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The Kyoto Protocol: 'Hot Air' for Russia?

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Abstract

The Kyoto Protocol sets the carbon emission targets for 2008-2012 for the major emitting countries. Several former Soviet countries have emissions quotas that appear to be in excess of their anticipated emissions as a result of economic downturn. This excess is sometimes referred

1 Introduction

There is a wide consensus among the scientists that increased emissions of \greenhouse gases" (where carbon dioxide, CO_2, is the major component) resulting from economic and demographic growth will cause signi cant global warming by the middle of the 21-st century in the absence of proximately 5840 MtC in 1990 to 8150 MtC in 2010 (with the Annex B share being 4255 MtC) in the absence of carbon reduction e orts. Under the terms of the Kyoto Protocol, the Annex B industrialized countries are expected to cut their emissions by 836 MtC, while 318 MtC are projected to be available from all EE and FSU countries for possible trading. The models differ in their projections but many of them show that meeting the Kyoto targets implies a drastic reduction in carbon emissions for some countries, such as the USA, Canada, and Japan, which are required to cut about 25-35% of their 2010 emissions. Marginal abatement costs are di erent among the countries. The costs depend on the required cutback, carbon intensity and substitution possibilities in di erent sectors across countries. The models are almost uniform in their estimates that Japan has the highest mitigation costs despite the wide di erences in the projections for the other countries.

There is a disagreement between the Annex B countries on the rules for emission permit trading. The European Union is opposed to the sales of emission permits without supplemental domestic abatement activities because of a stated preference for higher domestic abatement activities. This position is strictly rejected by the USA and other countries which advocate e ciency gains from unrestricted international trading of carbon permits. Indeed, due to the fact that the Annex B countries have di erent marginal abatement costs (Weyant, 1999, EMF, 2000), the Kyoto targets without emission trading would lead to misallocation of resources and distortions in international competition.

Di erent views on carbon emission trading are based on perceived costs of meeting the Kyoto obligations. The UMBRELLA group[4], which are required to cut 14% of their projected 2995 MtC in 2010 (DOE, 2000), are pessimistic about the possibility of meeting their commitments through purely domestic e orts. Emission trading lowers the cost of meeting reduction targets by exploiting di erences in marginal abatement costs across countries.

The EU and associates[5], with 8% projected reduction of 1260 MtC, are optimistic regarding domestic abatement costs and do not feel the same need for carbon trading except as a tool for relaxing conjectural tensions (Hourcade, 2000). The EU stresses that any trading should be "supplemental" to domestic actions. Their goal is to limit possibilities of "buying out" of the obligations for importers of "hot air" and to restrict the countries who gain from the emission trade without reducing domestic emissions.

It should be noted that US emissions account for approximately 60% of the UMBRELLA group, 40% of the total Annex B emissions, or 20% of the world emissions. Carbon emissions in implementation (Article 6), and the clean development mechanism (Article 12). Emission trading assumes a trade of emission allowances with each other. The joint implementation (JI) is obtaining credits for emissions avoided by investment in projects in other Annex B countries. The clean development mechanism (CDM) is obtaining similar credits from projects in developing countries that also contribute to their sustainable development. The Protocol does not specify the exact rules for implementation of these mechanisms. We focus our attention on the issues of emission trading.

Economic reasoning predicts that international trade in carbon emission rights can reduce mitigation costs. Any restrictions reduce gains from trade. Costs are lowest when there is full global trading. That is, when reductions are made where it is least expensive to do so regardless

Jensen *et al* (2000) argue that the most important ceiling is the ceiling described in the \however" clause. They notice that an Annex B country can sell as many emission permits as they want provided that they can verify that a similar volume of domestic abatement has been undertaken after 1993. However, the veri cation procedure is not de ned in the EU proposal. The introduction of such veri cation will be costly. It is possible to measure the level of emissions but it is problematic to quantify the level of domestic abatement activities that would have existed in the absence of the Kyoto agreement.

Jensen *et al* apply a dynamic computable general equilibrium model to analyse the economic e ects of the EU proposal. Their interpretation is that the proposal bans the sale of \hot air" but otherwise an Annex B country is allowed to sell any volume of emission permits as long as domestic abatement ratio is not less than 50% of the abatement requirement (\Proposal B"). They contrast their interpretation with the situation where \hot air" is not excluded but the requirement of domestic abatement is maintained (\HotAir"). Jensen estimated a global welfare cost of the introduction of the European Proposal as 14 billion of 1995 $ for the \Proposal B" scenario and 12 billion for the \HotAir" scenario. In the short-run, the EU proposal drives up the price for carbon permits. In the long-run, the proposal drives down the price due to binding import ceilings. \Hot air" exporters lose from the proposal, but lose even more under the global emission trade. However, the authors did not mention that those huge loses would happen in the case of *restricted* global trading. The results of their modeling are obtained under the assumption that the proposal stays forever, there are no administrative costs for veri cation procedures, banking of unused emission permits is not allowed (which is a contradiction of Article 3.13 of the Kyoto Protocol), and there is a possibility of global carbon permit trade (which, again, is not in the Kyoto Protocol).

Bohringer (2000) proposed \cooling down" strategies to satisfy both the UMBRELLA group and the European Union. The strategy requires scaling down Kyoto targets to eliminate "hot air". He shows that all countries are better o using these strategies for emission trading than without any trading. However, it will be politically di cult to impose stricter emission cutback requirements.

2.2 Economics of the European Proposal

Di erent aspects of the economic consequences of demand and supply ceilings are analysed in Baron *et al* (1999) and Jensen *et al* (2000). The potential e ects of the European proposal can be illustrated with the diagrams presented in Figures 1-3.

Figure 1.a shows demand and supply schedules for carbon permits, where the world market price is P_u in the unrestricted trade equilibrium. When demand is restricted, the demand schedule moves from abD_0 to abD_r. At the price P_u there is excess supply, and the price decreases to to P_r to clear the market. The restriction creates a dead weight loss (the black dotted triangle) being split between the buyer and seller and an income transfer from seller to buyer (the rectangle with empty circles inside) due to the lower price on all permits sold.

Figure 1.b shows the marginal abatement cost curve (MAC) for a net permit importer. The level of abatement increases and the level of emissions decreases along the X-axis. The origin corresponds to the business-as-usual case B with no abatement activities. The assigned amount of emissions is K. If a country is restricted to only domestic abatement activities, the MAC is equal to c. In the case of unrestricted trade, the country chooses to abate A_u units domestically and import permits up to K. When imports are restricted, permit imports must decrease and domestic abatement increases to A_r. The country experiences a welfare gain equal to the rectangular circled area due to the lower world market price on all imported permits, but also a welfare loss due to the extra costs of abating domestically equal to the black dotted triangle.

Figure 1.c shows that the permit exporter always loses, partly due to the lower price of permits and partly due to a lower volume of trade. The lower price of permits decreases domestic abatement from A_u to A_r as it is now less pro table to abate domestically and sell the released permits.

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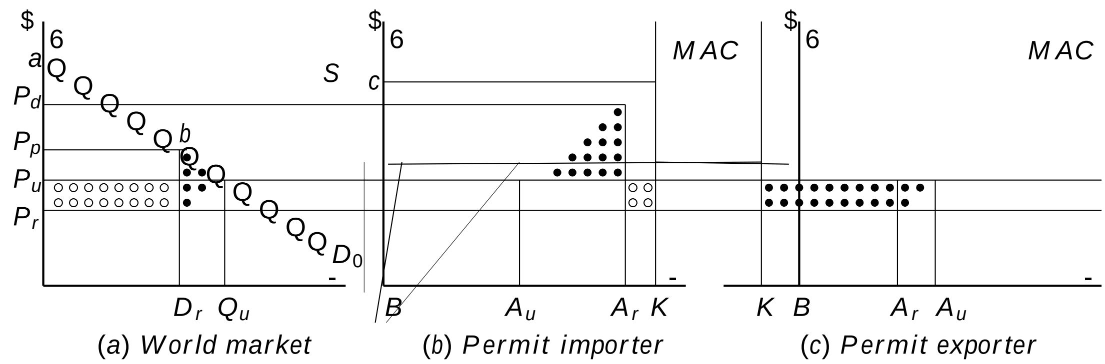
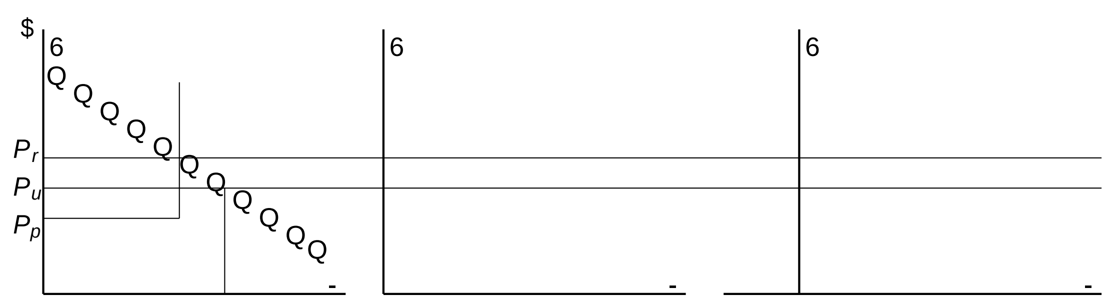


Fig. 1. A ceiling on demand.

Demand side restrictions have no impact on the sale of \hot air" unless total demand is reduced below the volume of available \hot air". It should be noted that if \hot air" is restricted, an exporting country has an opportunity to increase its emissions to an amount which would lie between K and B (which would correspond to negative abatement activities) on Figure 1.c.

Figure 2 shows the consequences of a binding ceiling on the supply side. All other things being equal, a binding ceiling creates excess demand, increasing the world market price from P_u to P_r to clear the market as seen in Figure 2.a. There is also a dead weight loss in this case, but now the income transfer goes from buyer to seller. Due to a higher price on permits, an importing country in Fig. 2.b. increases its domestic abatement from A_u to A_r. The importing country loses from the higher price on permits and from the higher costs of domestic abatement. Domestic abatement increases because of the higher opportunity costs of buying permits on the market.

The exporting country (Fig.2.c) has a gain when the income transfer from higher prices is bigger than the loss of revenue from the lower level of permits sold, and an economic loss when the opposite holds.



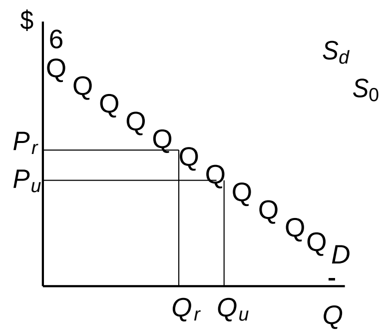


Fig. 3. Supply-side deduction.

In all three cases, the results would be di erent if either buyers or sellers were able to exploit their market power. If \hot air" is not eliminated from the market and Russia and Ukraine form a stable duopoly then the price of permits will be higher. The opposite e ect can happen if the importers of permits are able to exercise a monopsony power.

3 Data

In order to analyse the economic e ects of the Kyoto Protocol and the European Proposal we use a global economic-energy dataset GTAP-EG (Rutherford and Paltsev, 2000), where we have combined the GTAP economic data (Hertel, 1997) with the IEA energy data. The resulting dataset characterizes production and bilateral trade ows in 1995, including tax rates on imports and exports. For our analysis we calibrate the data to the year 2010 using di erent exogenous GDP projections (DOE, 1998; Victor, 1998).

It should be noted that di erent sources report di erent levels for 1990 former Soviet Union (FSU) emissions. Most of the publications provide the data for the FSU as a single region. In our opinion, the most reliable data come from the UNFCCC[6], the US Department of Energy International Energy Outlook (DOE, 2000), the OECD International Energy Agency (IEA, 1997), and the International Institute for Applied Systems Analysis[7] (Victor, 1998).

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	1990	Target	2010	Cutback(%)	Bubble
IEOlow	1034	1013	697	-45	316
IEOref	1034	1013	728	-39	285
IEOhi	1034	1013	797	-27	216
IEO23	854	853	591	-44	261
IIASA	1026	1005	748	-34	257

Table 1. Data for FSU carbon emissions (MtC).
Sources: DOE (2000), Victor et al (1998)

The Kyoto-related models have much wider discrepancy in terms of the 1990 data for the FSU region and 2010 projections. Some of the results (Morita, 1998) are presented in Table 2.

	1990	2010	Cutback(%)	Bubble
AMOCO	974	968-1110	-1.4 : +14.0	0-6
ICAM2/IMF14	1500	1500-1700	0 : +13.5	-
GREEN	1059	1739	+40.3	-
RICE	960	780-1257	-20.6 : +25.2	0-180
WorldScan	993	1122-1746	+13.3 : +44.3	-
YURI	965	910	-3.9	55
MIT/IMF14	960-1023	899-1728	-11.5 : +45.6	61
MERGE/IMF14	960	754-811	-24.8 : -16.0	149-206
AIM/SRES	1216	892-1150	-33.6 : -3.6	66-324

Table 2. Data for FSU carbon emissions (MtC) from di erent models.
Source: Morita (1998)

Table 3 shows the 1990 carbon emissions data for the potential \hot air" sellers, FSU and Eastern Europe, compiled from the di erent data sources. Note that Table 23 of the International Energy Outlook reports carbon emissions for Annex I FSU as being 854 MtC. Summation of UNFCCC statistics for Annex B FSU countries gives 867 MtC. Another Annex I FSU country (but not Annex B country) is Belarus, which accounts for 25-30 MtC according to di erent sources (but not reported by UNFCCC). It follows that even for 1990 emissions the data for the Annex I FSU region di ers by approximately 40 MtC in two widely recognized publications.

Region	Data and Source
Russia	647 (UNFCCC)
Ukraine	192 (UNFCCC), 182 (IEA, IIASA)
Russia+Ukraine	839 (UNFCCC)
Baltics	27.8 (UNFCCC), 17.1 (IEA)
Annex I FSU	854 (DOE), 867 (UNFCCC)
Annex I EE	281 (DOE)
Annex I EE/FSU	1135 (DOE)
FSU	1034 (DOE), 1026 (IIASA)
EE	303 (DOE)
EE/FSU	1337 (DOE)

Table 3. 1990 carbon emissions by the potential \hot air" sellers (MtC)
Sources: UNFCCC (2000), DOE (2000), IIASA (1998), Baron (1999).

In our analysis we use FSU data as a proxy for Russian and Ukrainian economic and energy-related data because of the structure of the GTAP dataset, which does not report statistics of individual FSU countries. Table 4 presents Russia's and \Russia plus Ukraine"'s shares as a percentage of emissions by the other potential exporters of the \hot air". Russia and Ukraine account for approximately 80% of FSU emissions. The deviation is much bigger for the models which use the EE/FSU combined region for all economies in transition.

	R+U	Annex I FSU	Annex I EE/FSU	FSU	EE/FSU
Russia as a percentage of	77.1	75.8	57.0	62.6	48.4
Russia and Ukraine as a percentage of	100	98.2	74.0	81.1	62.7

Table 4. Calculated percentage of emissions by \hot air" sellers.

Russian national estimates of its \carbon bubble" are very di erent from the above mentioned databases. Table 5 reports Russian projections reported to UNFCCC in 1995, 1997, and 1999. The 1998 Russian crisis resulted in negative 5% GDP growth in 1999 and decrease in the level of projected emissions. Taking into account that Russia emits 75% of Annex I FSU carbon emissions, even the pessimistic scenario projects the size of its \carbon bubble" much lower than IEO or IAASA, which are also presented in Table 5[8].

	1990	2010	

	1990	Target	2010	Cutback(%)	Bubble
Low growth					
Russia	647	647	448	-44	199
FSU	1026	1005	742	-35	263
High growth					
Russia	647	647	649	0.3	

Region	Symbol	Sector	Symbol
Annex B:			
United States	USA	Energy-Intensive Sectors	EIS
Canada	CAN	Other manufactures and Services	Y

elasticity. Fossil fuel output ($y(xe)$, where xe is one type of exhaustible energy: crude, gas, coal) is produced as an aggregate of a resource input ($pr(xe)$) and a non-resource input composite. The non-resource input for the production is a xed - coe cient (Leontief) composite of labor (pl) and the Armington aggregation ($pa(i)$) of domestic and imported intermediate input from a production sector i. The elasticity of substitution between pa and pl equals zero ($id : 0$), which characterizes a Leontief composite. The elasticity of substitution ($s : esub\_es$) between the resource input and the

5 Numerical Results

The major results of our numerical simulations are provided in Appendix 4. Our rst conclusion is that free trade in carbon permits increases welfare in almost all Annex B regions and keeps welfare in the non-Annex B countries virtually the same as in the scenario with no trading. Table 9 summarizes the results for the Annex B regions.

	USA	CAN	EUR	JPN	OOE	FSU
Reference case						
Trade	0.2	0.7	0.0	0.6	0.0	

	USA	CAN	EUR	EUA	JPN	OOE	FSU
United							
Trade	0.2	0.7	0.0	-	0.6	0.0	5.5
Cap	0.0	0.3	-0.1	-	0.2	0.0	1.7
Nocomply	0.0	0.2	-0.1	-	0.2	0.0	0.1
Separate							
Trade	0.2	0.7	0.2	1.1	0.6	0.0	5.5
Cap	0.0	0.1	0.0	0.7	0.2	0.1	2.0
Nocomply	0.0	0.0	0.0	0.8	0.2	0.1	0.0

Table 12. Change in welfare (%) in comparison with no trading regime in the case of the united and separate EE/EU region.

The Kyoto Protocol is subject to rati cation by the signatory parties. It will enter into force after not less than 55 parties, incorporating Annex B Parties which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 from that group, have rati ed it. As of today, 0 iy,

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6 Conclusion

The Kyoto Protocol sets the carbon emission targets for 2008-2012 for the major emitting countries and establishes the possibility for carbon emission trading. However, the exact rules of trading are being negotiated. Most projections show that Russia and Ukraine will have emission targets in excess of their anticipated emissions. This excess is called \carbon bubble" or \hot air". In principle, \carbon bubbles" may exist in some other European countries but political reasons will prevent them from the sale of their \bubbles".

The estimates of Russian \hot air" vary over time with the economic performance of Russia. Also, different projecting agencies have different views on the future paths of carbon intensity and energy intensity. While the \hot air" estimates range from 150 to 500 MtC, most of the US and European agencies project the difference between actual and targeted emissions of Eastern Europe and FSU in 2010 as 300-350 MtC, with the Russian share being 170-200 MtC. The other Annex B countries are expected to cut their emissions by 810-850 MtC, which results in the total Annex B decrease in carbon emissions by 500-550 MtC, or 12-15 percent of the Annex B emissions in 2010.

Russian national estimates of the difference between its actual and targeted emissions in 2010 range from 0 to 72 MtC, which corresponds to 0-12 percent of the Russian targeted emissions in 2010. Recent economic growth in Russia will lower the estimate of the \carbon bubble" even further. This implies a greater Kyoto-required decrease in the total Annex B emissions.

The main contribution of this paper is the quantitative assessment of the level of emissions and welfare costs in different scenarios of carbon permit trading. If the Kyoto Protocol is implemented, unrestricted emissions trading will improve welfare in all Annex B countries in comparison to the no trading scenario but the total world emissions rise. Such a free trade scenario leads to lower emissions in Russia than in the case when the Kyoto Protocol is not ratified or the protocol is ratified with no trading allowed. Unrestricted trade results in big welfare gains (5.5 percent) in Russia.

The EU proposal for a ceiling on emission trading is motivated by their desire to achieve lower total world emissions. However, the proposal implies substantial welfare losses for all Annex B parties. In addition, carbon leakage to Russia would mean that emissions would not be significantly reduced.

Without implementing unrestricted trade, Russia and Ukraine have an incentive not to ratify the protocol. However, they alone cannot impose a credible threat of removing themselves from the Kyoto agreement if the ceiling were imposed. An alliance with the other signatory countries who experience high mitigation costs and who want to exploit the full efficiency of free trade in carbon permits makes adoption of the ceiling proposal questionable. Indeed, with the possibility of exchanging excess carbon emissions, all countries would find it profitable to ratify the protocol.

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Appendix 1. Emission Limits under the Kyoto Protocol

Appendix 1 contains the list of Annex B countries and their emission limits as a percentage of a base year emissions according to the Kyoto Protocol (UNFCCC, 1997).

Country	%change in emissions
Australia	108
Austria	92
Belgium	92
Bulgaria*	92
Canada	94
Croatia*	95
Czech Republic*	92
Denmark	92
Estonia*	92
European Community	92
Finland	92
France	92
Germany	92
Greece	92
Hungary*	94
Iceland	110
Ireland	92
Italy	92
Japan	94
Latvia*	92
Liechtenstein	92
Lithuania*	92
Luxembourg	92
Monaco	92
Netherlands	92
New Zealand	100
Norway	101
Poland*	94
Portugal	92
Romania*	92
Russian Federation*	100
Slovakia*	92
Slovenia*	92
Spain	92
Sweden	92
Switzerland	92
Ukraine*	100
United Kingdom	92
United States of America	93

* Countries that are undergoing the process of transition to a market economy.

Appendix 2. Structure of the GTAP-EG model blocks

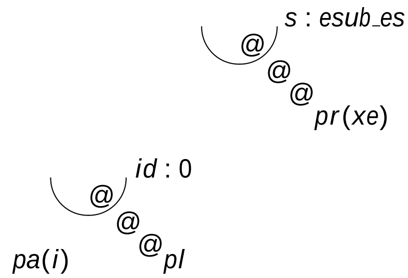


Fig. A.1. Fossil fuel production

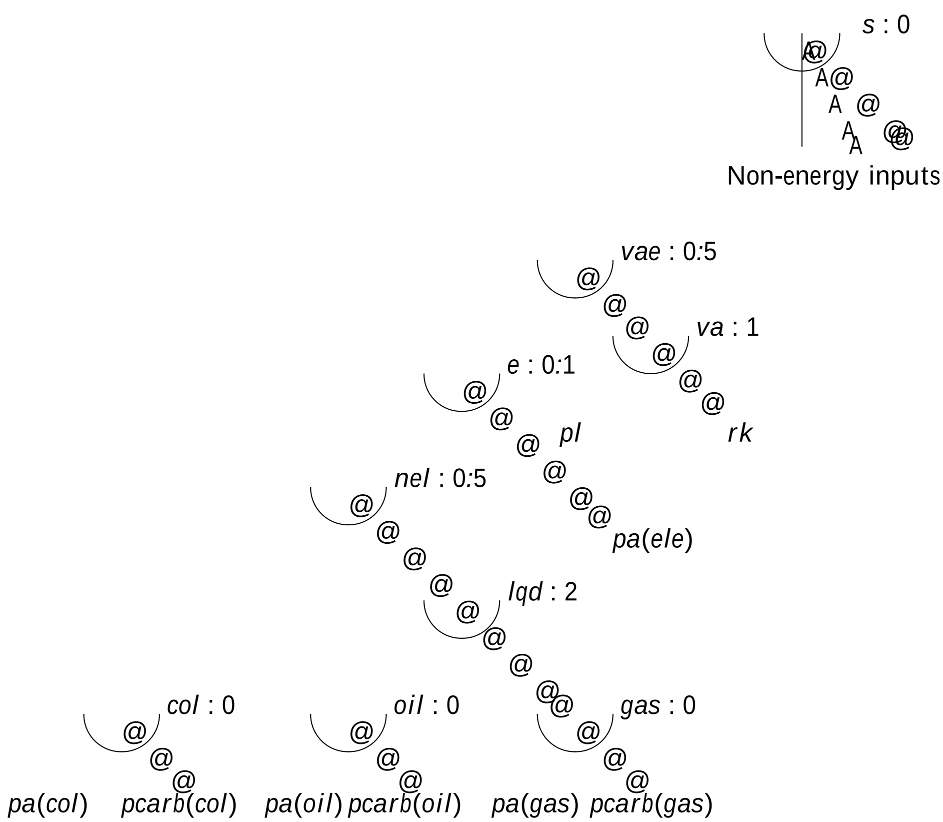
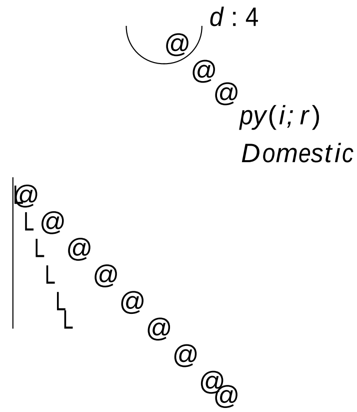


Fig. A.2. Non-fossil fuel production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py(i; r)
Domestic

Appendix 3: Algebraic Model Summary

A.1 Zero Profit Conditions

1. Production of goods except fossil fuels:

A.2 Market Clearance Conditions

8. Labor:

$$\bar{L}_r = \sum_i Y_{ir} \frac{\partial \Pi_{ir}^Y}{\partial w_r}$$

9. Capital:

$$\bar{K}_r = \sum_i Y_{ir} \frac{\partial \Pi_{ir}^Y}{\partial v_r}$$

10. Natural resources:

$$\bar{Q}_{ir} = Y_{ir} \frac{\partial \Pi_{ir}^Y}{\partial q_{ir}} \qquad i \in FF$$

11. Good markets:

$$Y_{ir} \frac{\partial \Pi_{ir}^Y}{\partial p_{ir}} = \sum_{dj} A_{djr} \frac{\partial \Pi_{djr}^A}{\partial p_{ir}} + \sum_s M_{is} \frac{\partial \Pi_{is}^M}{\partial p_{ir}}$$

12. Sector specific energy aggregate:

$$E_{ir} = Y_{ir} \frac{\partial \Pi_{ir}^Y}{\partial p_{ir}^E}$$

13. Import aggregate:

$$M_{ir} = \sum_d A_{dir} \frac{\partial \Pi_{dir}^A}{\partial p_{ir}^M}$$

14. Armington aggregate:

$$A_{dir} = \sum_j Y_{jr} \frac{\partial \Pi_{jr}^Y}{\partial p_{dir}^A} + C_r \frac{\partial \Pi_r^C}{\partial p_{dir}^A}$$

15. Household consumption:

$$C_r\, p_r^C = (w_r \bar{L}_r + v_r \bar{K}_r + \sum_{j \in FF} q_{jr} \bar{Q}_{jr} + t_r^{CO2} \overline{CO2}_r + p_{CGD,r} \bar{Y}_{CGD,r} + \bar{B}_r$$

16. Aggregate household energy consumption:

$$E_{Cr} = C_r \frac{\partial \Pi_r^C}{\partial p_{Cr}^E}$$

17. Carbon emissions:

$$\overline{CO2}_r = \sum_{di} A_{dir} a_i^{CO_2}$$

Table A.1: Sets

i	Sectors and goods
j	Aliased with I
r	Regions
s	Aliased with r
EG	All energy goods: Coal, crude oil, refined oil, gas and electricity
FF	Primary fossil fuels: Coal, crude oil and gas
LQ	Liquid fuels: Crude oil, refined oil and gas
d	Demand categories: Y = intermediate, C = household and I = investment

Table A.2: Activity variables

Y_{ir}	Production in sector *i* and region *r*
E_{ir}	Aggregate energy input in sector *i* and region *r*
M_{ir}	Aggregate imports of good *i* and region *r*
A_{dir}	Armington aggregate for demand category *d* of good *i* in region *r*
C_r	Aggregate household consumption in region *r*
E_{Cr}	Aggregate household energy consumption in region *r*

Table A.3: Price variables

p_{ir}	Output price of good *i* produced in region *r* for domestic market
p_{ir}^E	Price of aggregate energy in sector *i* and region *r*
p_{ir}^M	Import price aggregate for good *i* imported to region *r*
p_{dir}^A	Price of Armington aggregate for demand category *d* of good *i* in region *r*
p_r^C	Price of aggregate household consumption in region *r*
p_{Cr}^E	Price of aggregate household energy consumption in region *r*

r

Table A.4: Cost shares

q_{jir}	Share of intermediate good *j* in sector *i* and region *r* (i∉FF)
q_{ir}^{KLE}	Share of KLE aggregate in sector *i* and region *r* (i∉FF)
q_{ir}^{E}	Share of energy in the KLE aggregate of sector *i* and region *r* (i∉FF)
a_{ir}^{T}	Share of labor (*T*=*L*) or capital (*T*=*K*) in sector *i* and region *r* (i∉FF)
q_{ir}^{Q}	Share of natural resources in sector *i* of region *r* (i∈FF)
q_{Tir}^{FF}	Share of good *i* (*T*=*i*) or labor (*T*=*L*) or capital (*T*=*K*) in sector *i* and region *r* (i∈FF)
q_{ir}^{ELE}	Share of electricity in energy demand by sector *i* in region *r* (i∉FF)
	i (retheon-enectricit usehold energy consumption in region
q_{ir}^{COA}	Share of coal in fossil fuel demand by sector *i* in region *r*
b_{jir}	Share of liquid fossil fuel *j* in liquid fossil fuel demand by sector *i* in region *r* (i∉FF, j∈LQ)
q_{isr}^{M}	Share of imports of good *i* from region *s* to region *r*
q_{dir}^{A}	Share of domestic variety *i* in Armington aggregate for demand category *d* in region *r*
q_{Cr}^{E}	Share of energy in aggregate household consumption in region *r*
g_{ir}	Share of non-energy good *i* in non-energy household consumption demand in region *r*
	Share of non-enectricit ergy good
$q_{ELE,C,r}^{E}$	Share of electricity in aggregate household energy consumption in region Share of impF3 7 4 -6.24.36 D /F4 12

Appendix 4. Numerical results

Carbon emissions (BtC)

Reference case

	bau	notrade	trade	cap	nocomply
USA	1.861	1.279	1.483	1.356	1.325
CAN	0.173	0.118	0.139	0.125	0.125
EUR	1.488	1.213	1.260	1.160	1.145
JPN	0.429	0.295	0.378	0.313	0.313
OOE	0.109	0.088	0.085	0.083	0.083
FSU	0.901	0.957	0.639	0.957	0.962
CHN	1.140	1.170	1.173	1.170	1.170
IND	0.264	0.268	0.268	0.268	0.268
BRA	0.099	0.100	0.100	0.100	0.100
ASI	0.318	0.329	0.330	0.329	0.329
MPC	0.545	0.566	0.574	0.565	0.566
ROW	0.469	0.490	0.491	0.490	0.491
annnexB	4.960	3.948	3.983	3.993	3.952
non-anB	2.834	2.923	2.935	2.921	2.924
TOTAL	7.794	6.871	6.918	6.915	6.876

High growth

	bau	notrade	trade	cap	nocomply
USA	1.861	1.279	1.443	1.353	1.325
CAN	0.173	0.118	0.135	0.125	0.125
EUR	1.488	1.213	1.236	1.161	1.145
JPN	0.429	0.295	0.373	0.313	0.313
OOE	0.109	0.088	0.083	0.083	0.083
FSU	1.008	1.005	0.683	0.954	1.076
CHN	1.140	1.173	1.176	1.174	1.170
IND	0.264	0.269	0.269	0.269	0.268
BRA	0.099	0.101	0.100	0.100	0.100
ASI	0.318	0.330	0.333	0.330	0.329
MPC	0.545	0.569	0.578	0.571	0.566
ROW	0.469	0.491	0.494	0.493	0.491
annexB	5.067	3.996	3.952	3.988	4.066
non-anB	2.834	2.933	2.949	2.936	2.924
TOTAL	7.900	6.929	6.900	6.924	6.990

Low growth

	bau	notrade	trade	cap	nocomply
USA	1.861	1.279	1.564	1.356	1.325
CAN	0.173	0.118	0.146	0.125	0.125
EUR	1.488	1.213	1.310	1.165	1.145
JPN	0.429	0.295	0.389	0.313	0.313
OOE	0.109	0.088	0.090	0.083	0.083
FSU	0.742	0.787	0.572	0.791	0.792
CHN	1.140	1.170	1.165	1.169	1.170
IND	0.264	0.268	0.268	0.268	0.268
BRA	0.099	0.100	0.100	0.100	0.100
ASI	0.318	0.329	0.328	0.329	0.329
MPC	0.545	0.566	0.565	0.565	0.566
ROW	0.469	0.490	0.486	0.490	0.491
annexB	4.800	3.779	4.071	3.832	3.782
non-anB	2.834	2.923	2.911	2.920	2.924
TOTAL	7.634	6.701	6.982	6.752	6.705

Welfare

Reference case

	notrade	trade	cap	nocomply
USA	0.993	0.995	0.993	0.993
CAN	0.980	0.987	0.983	0.982
EUR	0.998	0.998	0.997	0.997
JPN	0.992	0.998	0.994	0.994
OOE	0.991	0.991	0.991	0.991
FSU	0.992	1.047	1.009	0.993
CHN	0.999	1.000	0.999	0.999
IND	1.002	1.002	1.002	1.002
BRA	1.001	1.001	1.001	1.001
ASI	1.001	1.001	1.001	1.001
MPC	0.991	0.992	0.992	0.991
ROW	0.997	0.998	0.997	0.997

High growth

	notrade	trade	cap	nocomply
USA	0.993	0.994	0.993	0.993
CAN	0.980	0.985	0.983	0.982
EUR	0.998	0.998	0.997	0.997
JPN	0.992	0.998	0.994	0.994
OOE	0.990	0.990	0.991	0.991
FSU	0.992	1.032	1.006	0.993
CHN	0.999	1.000	1.000	0.999
IND	1.002	1.002	1.002	1.002
BRA	1.001	1.001	1.001	1.001
ASI	1.001	1.002	1.001	1.001
MPC	0.990	0.990	0.990	0.991
ROW	0.997	0.998	0.997	0.997

Low growth

	notrade	trade	cap	nocomply
USA	0.993	0.996	0.993	0.993
CAN	0.980	0.990	0.983	0.982
EUR	0.998	0.998	0.997	0.997
JPN	0.992	0.999	0.994	0.994
OOE	0.991	0.992	0.991	0.991
FSU	0.992	1.061	1.011	0.993
CHN	0.999	1.000	0.999	0.999
IND	1.002	1.001	1.002	1.002
BRA	1.001	1.001	1.001	1.001
ASI	1.001	1.001	1.001	1.001
MPC	0.991	0.994	0.992	0.991
ROW	0.997	0.998	0.997	0.997

Permit price

Regional

	ref	hi	low
USA	180.38	180.74	180.38
CAN	198.34	198.90	198.34
EUR	109.18	110.95	109.18
JPN	428.18	429.56	428.18
OOE	73.47	74.59	73.47
FSU	M(0.37)	10.66	M(2.039)

World price

	trade	cap	nocomply
ref	90.08	140.06	154.69
hi	104.63	142.47	154.69
low	64.31	136.80	154.69