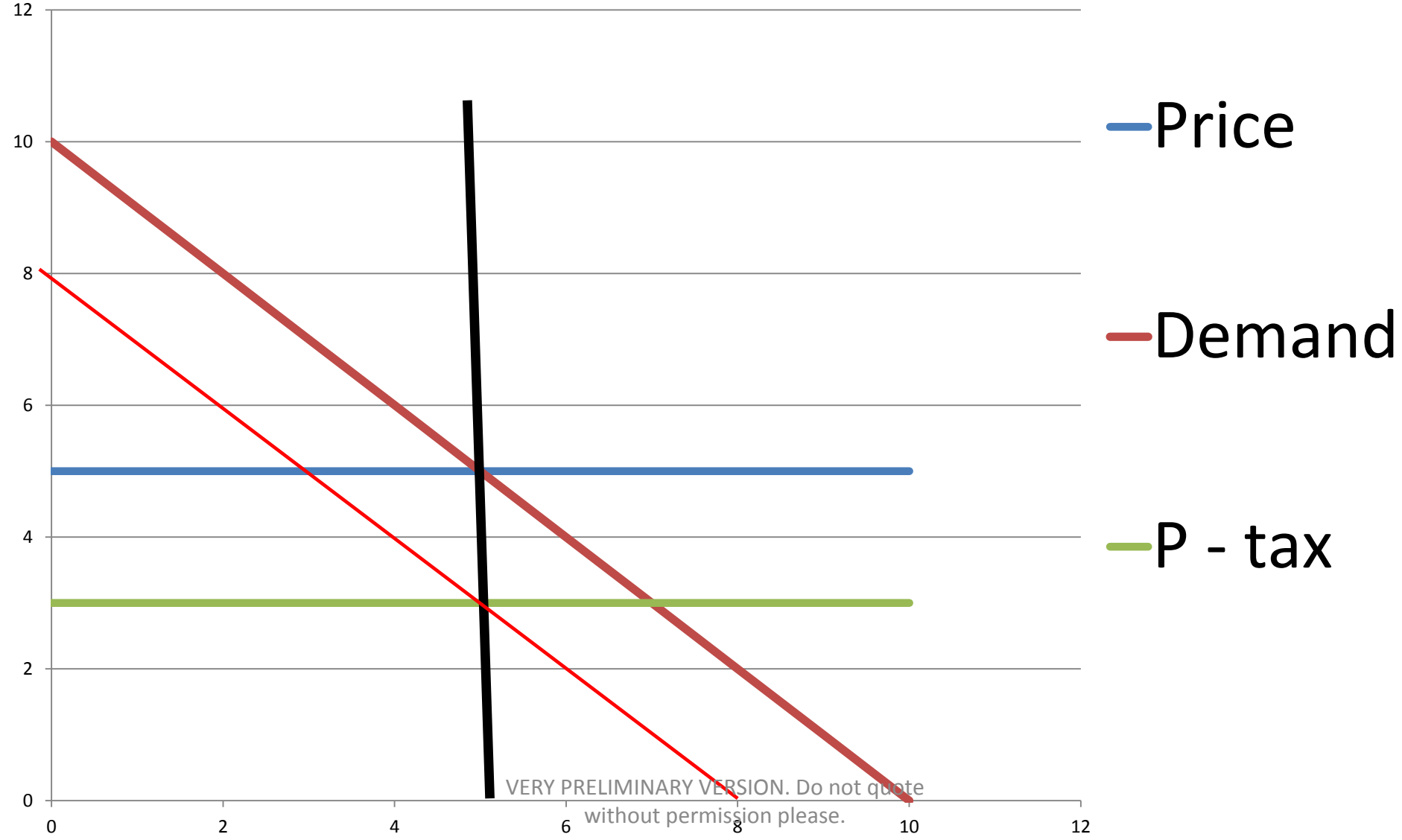
- This assumes: no competitivness effects, no substitution & no leakage.
- Competitivity effect small but PRICES change

- Gas tax in some countries (EU) →
- Oil demand down → World oil Price down
- → Leakage to other countries
- → Supply side effects
- → Leakage to other sources of energy

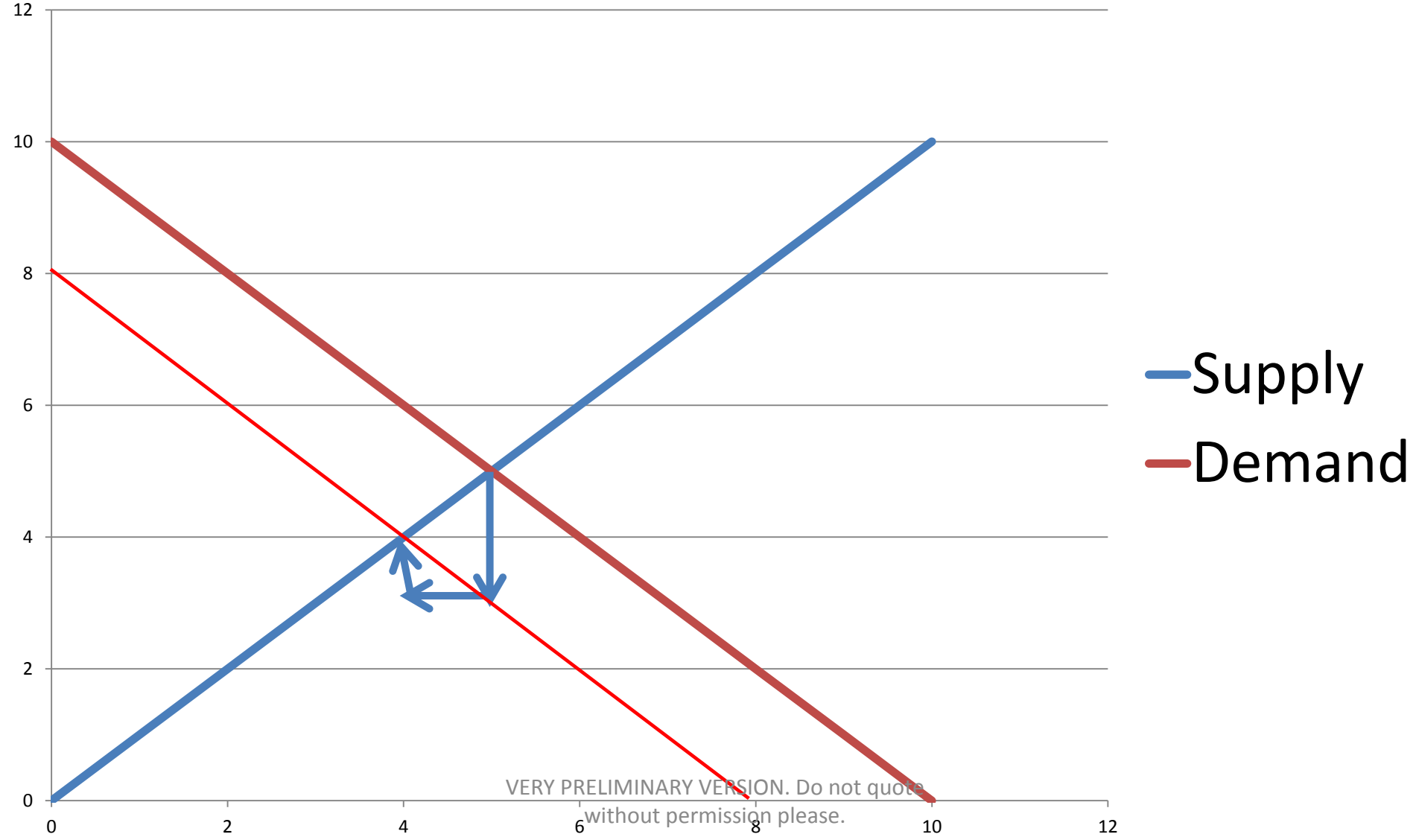
ONE COUNTRY: Totally elastic supply



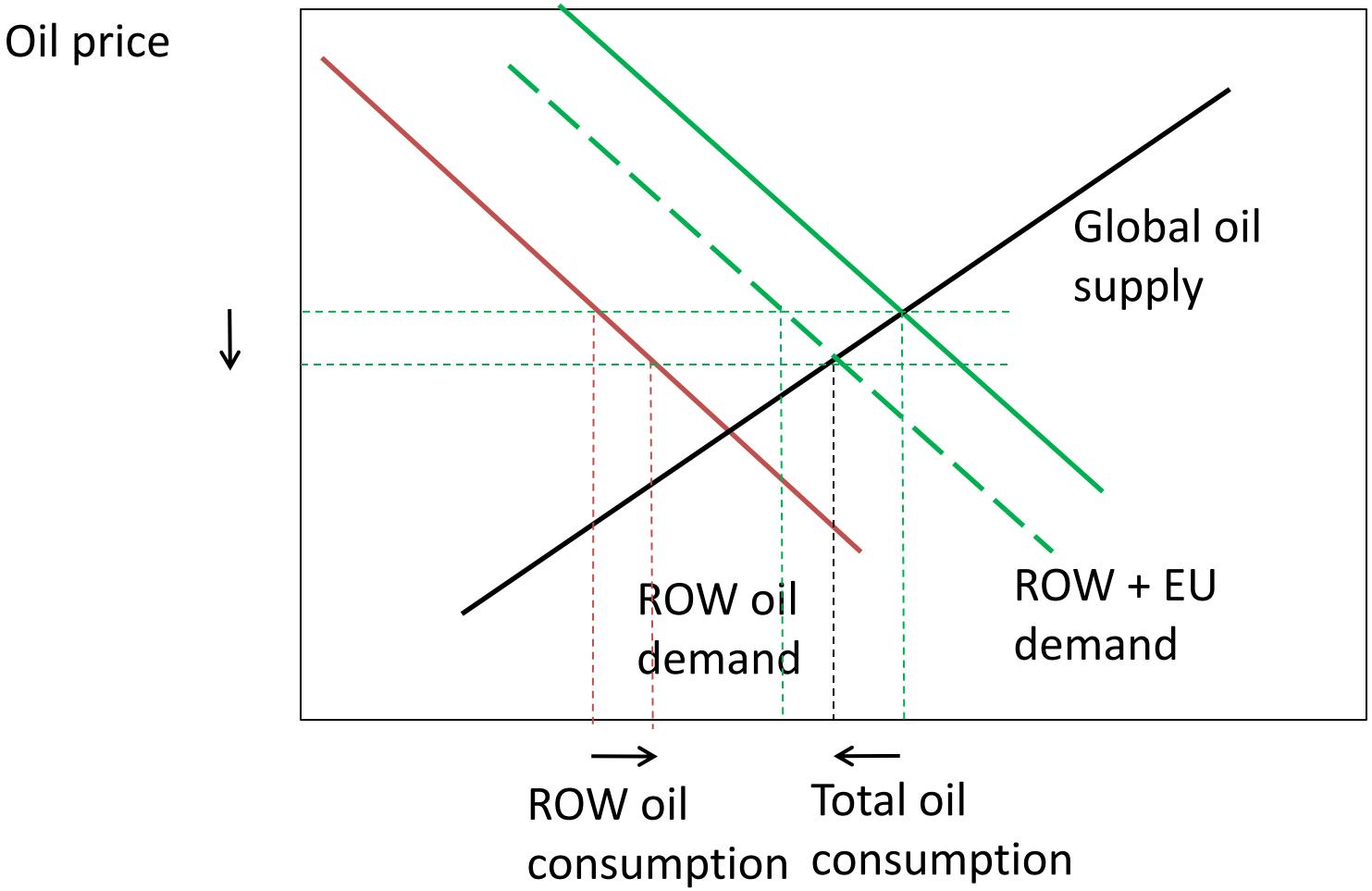
Constant supply – No effect (rent removed)



If supply elasticity is 1 Leakage is 0,5



Leakage in Oil market



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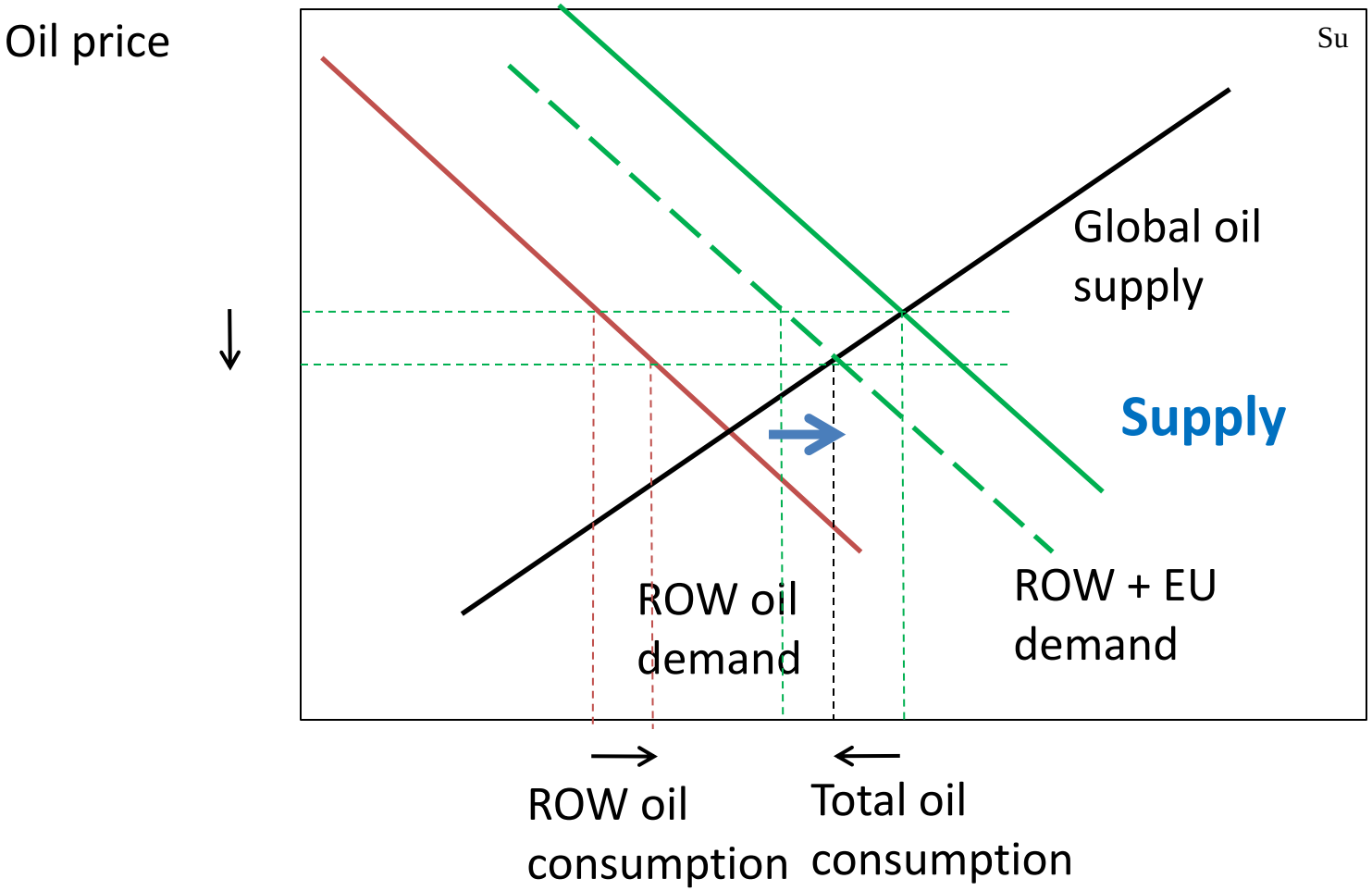


In real world

- Oil supply GAME not simple elasticity

- Cartels and other forms of market power. Games whose character changes
- Still use supply elasticity.

Partial equilibrium model

The global supply of fuel S_i (P_i) {oil, coal, gas}

Demand D_i ($P_i + T_i$)

$$D_i^R(\mathbf{p}+\mathbf{t})+D_i^U(\mathbf{p})=S_i(p_i)$$

$$E=\sum_i \mu_i S_i(p_i).$$

Let σ_i be supply elasticity of fuel *i*. Let η_i be own-price elasticity of demand and let χ be cross-price elasticity

Then the price change induced by a tax is

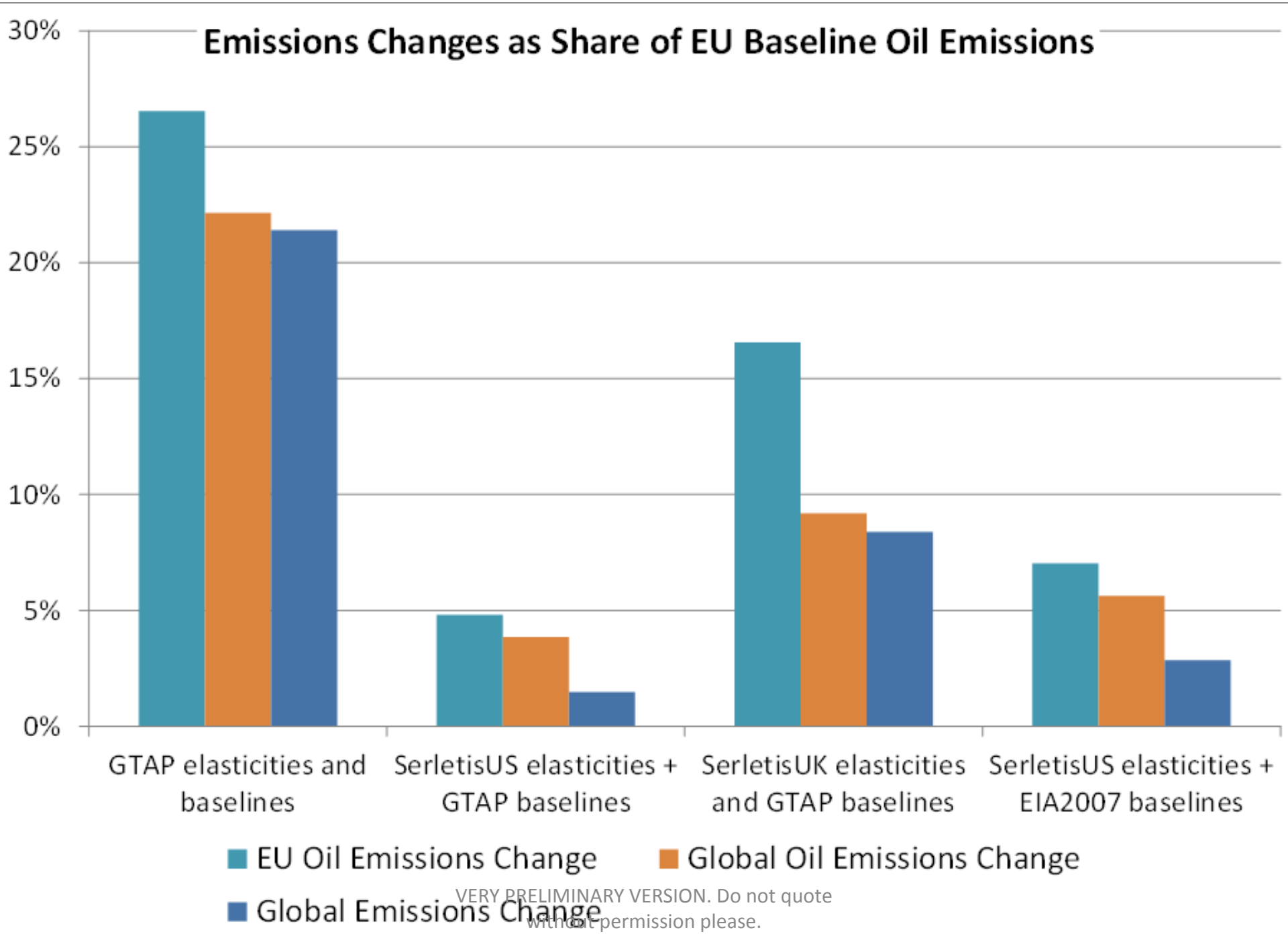
$$\frac{dp_{oil}}{dt_{oil}} = \frac{-\eta_{oil}\frac{D_{oil}^{R}}{P_{oil}^{R}} + \chi_{oil}^{coal}\frac{D_{coal}}{p_{coal}}\frac{dp_{coal}}{dt_{oil}} + \chi_{oil}^{gas}\frac{D_{gas}}{p_{gas}}\frac{dp_{gas}}{dt_{oil}}}{(\sigma_{oil}+\eta_{oil})\frac{D_{oil}}{p_{oil}}}$$

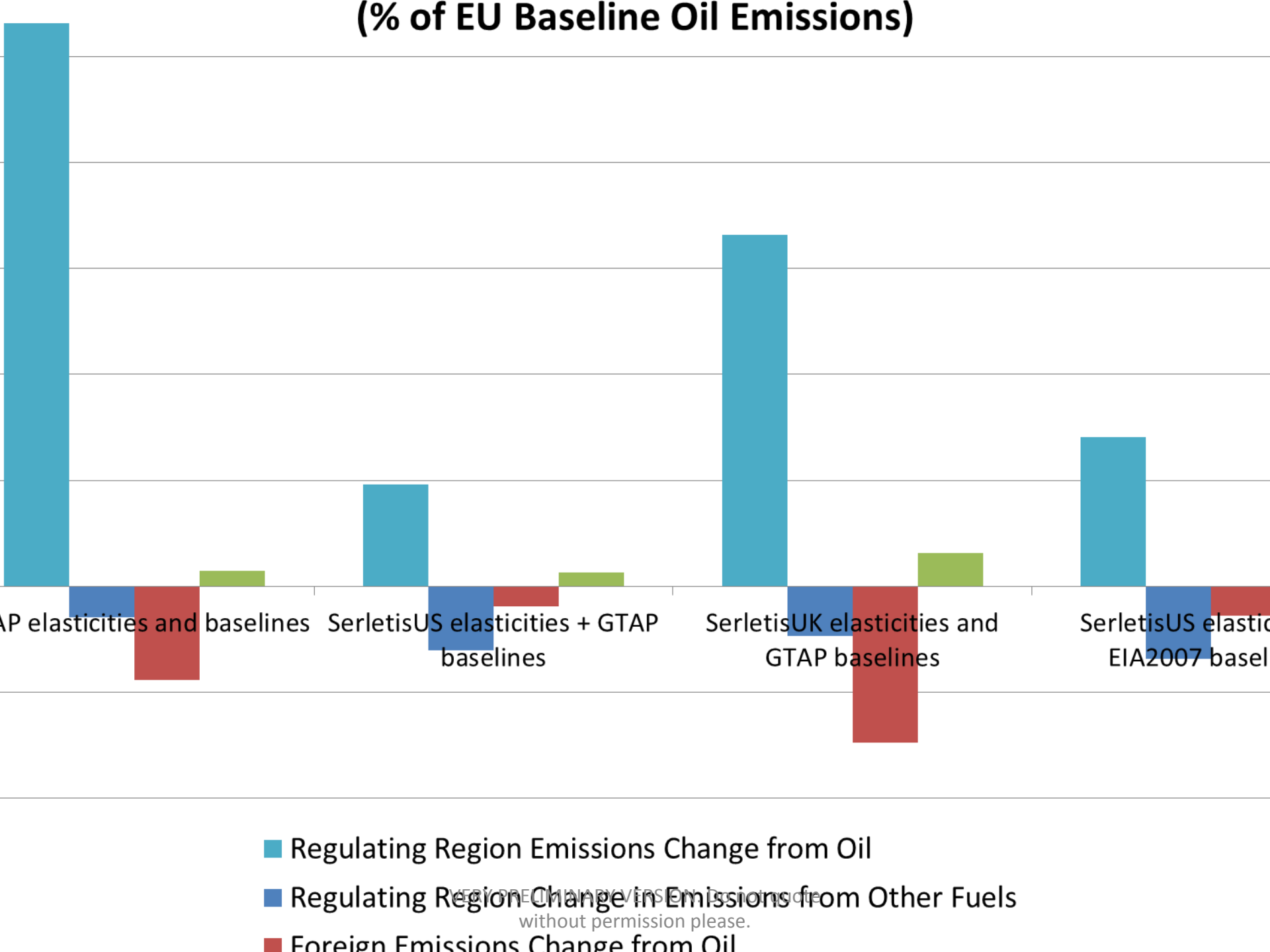
$$\frac{dE}{dt_{oil}} = \underbrace{\mu_{oil}\,\sigma_{oil} D_{oil}\,\frac{dp_{oil}\,/\,p_{oil}}{dt_{oil}}}_{\text{Direct and indirect effects on oil consumption}} +$$

$$+ \underbrace{\mu_{gas}\,\sigma_{gas} D_{gas}\,\frac{dp_{gas}\,/\,p_{gas}}{dt_{oil}}}_{\text{Indirect effects on gas consumption}} +$$

$$+ \mu_{coal}\,\sigma_{coal} D_{coal}\,\frac{dp_{coal}\,/\,p_{coal}}{dt_{oil}}$$

		GTAP	Serletis US	SerletisUK
Supply elasticities				
oil	sO	4.66	0.50	0.50
gas	sG	0.30	2.00	2.00
coal	sC	1.05	2.80	2.80
Demand elasticities: own-price (abs. val.)				
oil	hO	0.64	0.12	0.40
gas	hG	0.58	0.35	0.01
coal	hC	0.56	0.22	0.18
Cross-price elasticities (of i.w.r.t. j)				
	xOG	0.54	0.04	0.02
	xGO	0.06	0.13	0.02
	xOC	0.28	0.00	0.04
	xCO	0.00	-0.01	0.09
	xGC	0.05	0.07	0.00
	xCG	0.15	0.11	-0.05





LESSONS LEARNT

- Assumptions concerning elasticities (and fuel shares) crucial for overall leakage rates as well as composition between leakage from other fuels and leakage from other countries.

- Important to Survey of elasticities

Table 1. Price elasticities of gasoline and diesel demand

Reference	Commodity	Sample	Elasticities		
			Short run		Long run
Broadstock et al. (2010)	Gasoline	UK			-0.28 to -0.33
Brons et al. (2008)	Gasoline	Meta	-0.34		-0.84
Burke and Nishitateno (2013)	Gasoline	Meta			-0.2 to -0.5
Dahl (1995)	Gasoline	Meta			-0.7 to -1
Dahl (2012)	Gasoline	Meta		-0.11 to -0.33	
Dahl and Sterner (1991)	Gasoline	Meta			-0.6 to -1
Espey (1998)	Gasoline	Meta	-0.26		-0.58
Flood et al. (2010)	Gasoline	Meta	-0.077		-0.884
Frondel and Vance (2014)	Gasoline	Germany		-0.505 to -0.447	
Goodwin (1992)	Gasoline	Meta			-0.8
Graham and Glaister (2002)	Gasoline	Meta time-series	-0.27		-0.71
Graham and Glaister (2002)	Gasoline	Meta cross-section	-0.28		-0.84
Graham and Glaister (2004)	Gasoline	Meta			-0.6 to -1
Havranek et al. (2012)	Gasoline	Meta	-0.09		-0.31
Sterner (2007)	Gasoline	Meta	-0.2 to -0.3		-0.6 to -0.8
Barla et al. (2014)	Diesel	Canada 1986-2008	-0.15 to -0.43		-0.42 to -0.78
Belhaj (2002)	Diesel	Morocco 1970-1996	-0.18		-0.62
Broadstock et al. (2010)	Diesel	UK 1960-2008			-0.77 to -0.80
Dahl (2012)	Diesel	Meta		-0.16	
Frondel and Vance (2014)	Diesel	Germany 1997-2009		-0.416 to -0.437	

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Table 2. Price elasticities of coal, natural gas, oil and electricity

Reference	Commodity	Sample	Elasticities		
			Short run		Long run
Jones (1995)	Coal	US 1960-1992	-0.108 to -0.379		-0.248 to -0.386
Serletis and Shamoradi (2008)	Coal	US 1996-2004		-0.327 to -0.395	
Serletis et al. (2010a)	Coal	US 1960-2007		-0.224	
Alberini et al. (2011)	Natural gas	US 1997-2007	-0.572		-0.647
Asche et al. (2008)	Natural gas	EU 1978 -2002	-0.242		-1.541
Garcia-Cerrutti (2000)	Natural gas	California 1983-1997		negative but insignificant	
Jones (1995)	Natural gas	US 1960-1992	-0.170 to -0.375		-0.321 to -0.603
Kirchene (2002)	Natural gas	World 1918-1999			-0.70
Kirchene (2002)	Natural gas	World 1918-1973			-1.1
Kirchene (2002)	Natural gas	World 1973-1999			-1.1
Lin et al. (1987)	Natural gas	US 1960-1984	-0.154 to -0.283		-1.215 to -1.803
Liu (1983)	Natural gas	US 1967-1978		-0.2 to -0.6	
Maddala et al. (1997)	Natural gas	US 1970-1991		-0.099	
Serletis and Shamoradi (2008)	Natural gas	US 1996-2004		-1.012 to -1.507	
Serletis et al. (2010a)	Natural gas	US 1960-2007		-0.347	
Alberini et al. (2011)	Electricity	US 1997-2007	-0.67 to -0.736		-0.814 to -0.86
Asche et al. (2008)	Electricity	EU 1978 -2003	insignificant		insignificant
Bernard et al. (2011)	Electricity	Quebec 1989-2002	-0.51		-1.32
Garcia-Cerrutti (2000)	Electricity	California 1983-1997		-0.132 to -0.172	
Jones (1995)	Electricity	US 1960-1992	-0.080		-0.093 to -0.142
Lin et al. (1987)	Electricity	US 1960-1985	-0.161 to -0.388		-1.160 to -1.326
Maddala et al. (1997)	Electricity	US 1970-1991		-0.158	
Serletis et al. (2010a)	Electricity	US 1960-2007		-0.126	
Jones (1995)	Oil	US 1960-1992	-0.100		-0.112 to -0.353
Kirchene (2002)	Oil	World 1918-1999			-0.05
Kirchene (2002)	Oil	1918-1973			-0.13
Kirchene (2002)	Oil	1973-1999			-0.005
Lin et al. (1987)	Oil	US 1960-1983	-0.191 to -0.208		-0.3402 to 3.502
Serletis and Shamoradi (2008)	Oil	US 1996-2004		-0.253 to -0.635	
Serletis et al. (2010a)	Oil	US 1960-2007		-0.116	

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Alberini et al. (2011)	Fossil Gas				-0.647
Asche et al. (2008)	Fossil Gas				-1.541
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Energy carrier	Approximate average LR
Coal	-0.3
Fossil Gas	-1.0
Electricity	-0.9
Oil	-0.5

Table 3. Cross-price elasticities

	Reference	Sample	Cross-price elasticities					
			oil-gas	oil-coal	oil-electricity	gas-electricity	gas-coal	electricity-coal
Allen elasticities	Serletis et al. (2010a)	US 1960-2007 National	0.344*	-0.028	0.185*	0.326*	1.050*	0.283*
	Serletis et al. (2010a)	US 1960-2007 Industrial	0.331	0.638*	0.024	1.693*	-6.589*	2.824*
	Serletis et al. (2010a)	US 1960-2007 Residential	-1.385		1.532*	0.675*		
	Serletis et al. (2010a)	US 1960-2007 Commercial	-1.697		1.280	0.497*		
	Serletis and Shamordi (2008)	US AIM model	1.292*	0.520*			-0.175	
	Serletis and Shamordi (2008)	US Fourier model	0.151*	0.423*			0.608*	
Shadow elasticities	Stern (2012)	US Meta: cross section	2.069*	2.504*	1.383*	1.348*	1.416	0.918
	Stern (2012)	US Meta: static time series	0.419	0.132	-0.474	1.045	1.586*	0.283
	Stern (2012)	US Meta: dynamic long run	-0.009	0.925*	0.325	1.286*	0.26	0.908

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			-1.697		1.280	0.497*		
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Defies averaging.
Generally positive
Depends fct. form

Table 4. Price elasticities of fuel supply

Reference	Commodity	Sample	Elasticities		
			Short run		Long run
Beck et al. (1991)	Coal	Australia 1979-1988	0.4		**1.9**
Harvey (1986)	Coal	US 1950-1984	0.14		**0.3**
Dahl and Duggan (1996)	Oil	Meta			0.58
Ramcharran (2002)	Oil	OPEC 1973-1997		-0.15, -0.58	
Ramcharran (2002)	Oil	non-OPEC 1973-1997		0.04 to 2.4	
Kirchene (2002)	Crude oil	World 1918-1999			0.25
Kirchene (2002)	Crude oil	World 1918-1973			1.1
Kirchene (2002)	Crude oil	World 1973-1999			0.1
Kirchene (2006)	Crude oil	World 1970-2005			0.08
Kirchene (2002)	Natural gas	World 1918-1999			0.6
Kirchene (2002)	Natural gas	World 1918-1973			0.28
Kirchene (2002)	Natural gas	World 1973-1999			0.8
Kirchene (2006)	Natural gas	World 1970-2005	0.11-0.26		0.3

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					0.58
		-1997		-0.15, -0.58	
		-1997		0.04 to 2.4	
		-1999			0.25
		-1973			1.1
		-1999			0.1
		-2005			0.08
Kirchene (2002)	Natural gas	World 1918-1999			0.6
Kirchene (2002)	Natural gas	World 1918-1973			0.28
Kirchene (2002)	Natural gas	World 1973-1999			0.8
Kirchene (2006)	Natural gas	World 1970-2005	0.11-0.26		0.3

Defies averaging.
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Summary and conclusions

- Oil taxes do have a strong effect and urgently needed for **GREEN GROWTH**

- Particularly in transport where long run elasticities are high and equity issues manageable

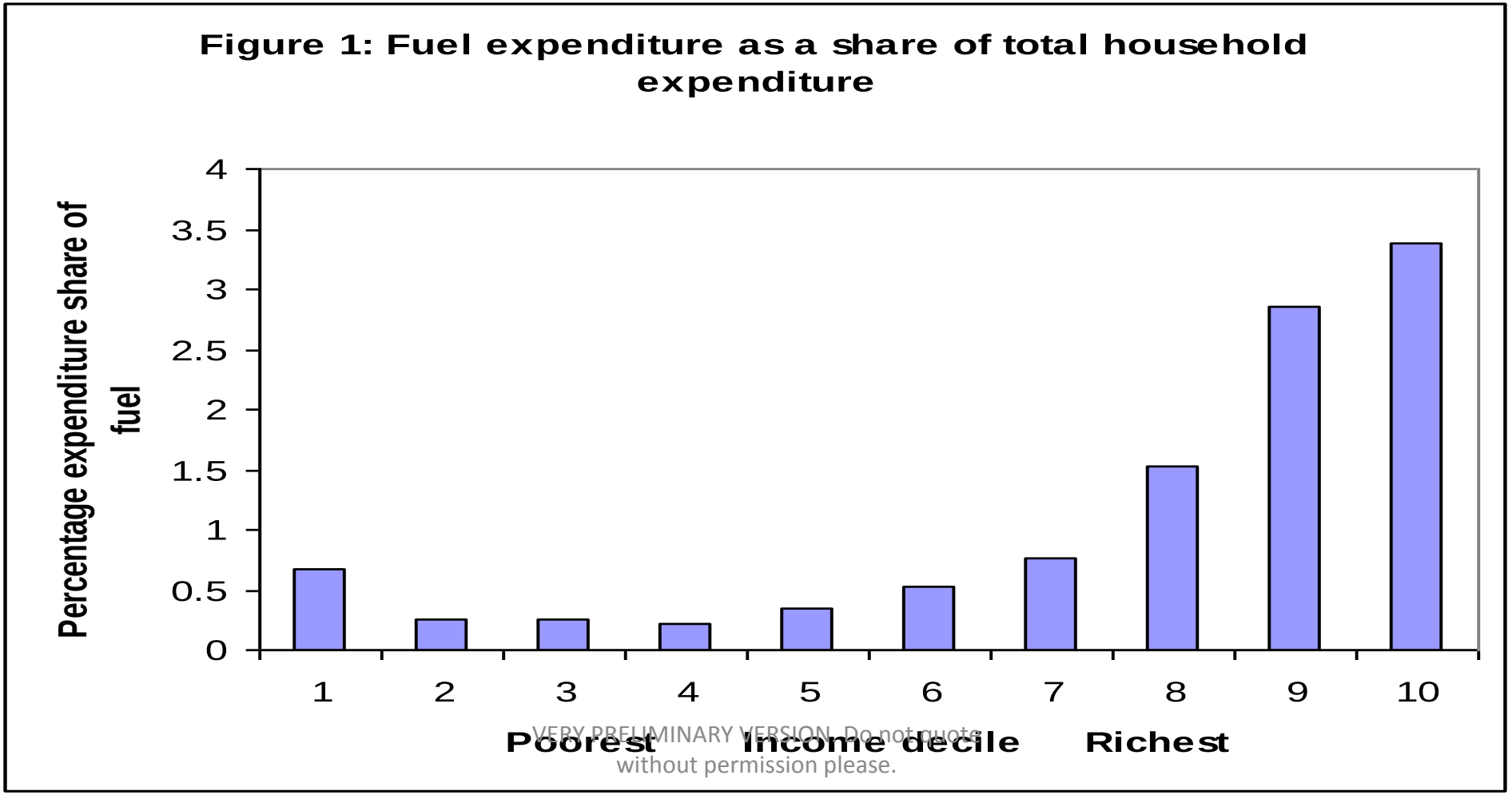
- Important to coordinate policy even in this area, with other countries and other fuels. Otherwise 20-50% of effect lost.

Many other areas of concern

- Distributional effects
- Feasibility
- Refunding or use of funds
- Elasticities changing over time due to design – multifuel capacity desired.

Nigeria abolished fuel subsidy Jan 1

S Africa



Most developing: Progressive