Environmental implications of Russia's WTO Accession

Natalia Turdyeva,
CEFIR, Moscow

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Key messages

1. Market based methods of reducing CO2 emissions are substantially less costly to GDP than command and control measures.
   - Market based measures to reduce emissions are "Cap and Trade" or a tax on emissions.
   - Command and control measures we examine are emissions intensity standards and energy intensity standards.
2. If foreign direct investment or imperfect competition issues are present, ignoring them and their endogenous productivity effects risks getting the sign wrong.

Policy background: trade

- **WTO Reform**

  Accession of Russia to WTO after 19 years of negotiation in 2012:

  - After all commitments are implemented (in 2020),
    - un-weighted average tariffs will fall from 11.5 percent to 7.9 percent;
    - weighted average tariffs will fall from 13.0 percent to 5.8 percent;
    - The average "bound" tariff rate of Russia under its World Trade Organization commitments will be 8.6 percent, that is, 0.7 percentage points higher than the applied tariffs.
- Commitments in business services, including to foreign environmental services provides.

Policy background: climate

- Russia is 5th largest CO2 emitter
  - 5% of global CO2 emissions in 2014 ()
- 31 March 2015: Russian Federation submitted intended nationally determined contribution (INDC)
  - "Limiting anthropogenic greenhouse gases in Russia to 70-75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests."
- *Climate Action Tracker: "*After accounting for forestry this is a reduction of only 6% to 11% below 1990 levels of industrial GHG emissions, and an increase of 30% to 38% compared to 2012 levels."

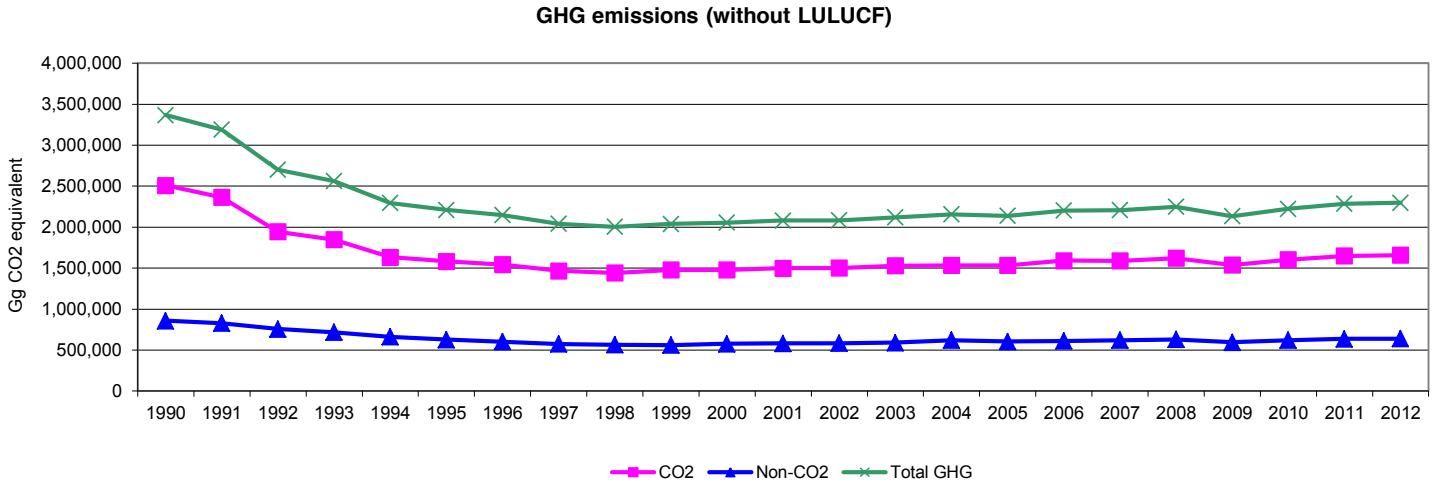
Policy background: climate

Summary of GHG Emissions for Russian Federation

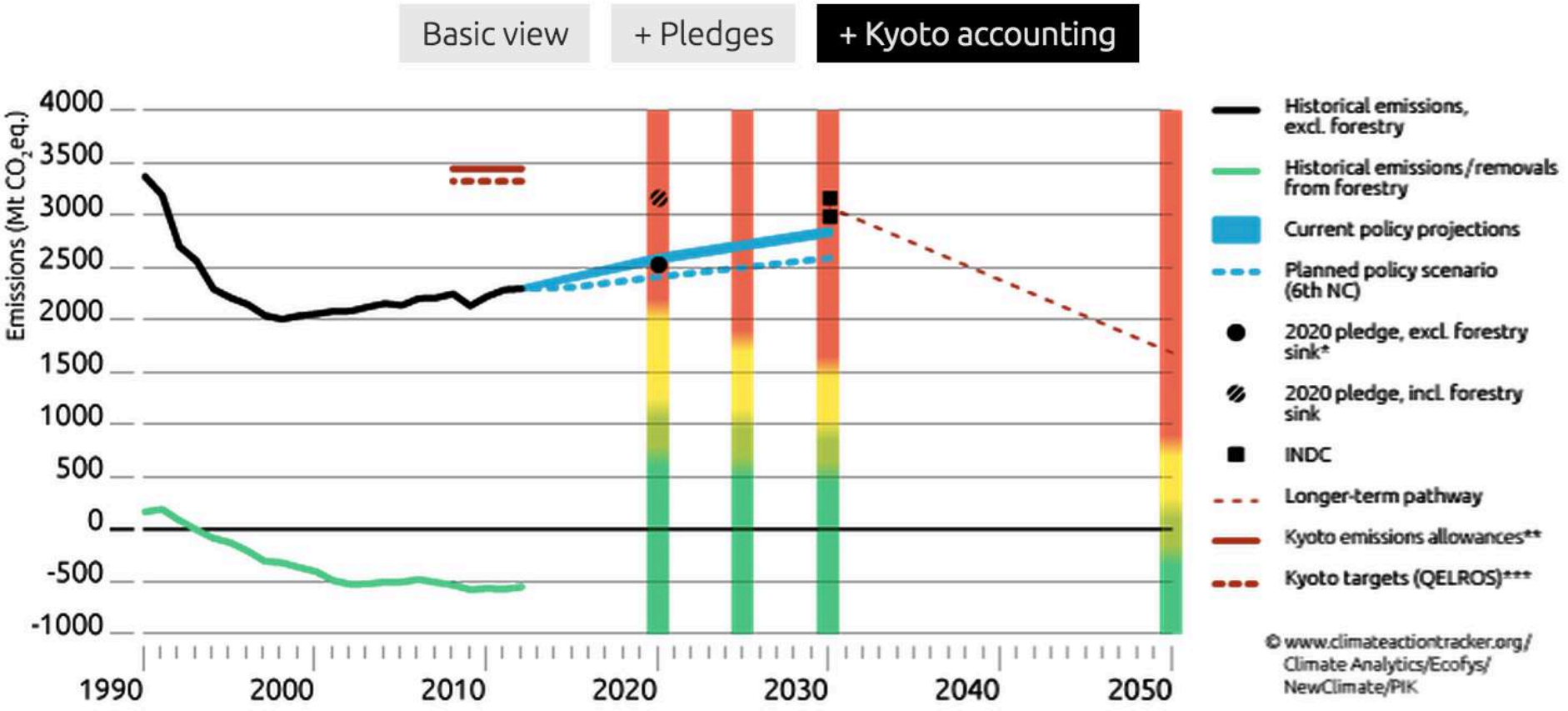
Base year (Convention) = 1990

	Emissions, in Gg CO_2 equivalent		
	1990	2000	2012
CO_2 emissions without LULUCF	2,509,802.4	1,479,193.2	1,658,872.1
CO_2 net emissions/removals by LULUCF	127,526.1	-442,961.6	-580,726.2
CO_2 net emissions/removals with LULUCF	2,637,328.5	1,036,231.7	1,078,145.9
GHG emissions without LULUCF	3,367,781.5	2,055,527.8	2,297,151.8
GHG net emissions/removals by LULUCF	164,571.0	-406,501.9	-542,016.8
GHG net emissions/removals with LULUCF	3,532,352.5	1,649,026.0	1,755,135.0

	Changes in emissions, in per cent		
	From 1990 to 2000	From 2000 to 2012	From 1990 to 2012
CO_2 emissions without LULUCF	-41.1	12.1	-33.9
CO_2 net emissions/removals by LULUCF	--	31.1	--
CO_2 net emissions/removals with LULUCF	-60.7	4.0	-59.1
GHG emissions without LULUCF	-39.0	11.8	-31.8
GHG net emissions/removals by LULUCF	--	33.3	--
GHG net emissions/removals with LULUCF	-53.3	6.4	-50.3

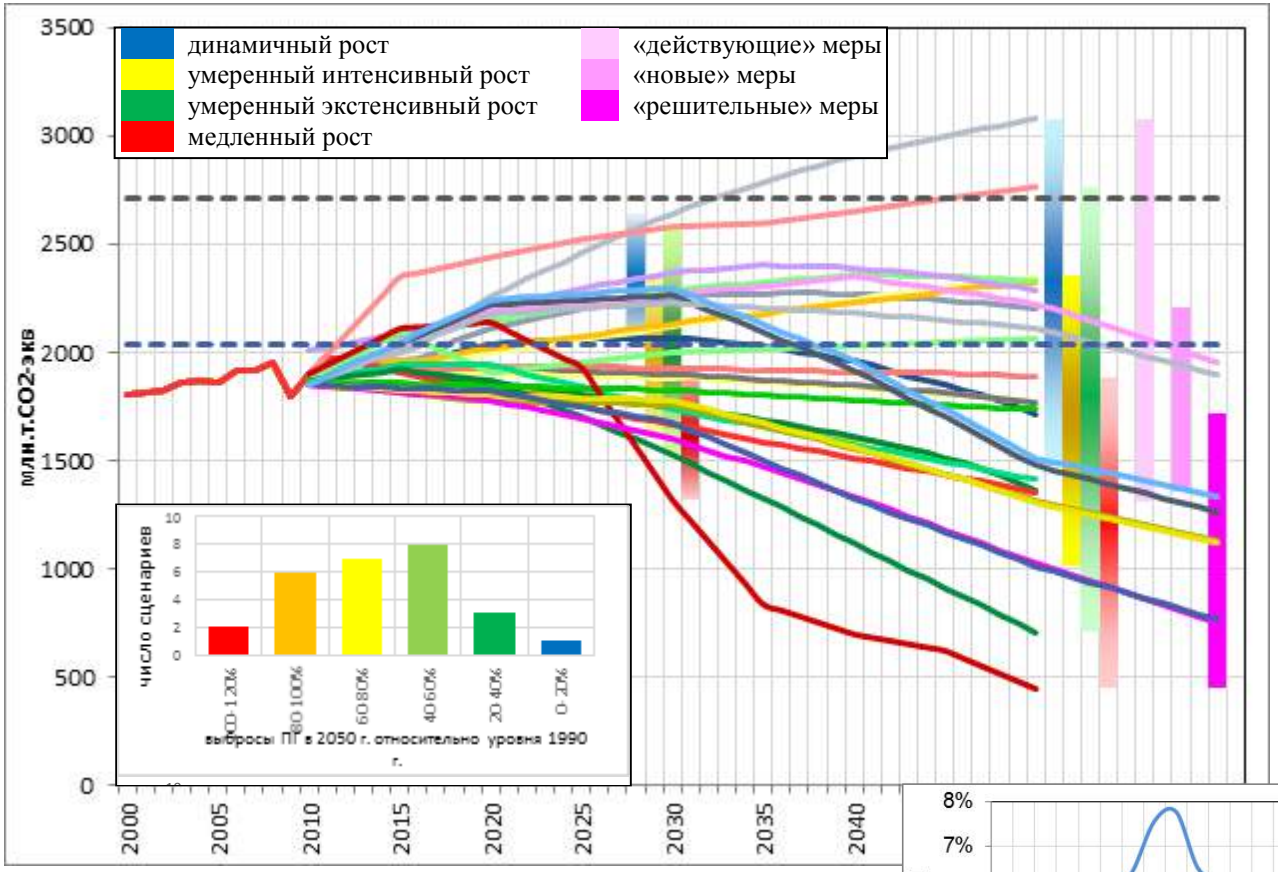


Policy background: climate



Source: climateactiontracker.org

Energy sector CO2 emission projections

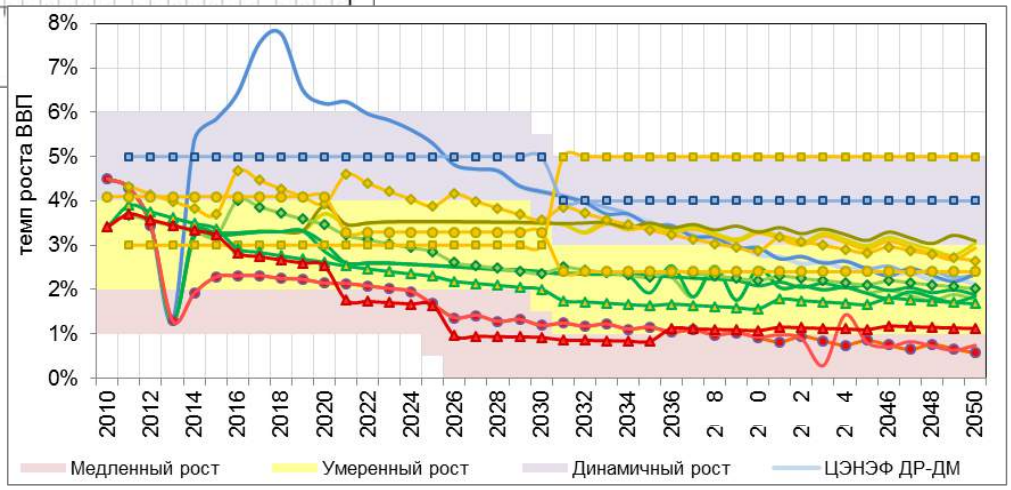


Source: Bashmakov et al (2014)

Almost all scenarios predict energy sector emissions in 2050 at least 11% less than in 1990.

Slow economic growth lowers projections.

GDP growth assumptions



Climate awareness: extreme weather events

- 2010 heat wave and peat fires around Moscow

- 2013 Amur river flood in Far East

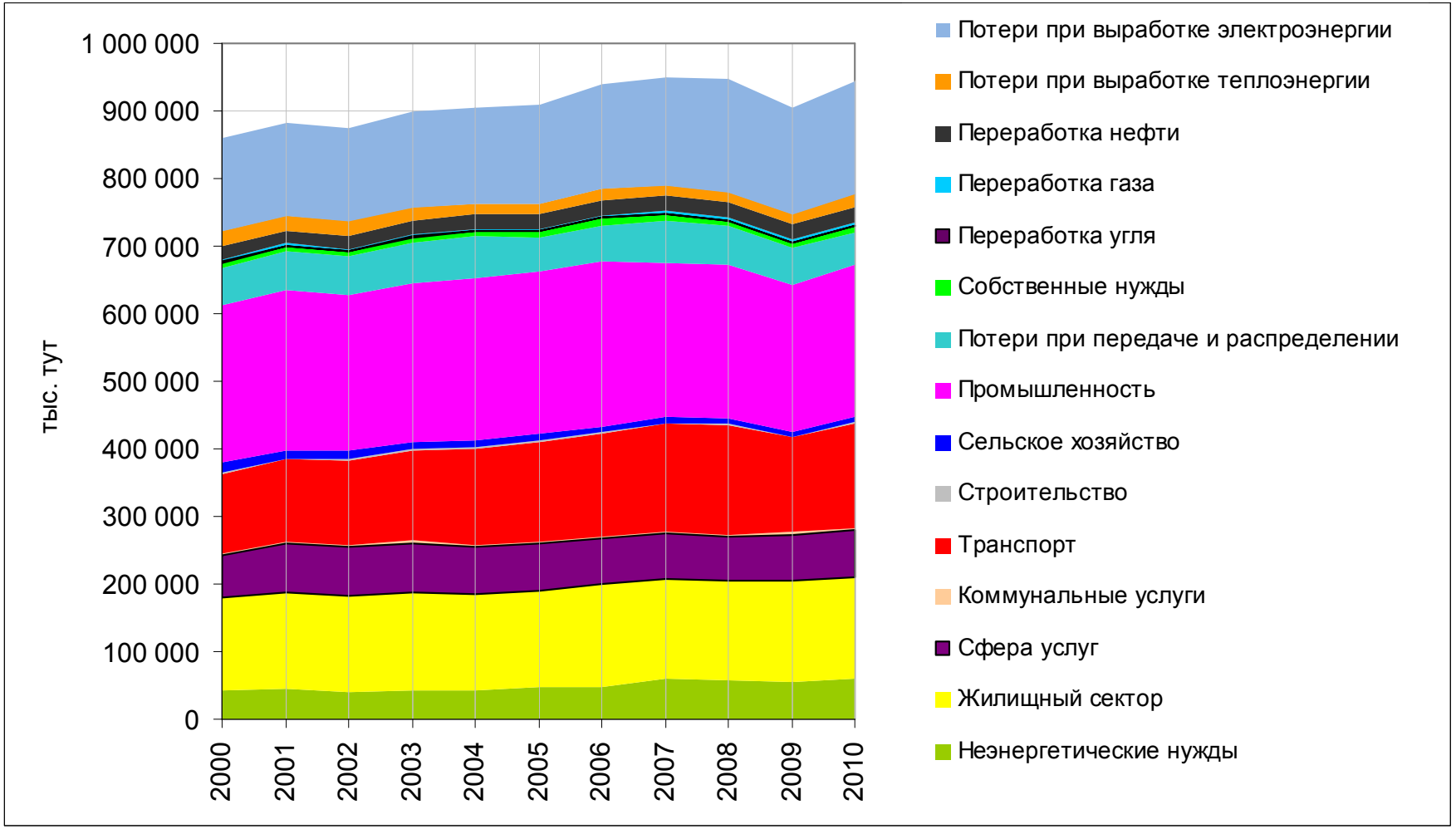
- 2015 Forest fires in Siberia

Policy background: energy efficiency

- **Energy efficiency**

  "Energy Saving and Energy Efficiency Improvement until 2020" program: energy intensity (energy/ GDP) reduction by 40 percent by 2020 compared to 2007
- IEA (WEO 2011): Russian energy efficiency goal is feasible only in 2028 *(New Policies Scenario)*.

Energy use by sector



Source: Bashmakov, Myshak (2012)

CGE model for Russia – basic features

- **Aggregation:** multi-sector (30 industries) , multi-province (10 regions)
- **Time treatment:** static
- **Market conduct:** perfect and imperfect (monopolistic) competition
- **FDI:** multinational service providers can invest to obtain domestic presence
- **Factors:**
  - 2 types of labor: skilled and unskilled Labor – mobile across sectors, but immobile across regions
  - 3 types of capital: region- and sector-specific capital in fuel sectors and in imperfectly competitive industries; capital mobile across sectors but immobile across regions
  - Primary input imported by multinational service providers
- **Trade:** Armington assumption of product heterogeneity

Table 1. List of Sectors

1. Sectors where foreign direct investment from new multinational services providers is possible

RLW	Railway transportation
TRK	Truck transportation
PIP	Pipelines transportation
MAR	Maritime transportation
AIR	Air transportation
TRO	Other transportation
TMS	Telecommunications
SCI	Science & science servicing
FIN	Financial services

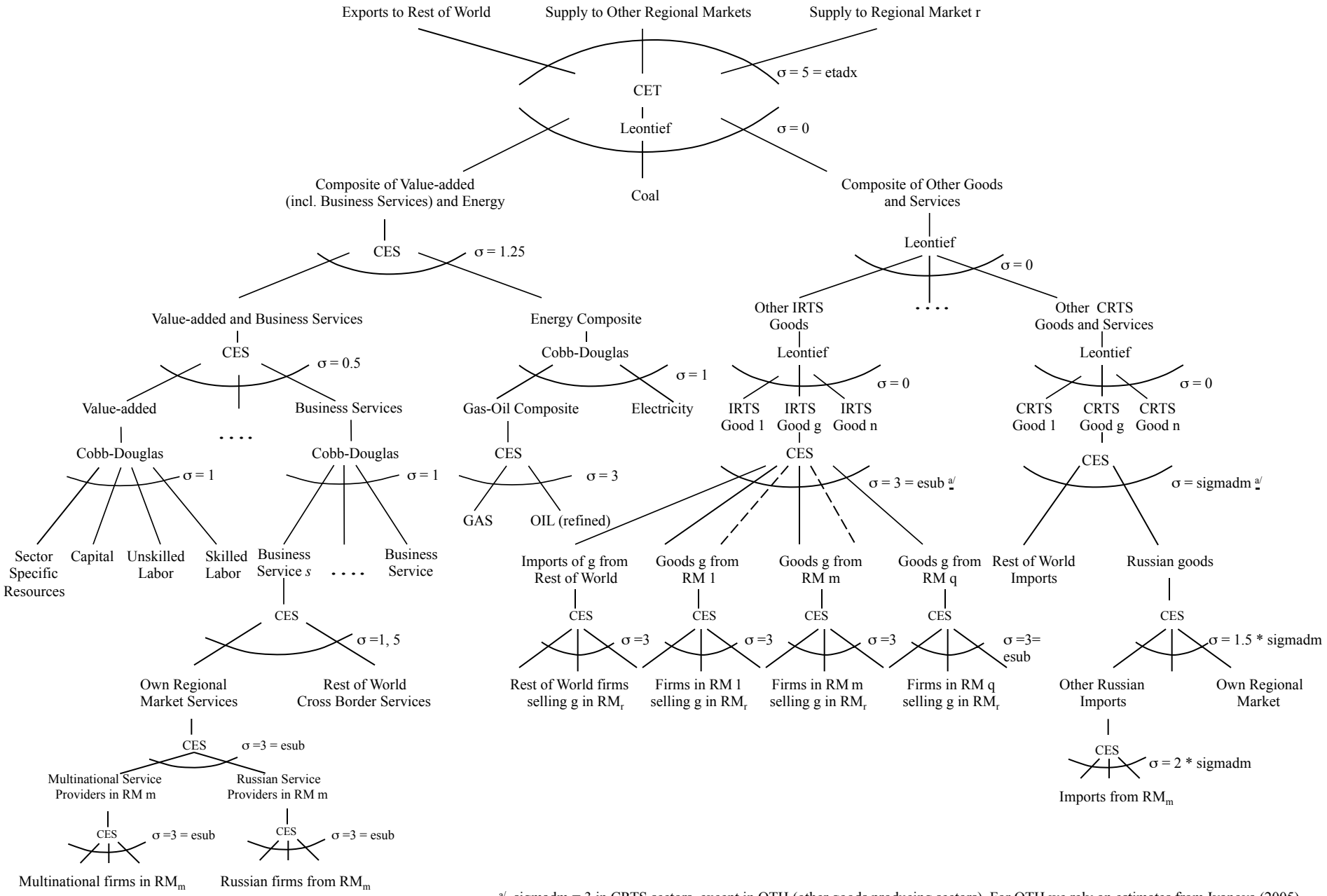
2. Sectors where new foreign firms may provide new goods from abroad

FME	Ferrous metallurgy
NFM	Non-ferrous metallurgy
CHM	Chemical & oil-chemical industry
MWO	Mechanical engineering & metal-working
TPP	Timber & woodworking & pulp & paper industry
CNM	Construction materials industry
FOO	Food industry
OTI	Other industries

3. Competitive sectors subject to constant returns to scale

HEA	Public services, culture and arts
AGR	Agriculture & forestry
COL	Coalmining
HOU	Housing and communal services
CON	Construction
ELE	Electric industry
GAS	Gas
CRU	Crude oil extraction
OIL	Oil refining and processing
OTH	Other goods-producing sectors
PST	Post
TRD	Wholesale and retail trade
CLI	Textiles and apparel

Structure of Production (other than fossil fuels) in Representative Regional Market r



a/ sigmadm = 3 in CRTS sectors, except in OTH (other goods producing sectors). For OTH we rely on estimates from Ivanova (2005).

Dixit-Stiglitz endogenous productivity effects*

- Two final goods, X and Y, $Y = S_y^{\alpha_y} L_y^{(1-\alpha_y)}. \qquad X = S_x^{\alpha_x} L_x^{\beta_x} Z_x^{(1-\alpha_x-\beta_x)}.$
- Two primary factors available on the domestic market,
  - Skilled labour (S);
  - All other factors (L).
- Services (Z) are an intermediate input into X production. Services are produced by imperfectly competitive domestic (ZD) and foreign (ZM) firms.

$$Z_x = (ZD^{\gamma} + ZM^{\gamma})^{1/\gamma}. \qquad ZD = \left[\sum_i^{n_d} zd_i^{\delta}\right]^{1/\delta} \qquad ZM = \left[\sum_i^{n_m} zm_j^{\in}\right]^{1/\in}$$

- Cost functions for domestic and foreign intermediates

$$C^D(r,\ w,\ zd) = cd(r,\ w)zd + fd(r,\ w)$$

$$C^M(r,\ w,\ p_v,\ zm) = cm(r,\ w,\ p_v)zm + fm(r,\ w,\ p_v).$$

* Based on "Trade and direct investment in producer services and the domestic market for expertise" Markusen, Rutherford, Tarr (2005)

Dixit-Stiglitz endogenous productivity effects*

- Large-group monopolistic competition.
- Dual to the output indices are cost functions. Substituting the symmetry of the equilibrium into the cost functions for a unit of ZM or ZD implies that CM and CD can be written as

$$CM = \frac{P_{zm}}{n_m^{\sigma_m - 1}} \quad \text{and} \quad CD = \frac{P_{zd}}{n_d^{\sigma_d - 1}},$$

- where P_{zd} is the price of the output of a domestic firm and n_d and n_m are the number of domestic and foreign firms
- Since the elasticities of substitution exceed unity, the cost of obtaining an aggregate unit of foreign or domestic services decreases as the number of varieties increases
- Additional varieties convey an externality on the final goods sector X by lowering its costs of obtaining a unit of composite services
- Thus, quality adjusted costs decline with the number of varieties—the Dixit-Stiglitz love of variety effect.

* Based on "Trade and direct investment in producer services and the domestic market for expertise" Markusen, Rutherford, Tarr (2005)

Russian Federation

Pollutants

Pollutant	Abbreviation	Environmental impacts	Health effects
Particulate matter	PM	Soiling and damage to materials, smog	Lung cancer, asthma, birth defects
Sulphur dioxide	SO_2	Acid rain, atmospheric particulates	Asthmatic, alterations in the lungs
Carbon monoxide	CO	Leads to increased concentrations of methane and tropospheric ozone	Headache, nausea, dizziness, seizures
Nitrogen oxide	NOx	Acid rain, eutrophication in coastal waters	difficulty breathing, fluid build-up in the lungs
Hydrocarbons	CnHm	Smog, leads to increased concentrations of tropospheric ozone	Affects the central nervous System
Volatile organic components	VOC	Damage to soil and groundwater	Damage to liver, cancer, headaches
Carbon dioxide	CO_2	Climate change, ocean acidification	High concentration: rapid heart rade, clumsiness

Emission accounting and abatement

- **CO2:**
  - linked in fixed proportions to the use of fossil fuels
  - abatement via fuel switching or energy savings

- **Non-CO2 pollutants:**
  - linked in fixed proportions to sectoral output
  - without explicit process-related abatement options emission reduction can only take place through an equivalent decrease in production.
  - process-level abatement options – marginal abatement cost curves (MAC) –based on bottom-up engineering data (discrete step function)

Data

Economic input-output data (base year: 2001)

- national IO data for 24 sectors in 2001 (Rosstat))
- disaggregate national account to include 6 explicit sectors for transportation and communication
- decomposition into provinces according to regional/sectoral value-added for 88 regions in 2001 (Rosstat) with bilateral trade data (exports by region to other regions and world market)

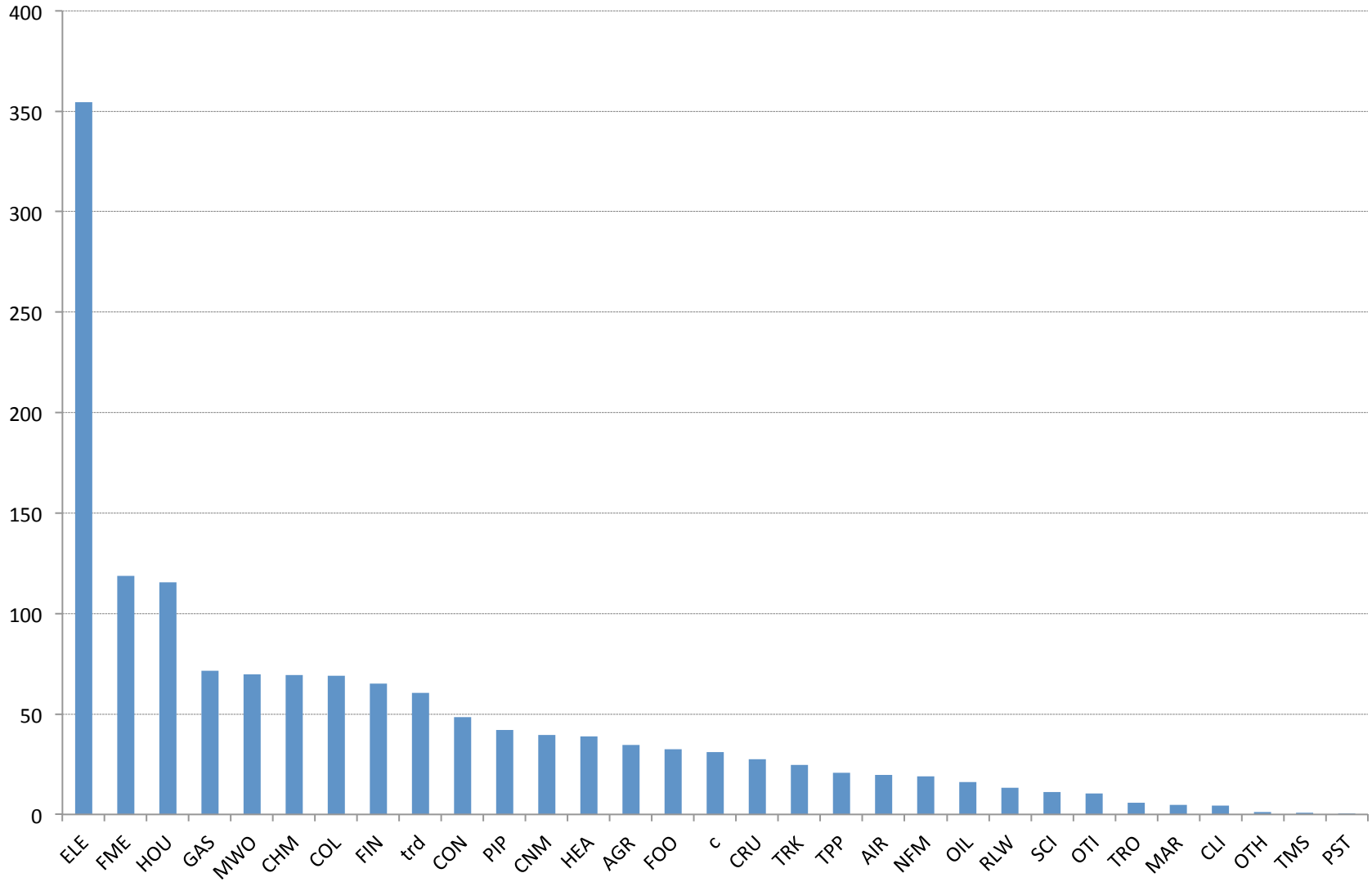
Environmental data (base year: 2006)

- SUSTRUS database:
  - production output by 32 industries in 7 federal districts
  - pollution levels for 32 industries at the nation-wide level
  - pollution levels for each pollution type at the region level
- Sector-specific non-CO2 pollution intensities
- Fuel-specific CO2 coefficients
- Non-CO2 abatement MAC for non-CO2 pollutants based on IIASA-GAINS model (scenario: National 2010 baseline, European part of Russia)

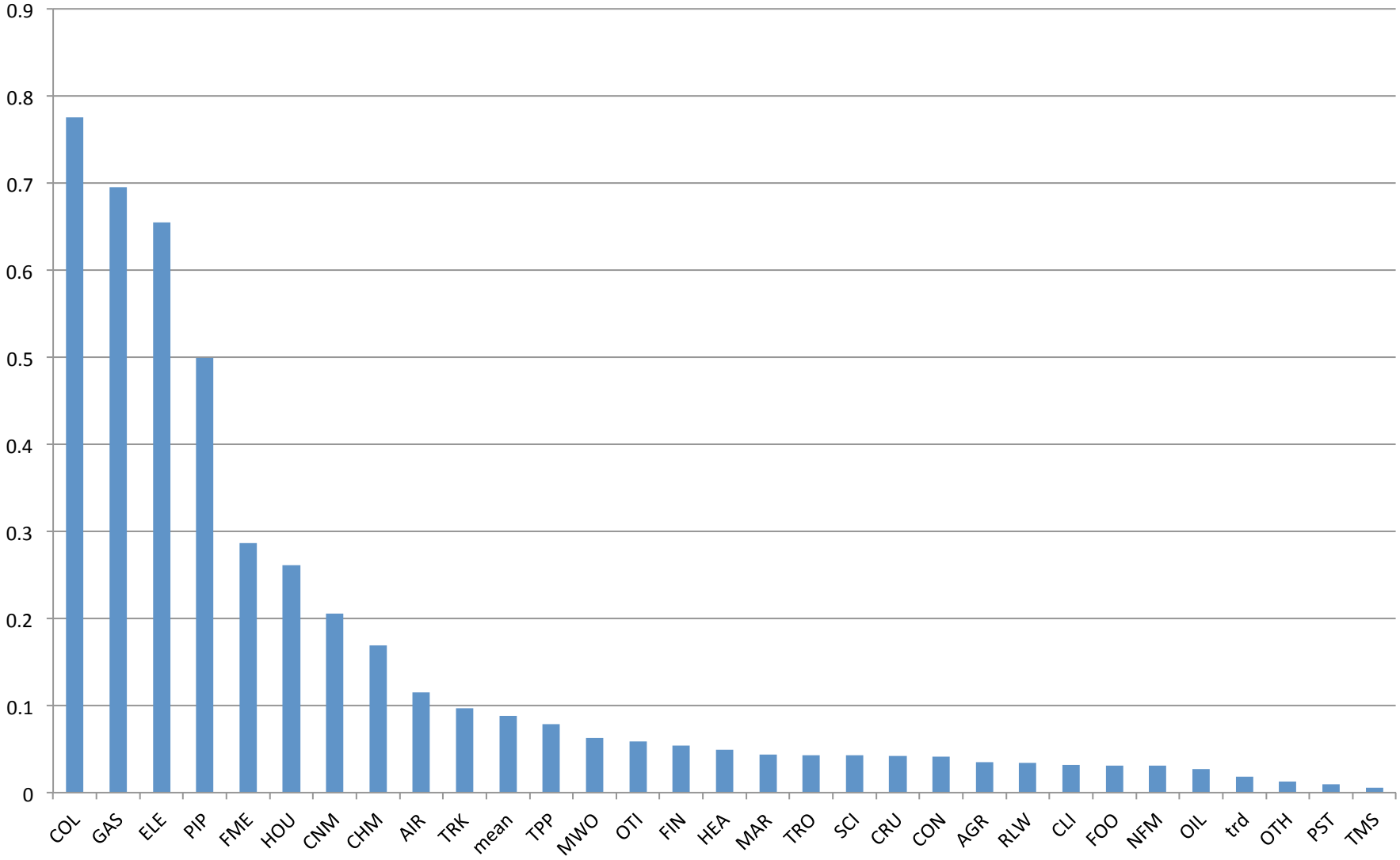
Base-year data: emissions

Pollutant	Emissions
CO2 in Mt	1441
CO2 from coal (Mt)	315
CO2 from gas (Mt)	761
CO2 from oil (Mt)	364
PM in kt	2973
SO2 in kt	5254
CO in kt	5148
NOx in kt	1679
CnHm in kt	2724
VOC in kt	1131

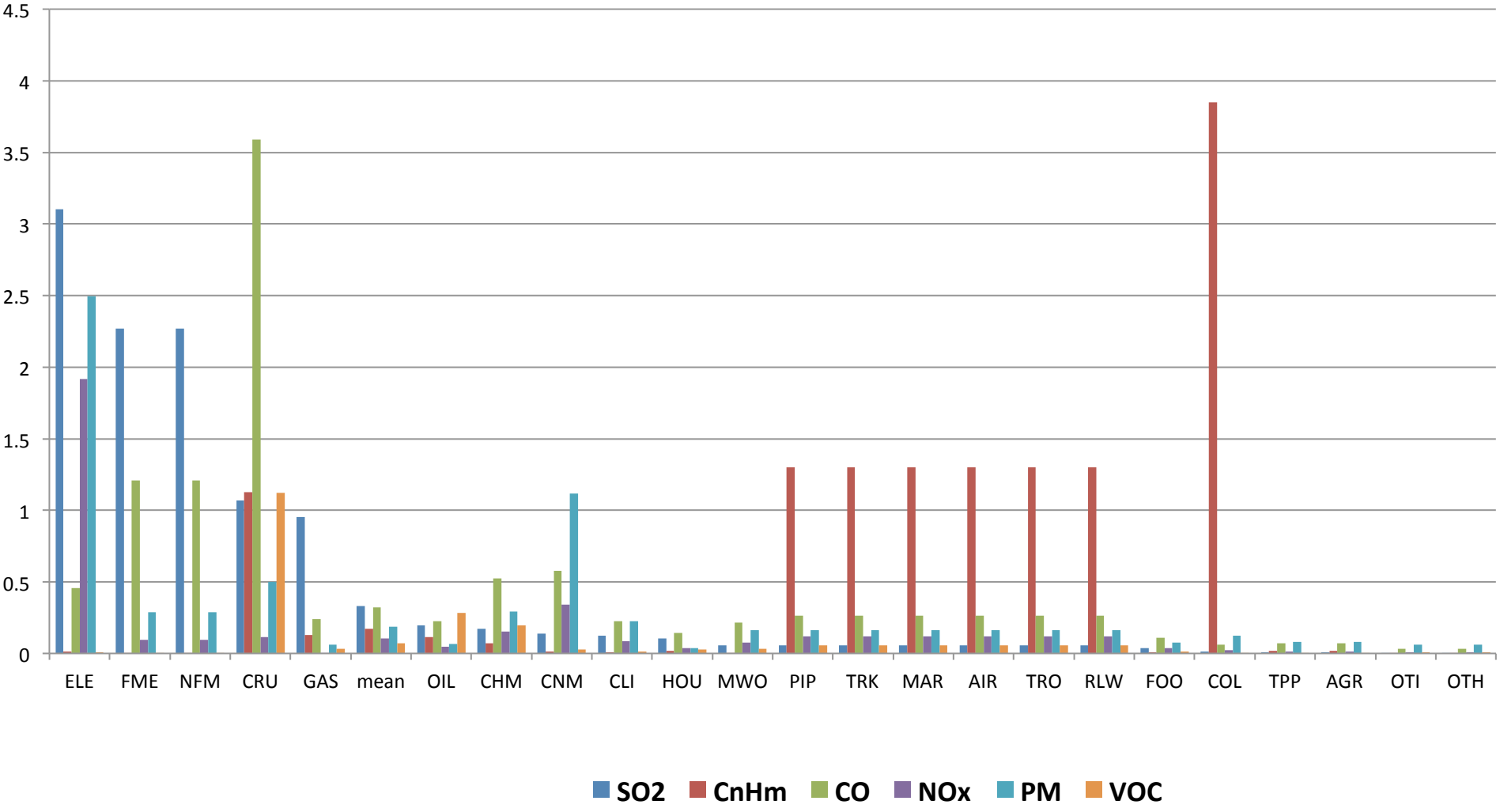
CO2 emissions in Mt (Total: 1441 Mt)



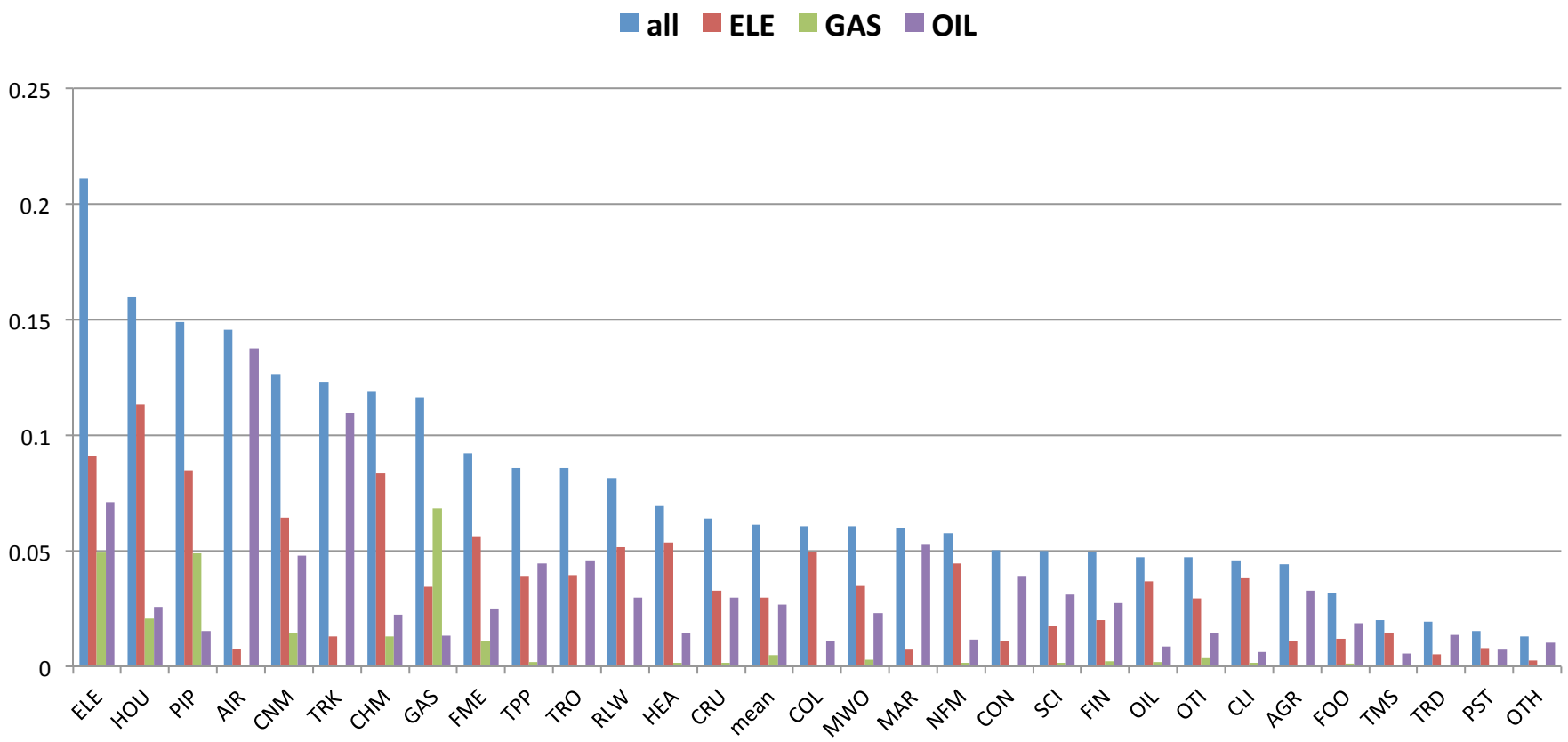
CO2 intensities (kg per RUB)



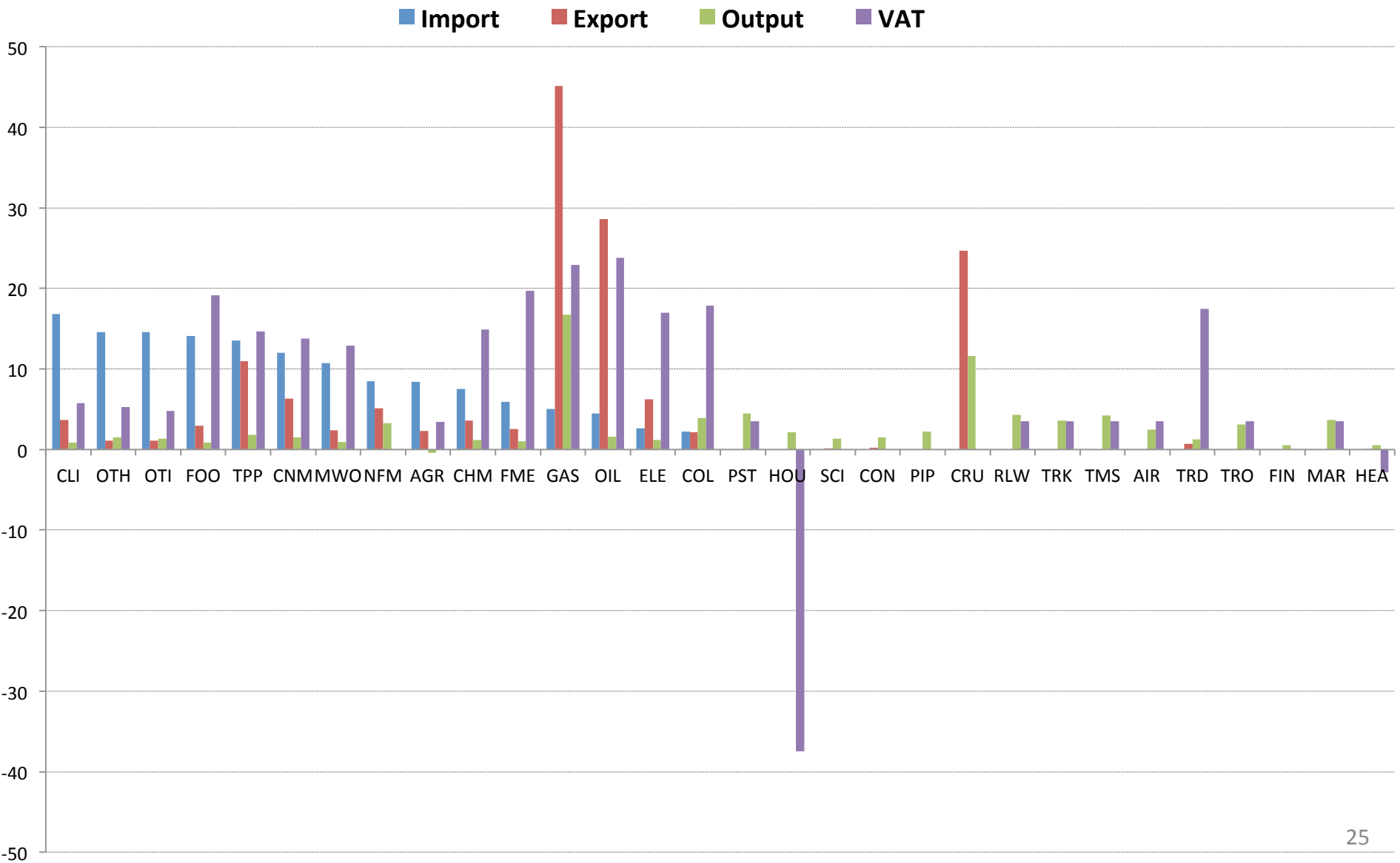
Emission intensities (g per RUB)



Energy intensities (energy per RUB)



Tax rates (%)


Import
Export
Output
VAT
50
40
30
20
10
0
-10
-20
-30
-40
-50
CLI
OTH
OTI
FOO
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MWO
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COL
PST
HOU
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CON
PIP
CRU
RLW
TRK
TMS
AIR
TRD
TRO
FIN
MAR
HEA

Policy scenarios

- *WTO*:
  - (i) barriers to foreign direct investment are eliminated or reduced (depending on the sector);
  - (ii) applied tariffs will fall according to the commitments of the Russian Federation as part of its WTO accession agreement;
  - (iii) better access to export markets (6 industries) -- will lead to improvement in their export prices ranging from 0.5 percent to 1.5 percent

Policy scenarios

- "Green" policy initiatives - CO_2 emissions reduction by twenty percent
  - (i) market based "cap and trade" regulation: (imposes 20% reduction in CO2 emissions through a system of tradable emission rights)
  - (ii) uniform emissions intensity standards: all sectors and regions except for fossil fuels sectors (coal, crude oil and gas) uniformly reduce the intensity of their CO2 emissions per unit of the value of output produced. We solve for the uniform reduction in the intensity of CO2 emissions such that a twenty percent reduction in CO2 emissions is achieved
  - (iii) uniform energy efficiency standards: in all regions, all sectors except electricity and fossil fuel production (crude oil, coal and natural gas) equi-proportionately reduce their use of gas, refined oil and electricity. We solve for the uniform reduction in the use of energy inputs such that a twenty percent reduction in CO2 emissions is achieved.

Benchmark distortions

	Tariff rates		Export	Change in	Effective barriers to FDI (%)	
	2011-pre WTO accession	2020-final commitments	tax rates	world market price	Base Year	Post-WTO Accession
Electric industry	0.0	0.0	0.0	0.0		
Oil extraction	1.7	1	7.9	0.0		
Oil processing	5.1	4.9	4.6	0.0		
Gas	4.7	5	18.8	0.0		
Coalmining	4.4	4.4	0.0	0.0		
Ferrous metallurgy	8.6	5.9	0.4	1.5		
Non-ferrous metallurgy	10	7.4	5.3	1.5		
Chemical & oil-chemical industry	7.4	5.2	1.6	1.5		
Mechanical engineering & metal-working	8.9	5.7	0.0	0.0		
Timber & woodworking & pulp & paper industry	14.3	8.2	6.9	0.0		
Construction materials industry	12.7	9.9	1.6	0.0		
Textiles and Apparel	12.3	8.2	4.1	0.5		
Food industry	18.2	13.6	3.1	0.5		
Other industries	10.4	7.4	0.0	0.5		
Agriculture & forestry	7.7	5.7	0.6	0.0		
Other goods-producing sectors	14.2	10.7	0.0	0.5		
Telecommunications					33.0	0.0
Science & science servicing (market)					33.0	0.0
Financial services					36.0	0.0
Railway transportation					33.0	0.0
Truck transportation					33.0	0.0
Pipelines transportation					33.0	0.0
Maritime transportation					95.0	80.0
Air transportation					90.0	75.0
Other transportation					33.0	0.0

WTO accession without environmental abatement policies will increase CO2 emissions and other pollution

- Welfare gain of 8.6% of consumption in aggregate
- WTO accession leads to an expansion of dirty industries (negative composition effect)
  - chemicals,
  - ferrous metals and
  - non-ferrous metals
- It allows a reduction of energy intensity from increased productivity (positive technique effect)
- But the expansion of output dominates (negative scale effect)

Results of IRTS central model

	WTO Accession only	WTO Accession plus carbon emissions trading	WTO Accession plus emissions intensity standards	WTO Accession plus energy intensity standards	Carbon Reduction Policies Alone emissions trading	Carbon Reduction Policies Alone emissions intensity standards	Carbon Reduction Policies Alone energy intensity standards
Aggregate welfare							
Welfare (EV as % of consumption)	8.6	7.2	6.4	0.6	-1.1	-1.7	-5.9
Welfare (EV as % of GDP)	4.0	3.3	3.0	0.3	-0.5	-0.8	-2.7
Carbon Dioxide Emissions and Decomposition							
CO2 price (ruble per ton of CO2)		112.4			96.0		
CO2 emissions, decomposed into:	4.3	-20.0	-19.2	-19.7	-20.0	-20.0	-19.8
Output effect (% of CO2)	4.9	3.6	2.7	-3.0	-1.0	-1.8	-6.1
Composition effect (% of CO2)	1.0	-3.6	-0.4	-6.5	-3.1	-1.0	-6.0
Technique effect (% of CO2)	-1.6	-19.5	-20.3	-10.6	-16.3	-17.1	-8.2
Non-Carbon Dioxide Emissions							
Sulphur Dioxide	6.2	5.9	7.1	-1.3	-0.1	1.0	-6.9
Nitrogen Oxide	2.8	-1.3	5.1	-16.4	-3.3	2.0	-16.1
Hydrocarbons	1.7	-3.6	-2.6	-6.4	-4.2	-3.6	-6.5
Particulate Matter	3.0	-0.6	4.3	-12.0	-2.9	1.1	-12.5
Volatile Organic Components	2.7	0.8	1.1	-5.8	-1.5	-1.4	-6.8
Carbon Monoxide	4.5	2.2	3.0	-1.2	-1.7	-1.2	-4.7

WTO accession and environmental regulation to reduce CO2 emissions by 20%

- With cap and trade, welfare gain is reduced to 7.2% of consumption (1.4% reduction). Technique effect dominates—sign of composition effect switches as dirty industries contract
- With emissions reduction, welfare gain is reduced to 6.4% of consumption. Weaker composition effect since little incentive to switch production to cleaner sectors
- With energy efficiency standards, welfare gain is reduced to 0.6% of consumption—very inefficient policy at CO2 reduction.
- Why? No market based adjustments; but more importantly, the command and control policy does not target CO2 emissions.

WTO Simulation results: regional

	Overall average	Moscow	St.Peters.	Tumen	Northwest	North	Central	South	Urals	Siberia	Far East
Aggregate welfare											
Welfare (EV as % of consumption)	7.2	5.5	9.7	13.7	12.5	9.2	8.4	7.4	6.4	7.5	8.5
Welfare (EV as % of GDP)	3.3	3.0	4.4	2.9	5.8	3.8	3.9	3.5	2.9	3.5	3.8
Carbon Dioxide Emissions and Decomposition											
CO2 price (ruble per ton of CO2)	0.0	112.4	112.4	112.4	112.4	112.4	112.4	112.4	112.4	112.4	112.4
CO2 emissions, decomposed into:	-20.0	-19.0	-17.7	-22.0	-18.8	-18.1	-19.1	-17.8	-21.3	-20.8	-18.3
- Output effect (% of CO2)	3.6	3.5	5.9	2.3	6.0	5.2	4.0	4.0	2.5	3.8	5.3
- Composition effect (% of CO2)	-3.6	-1.0	-0.7	-11.4	-2.7	-3.4	-1.3	-1.5	-3.0	-5.2	-2.9
- Technique effect (% of CO2)	-19.5	-20.8	-21.6	-13.1	-20.9	-19.1	-21.1	-19.7	-20.7	-19.1	-19.8
Non-Carbon Dioxide Emissions											
Sulphur Dioxide	5.9	1.6	11.7	-2.6	-8.6	7.4	-2.9	2.7	5.3	7.3	5.2
Nitrogen Oxide	-1.3	-2.9	0.3	-1.4	1.3	-0.1	-1.9	-1.6	-1.7	0.0	-1.0
Hydrocarbons	-3.6	-4.7	0.6	-0.5	1.2	-3.4	-2.0	-1.7	-2.8	-10.7	-16.7
Particulate Matter	-0.6	-3.2	-0.4	-0.3	0.1	0.7	-2.1	-2.1	-1.2	1.0	-0.4
Volatile Organic Components	0.8	-1.6	2.2	0.9	17.6	1.4	9.2	1.9	-0.1	-1.5	3.3
Carbon Monoxide	2.2	9.5	6.0	0.7	-9.2	4.1	-3.4	2.3	1.8	5.2	3.1

Perfect competition model estimates less emissions from WTO accession alone and less welfare gain

- In WTO scenario alone, CO2 emissions increase by 4.3% with our central IRTS model, but only 1.0% with the CRTS model
- But the IRTS model estimates larger welfare gains
- Policies that produce a cleaner environment combined along with our trade and foreign direct investment liberalization (WTO accession) yield larger estimated net gains in our imperfect competition model.

CRTS simulation results: emissions

	WTO Accession only	WTO Accession plus carbon emissions trading	WTO Accession plus emissions intensity standards	WTO Accession plus energy intensity standards	Carbon Reduction Policies Alone emissions trading	Carbon Reduction Policies Alone emissions intensity standards	Carbon Reduction Policies Alone energy intensity standards
Aggregate welfare							
Welfare (EV as % of consumption)	1.1	0.7	0.0	-3.5	-0.4	-1.0	-4.1
Welfare (EV as % of GDP)	0.5	0.3	0.0	-1.6	-0.2	-0.4	-1.9
Carbon Dioxide Emissions and Decomposition							
CO2 price (ruble per ton of CO2)		107.8			103.4		
CO2 emissions, decomposed into:	1.0	-20.0	-20.4	-20.2	-20.0	-19.9	-19.9
Output effect (% of CO2)	1.1	0.4	-0.4	-4.7	-0.7	-1.4	-5.3
Composition effect (% of CO2)	0.4	-2.4	-0.9	-6.2	-2.5	-1.2	-6.1
Technique effect (% of CO2)	-0.4	-18.0	-18.6	-9.7	-17.2	-17.3	-8.8
Non-Carbon Dioxide Emissions							
Sulphur Dioxide	4.6	4.5	5.2	-4.7	-0.4	0.6	-8.9
Nitrogen Oxide	0.9	-2.1	3.1	-16.5	-2.9	2.1	-16.4
Hydrocarbons	0.1	-4.5	-3.8	-7.1	-4.3	-3.6	-6.7
Particulate Matter	1.1	-1.4	2.4	-12.5	-2.5	1.2	-12.9
Volatile Organic Components	0.1	-1.1	-1.0	-6.7	-1.1	-1.1	-6.4
Carbon Monoxide	1.9	0.5	0.6	-3.6	-1.4	-1.2	-5.2

Even the sign of the estimated impact changes with perfect competition

- WTO accession combined with environmental regulation results in net gains with all 3 policies in our IRTS model
- But there are net gains only with cap and trade regulation with the CRTS model

Simulation results: welfare

		WTO accession only	WTO accession +			Carbon reduciton policies alone		
			carbon emission trading	emission intensity standards	energy intensity standards	carbon emission trading	emission intensity standards	energy intensity standards
CRTS	Welfare (EV as % of consumption)	1,1	0,7	0	-3,5	-0,4	-1	-4,1
	Welfare (EV as % of GDP)	0,5	0,3	0	-1,6	-0,2	-0,4	-1,9
IRTS	Welfare (EV as % of consumption)	8,6	7,2	6,4	0,6	-1,1	-1,7	-5,9
	Welfare (EV as % of GDP)	4	3,3	3	0,3	-0,5	-0,8	-2,7

Conclusions

- Crucial to choose efficient environmental regulation to avoid political backlash that could reverse green environmental policies
- Market based policies are most efficient—cap and trade or common tax rate for all emissions
- If foreign direct investment or imperfect competition issues are present, ignoring them and their endogenous productivity effects risks getting the sign of the impact wrong.

Outlook

- Update to 2011 IO and emissions data
- Role of initial tax distortions: export taxes
- Optional cross-comparison with GTAP9-based model