

Alternative futures for Kazakhstan

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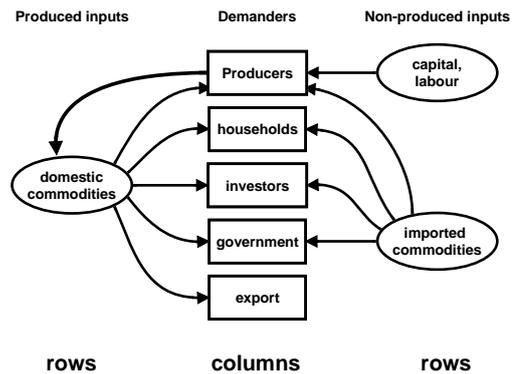
CoPS: Centre of Policy Studies

- Building and using CGE models since 1975
- Notable for detailed models, using percent change formulation, and GEMPACK software.
- Replaced small, long-run CGE models, with 100 sector short-run CGE models, emphasizing adjustment costs.
- Initial applications to tariff-reduction, but now
 - Analysis of domestic tax changes (VAT)
 - Detailed Employment forecasting
 - Climate-change issues (CO2 tax)
 - Foreign ownership issues
 - Drought and other natural disasters
 - And many others

Countries modelled by CoPS

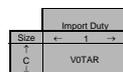
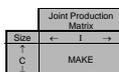


Stylized CGE model: material flows



Model Database

	Size	1 Producers	2 Investors	3 Household	4 Export	5 Government	6 Inventories
Basic Flows	CxS	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	CxSxM	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
Taxes	CxS	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labour	O	V1LAB	C = Number of Commodities				
Capital	I	V1CAP	I = Number of Industries				
Land	I	V1LND	S = 2: Domestic, Imported				
Production Tax	I	V1PTX	O = Number of Occupation Types				
Other Costs	I	V1OCT	M = Number of Commodities used as Margins				



CGE model resembles input-output model

- For IO model, inputs are proportional to output
- For CGE model, prices also play a role; use less of higher priced inputs.
- CGE model also links demands to incomes.

What is an applied CGE model ?

- Computable, based on data
 - It has many sectors
 - And perhaps many regions, primary factors and households
 - A big database of matrices
 - Many, simultaneous, equations (hard to solve)
- Unlike Input-Output models:
- Nonlinear equations (harder to solve)
 - Prices guide demands by agents
 - Prices determined by supply and demand
 - Trade focus: elastic foreign demand and supply

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Kazakhstan CGE Model

- Based on ORANI-G CGE model
- Data based mainly on Simplified 2015 IO tables
- Hope to rebuild using more detailed 2015 IO tables
- Base forecast runs 2015 to 2030 and shows effects of population and productivity growth with flat oil price.
- Policy simulations show effects of:
 - 80% increase world oil price
 - 10% efficiency increase in different sector groups

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ORANI-G

- A model of the Australian economy, still used, but superseded at CoPS (by MMRF and other models).
- A teaching model.
- A template model, adapted for use in many other countries (INDORANI, TAIGEM, PRGEM).
- Most versions do not use all features and add their own features.
- Still evolving

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ORANI-G like other CGE models

Equations typical of an AGE model, including:

- market-clearing conditions for commodities and primary factors;
- producers' demands for produced inputs and primary factors;
- final demands (investment, household, export and government);
- the relationship of prices to supply costs and taxes;
- a few macroeconomic variables and price indices.

Neo-classical flavour

- Demand equations consistent with optimizing behaviour (cost minimisation, utility maximisation).
- fixed markup: producers price proportional to marginal cost.

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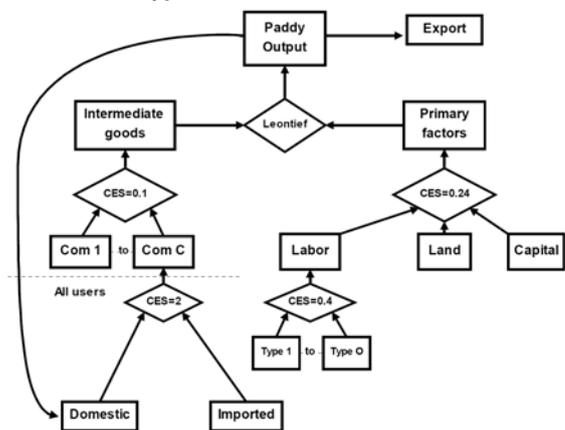
CGE simplifications

- An imposed structure of behaviour, based on theory
- Neoclassical assumptions (optimizing, competition)
- Nesting (separability assumptions)

Why: time series data for huge matrices cannot be found.
Theory and assumptions (partially) replace econometrics

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Typical Production structure



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Figure 3. Production Technology

What is a CGE model good for ?

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Analysing policies that affect different sectors in different ways

The effect of a policy on different:

- Sectors
- Regions
- Factors (Labour, Land, Capital)
- Household types

Policies (tariff or subsidies) that help one sector a lot, and harm all the rest a little.

Winners and Losers

- reducing the fears of the losers
- making deals

What-if questions

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- What if productivity in agriculture increased 10%?
- What if foreign demand for exports increased 5%?
- What if government demands were reduced?
- What if CO2 emissions were taxed?
- What if water became scarce?

A great number of exogenous variables (tax rates, endowments, technical coefficients).

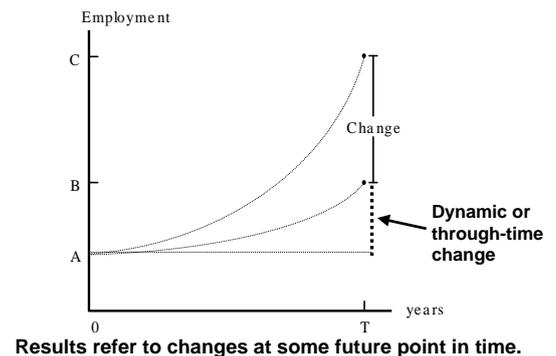
Two simulations

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- A one-shot base forecast taking the economy from 2015 to 2030, yielding percent changes 2015-30 and a 2030 database.
- A comparative static simulation, starting from 2030 database, and imposing oil price change and several efficiency shocks

Dynamic and Comparative-static interpretation of results

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Baseline forecast 2015-30

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	Total % change	Ave Annual Growth Rate	Assumptions	% p.a.
Real household consumption	32.1	1.87	pop growth	1
Real investment	32.1	1.87	labour tech	1
Real government consumption	32.1	1.87	land tech	1
Aggregate export volume	25.1	1.51	export demand	2
Aggregate import volume	27.1	1.61		
Real GDP	29.8	1.75		
Employment	16.1	1.00		
Real wage	11.8	0.74		
Aggregate capital stock	28.3	1.67		
Quantity mining/oil exports	16.2	1.01		
Price mining/oil exports	1.4	0.09		
Revenue mining/oil exports	17.8	1.10		

Baseline forecast 2015-30

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Broad Sectoral Outputs	Total %	Average %
AgricForFish	23.8	1.44
Mining	18.4	1.13
BasicManufact	38.7	2.21
OthManufact	35.3	2.03
Construction	32.6	1.90
ElecGasWater	34.0	1.97
Trade	30.7	1.80
Transport	29.9	1.76
OtherService	35.8	2.06
GovEducHlth	32.6	1.90

Baseline forecast 2015-30

Regional GDP	Total %	Average %
Akmolin	36.7	2.11
Aktubin	25.5	1.52
Almatin	30.8	1.81
Atyrau	22.9	1.38
ZapKazakhstn	22.4	1.36
Zhambyl	30.7	1.80
Karagandin	28.1	1.66
Kostanai	34.1	1.98
Kyzylordn	25.6	1.53
Mangistau	22.8	1.38
YuzKazakhstn	29.1	1.72
Pavlodar	32.2	1.88
SevKazakhstn	33.8	1.96
VosKazakhstn	27.8	1.65
Astana	36.0	2.07
Almaty	35.4	2.04

Regional Specialization 2015

	AgricForFish	Mining	BasicManufac	OthManufac	Construction	ElecGasWater	Trade	Transport	OtherService	GovEducHlth	Total
Akmolin	4.0	1.0	50.8	30.1	1.6	0.6	3.6	2.1	4.3	1.8	100.0
Aktubin	5.2	33.2	3.8	3.7	6.3	3.4	17.8	8.5	13.3	5.0	100.0
Almatin	20.5	1.1	6.7	2.5	13.3	2.4	13.3	12.2	19.2	8.8	100.0
Atyrau	1.2	60.5	2.1	6.0	7.1	0.6	3.4	5.8	11.9	1.4	100.0
ZapKazakhstn	3.1	58.6	7.0	0.4	3.9	1.6	7.5	4.8	9.4	3.8	100.0
Zhambyl	14.1	3.8	5.3	4.1	10.1	4.1	14.4	14.6	17.3	12.3	100.0
Karagandin	5.2	18.4	4.6	1.8	6.3	7.0	19.8	12.9	16.9	7.1	100.0
Kostanai	10.1	8.4	29.0	5.4	4.8	1.4	12.7	9.5	13.5	5.1	100.0
Kyzylordn	3.6	38.0	3.4	8.2	8.7	1.7	8.2	9.0	12.2	7.0	100.0
Mangistau	0.5	57.4	1.3	0.7	6.7	2.4	4.7	7.6	16.0	2.7	100.0
YuzKazakhstn	12.6	10.9	3.0	0.5	8.8	1.9	16.2	10.7	23.8	11.6	100.0
Pavlodar	4.9	5.2	17.7	8.2	8.8	6.8	15.0	16.1	11.9	5.3	100.0
SevKazakhstn	22.2	0.1	22.1	6.4	4.2	2.6	14.3	8.2	14.8	7.1	100.0
VosKazakhstn	12.6	13.6	0.6	3.0	7.0	3.8	19.8	10.7	19.9	9.0	100.0
Astana	0.1	0.0	6.9	3.0	10.6	0.8	25.2	8.7	38.4	6.3	100.0
Almaty	0.0	0.0	1.6	0.5	3.3	1.1	44.2	5.9	40.1	3.3	100.0

Scenario variations

- A comparative static simulation, starting from 2030 database, and imposing oil price change and several efficiency shocks.
- Efficiency shocks are 10% reduction in all-inputs-per-output for:
 - the four transport sectors
 - selected service sectors: MVPdealers, WholesaleTrd, Retail, HotelsRestnt, PostTelecoms, FinanInterm, OthrBusiness, OthComSocPer
 - agriculture
- Results show contribution of each shock to total result.

Variations -- % difference from Base 2030

	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
Real household consumption	3.2	2.3	8.3	1.3	15.0
Real investment	3.2	2.3	8.3	1.3	15.0
Real government consumption	3.2	2.3	8.3	1.3	15.0
Aggregate export volume	20.6	1.0	3.5	0.1	25.2
Aggregate import volume	28.5	1.3	4.8	0.2	34.8
Real GDP	2.8	2.0	7.2	1.1	13.0
Employment	0.0	0.0	0.0	0.0	0.0
Real wage	-2.1	1.6	7.6	2.3	9.3
Aggregate capital stock	6.4	1.7	6.4	0.9	15.5
Quantity mining/oil exports	46.2	0.0	-0.6	-0.3	45.3
Price mining/oil exports	73.8	0.0	0.1	0.0	73.9
Revenue mining/oil exports	153.7	0.0	-0.7	-0.3	152.6

Variations -- % difference from Base 2030

Broad Sectoral Outputs	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
AgricForFish	0.6	1.1	2.9	7.3	11.9
Mining	10.0	0.2	0.5	-0.1	10.6
BasicManufac	-33.2	1.6	6.0	-0.2	-25.9
OthManufac	-2.8	2.6	8.1	2.0	9.9
Construction	1.9	2.2	7.6	1.1	12.8
ElecGasWater	-0.1	1.9	5.4	0.7	7.9
Trade	4.0	1.8	9.1	0.8	15.8
Transport	2.9	2.6	4.7	1.1	11.3
OtherService	4.3	2.1	9.9	0.7	17.0
GovEducHlth	3.3	2.3	8.2	1.2	15.0

Variations -- % difference from Base 2030

Regional GDP	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
Akmolin	-19.8	2.0	6.9	0.8	-10.1
Aktubin	7.2	1.0	3.7	0.7	12.6
Almatin	-1.9	1.8	7.7	1.8	9.4
Atyrau	8.6	0.7	2.5	0.3	12.1
ZapKazakhstn	7.7	0.5	2.2	0.3	10.6
Zhambyl	0.4	1.5	7.3	1.7	10.8
Karagandin	4.7	1.1	5.2	0.9	11.9
Kostanai	-14.7	1.8	6.2	0.9	-5.8
Kyzylordn	6.6	1.1	3.9	0.7	12.4
Mangistau	10.3	0.7	2.8	0.3	14.0
YuzKazakhstn	4.7	1.5	6.9	1.3	14.4
Pavlodar	-6.9	1.1	6.5	1.2	1.9
SevKazakhstn	-13.7	2.1	6.9	1.6	-3.1
VosKazakhstn	6.5	1.4	5.8	1.4	15.1
Astana	-4.0	2.4	8.8	1.1	8.3
Almaty	3.2	2.5	8.9	0.9	15.4

BaseLine forecast 2015-30

	Total % change	Ave Annual Growth Rate	Assumptions	% p.a.
Real household consumption	32.1	1.87		
Real investment	32.1	1.87	pop growth	1
Real government consumption	32.1	1.87	labour tech	1
Aggregate export volume	25.1	1.51	land tech	1
Aggregate import volume	27.1	1.61	export demand	2
Real GDP	29.8	1.75		
Employment	16.1	1.00		
Real wage	11.8	0.74		
Aggregate capital stock	28.3	1.67		
Quantity mining/oil exports	16.2	1.01		
Price mining/oil exports	1.4	0.09		
Revenue mining/oil exports	17.8	1.10		

Broad Sectoral Outputs

	Total %	Average %
AgricForFish	23.8	1.44
Mining	18.4	1.13
BasicManufac	38.7	2.21
OthManufact	35.3	2.03
Construction	32.6	1.90
ElecGasWater	34.0	1.97
Trade	30.7	1.80
Transport	29.9	1.76
OtherService	35.8	2.06
GovEducHlth	32.6	1.90

Regional GDP

	Total %	Average %
Akmolin	36.7	2.11
Aktubin	25.5	1.52
Almatin	30.8	1.81
Atyrau	22.9	1.38
ZapKazakhstn	22.4	1.36
Zhambyl	30.7	1.80
Karagandin	28.1	1.66
Kostanai	34.1	1.98
Kyzylordin	25.6	1.53
Mangistau	22.8	1.38
YuzKazakhstn	29.1	1.72
Pavlodar	32.2	1.88
SevKazakhstn	33.8	1.96
VosKazakhstn	27.8	1.65
Astana	36.0	2.07
Almaty	35.4	2.04

BaseLine forecast 2015-30

Industry outputs	Total % change	Ave Annual Growth Rate
AgricForFish	23.8	1.44
Mining	18.4	1.13
FoodBevCigs	30.0	1.77
TextilePrd	40.5	2.29
LeatherShoes	72.9	3.72
WoodProducts	43.2	2.42
PulpPaperPrt	37.2	2.13
CokeRefPetrl	33.0	1.92
Chemicals	38.7	2.20
PlasticRubbr	37.6	2.15
OtNonMtlcMin	37.1	2.13
BasFabMetals	43.5	2.44
Machinery	56.4	3.03
ElectOpticEq	59.4	3.16
TransportEqp	38.4	2.19
ManufactNec	56.7	3.04
ElecGasWater	34.0	1.97
Construction	32.6	1.90
MVPdealers	32.7	1.90
WholesaleTrd	30.2	1.78
Retail	30.6	1.79
HotelsRestnt	36.2	2.08
InlandTransp	30.0	1.76
WaterTransp	31.5	1.84
AirTransp	30.7	1.80
OtherTransp	29.6	1.74
PostTelecoms	34.5	1.99
FinancInterm	33.3	1.93
RealEstate	37.2	2.13
OthrBusiness	34.3	1.99
PubAdminDfnc	32.2	1.88
Education	33.0	1.92
HealthSocial	32.6	1.90
OthComSocPer	37.5	2.15
Servants	38.5	2.20

Variations -- % difference from Base 2030

80% Oil price rise; 10% efficiency rise

	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
Real household consumption	3.2	2.3	8.3	1.3	15.0
Real investment	3.2	2.3	8.3	1.3	15.0
Real government consumption	3.2	2.3	8.3	1.3	15.0
Aggregate export volume	20.6	1.0	3.5	0.1	25.2
Aggregate import volume	28.5	1.3	4.8	0.2	34.8
Real GDP	2.8	2.0	7.2	1.1	13.0
Employment	0.0	0.0	0.0	0.0	0.0
Real wage	-2.1	1.6	7.6	2.3	9.3
Aggregate capital stock	6.4	1.7	6.4	0.9	15.5
Quantity mining/oil exports	46.2	0.0	-0.6	-0.3	45.3
Price mining/oil exports	73.8	0.0	0.1	0.0	73.9
Revenue mining/oil exports	153.7	0.0	-0.7	-0.3	152.6

Broad Sectoral Outputs	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
AgricForFish	0.6	1.1	2.9	7.3	11.9
Mining	10.0	0.2	0.5	-0.1	10.6
BasicManufac	-33.2	1.6	6.0	-0.2	-25.9
OthManufac	-2.8	2.6	8.1	2.0	9.9
Construction	1.9	2.2	7.6	1.1	12.8
ElecGasWater	-0.1	1.9	5.4	0.7	7.9
Trade	4.0	1.8	9.1	0.8	15.8
Transport	2.9	2.6	4.7	1.1	11.3
OtherService	4.3	2.1	9.9	0.7	17.0
GovEducHlth	3.3	2.3	8.2	1.2	15.0

Regional GDP	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
Akmolin	-19.8	2.0	6.9	0.8	-10.1
Aktubin	7.2	1.0	3.7	0.7	12.6
Almatin	-1.9	1.8	7.7	1.8	9.4
Atyrau	8.6	0.7	2.5	0.3	12.1
ZapKazakhstn	7.7	0.5	2.2	0.3	10.6
Zhambyl	0.4	1.5	7.3	1.7	10.8
Karagandin	4.7	1.1	5.2	0.9	11.9
Kostanai	-14.7	1.8	6.2	0.9	-5.8
Kyzylordin	6.6	1.1	3.9	0.7	12.4
Mangistau	10.3	0.7	2.8	0.3	14.0
YuzKazakhstn	4.7	1.5	6.9	1.3	14.4
Pavlodar	-6.9	1.1	6.5	1.2	1.9
SevKazakhstn	-13.7	2.1	6.9	1.6	-3.1
VosKazakhstn	6.5	1.4	5.8	1.4	15.1
Astana	-4.0	2.4	8.8	1.1	8.3
Almaty	3.2	2.5	8.9	0.9	15.4

Variations -- % difference from Base 2030

Industry outputs	Increased Oil price	Efficiency improvements in			Total
		Transport	Services	Agriculture	
AgricForFish	0.6	1.1	2.9	7.3	11.9
Mining	10.0	0.2	0.5	-0.1	10.6
FoodBevCigs	1.8	2.1	7.1	2.9	14.0
TextilePrd	-2.7	3.0	9.3	3.3	12.8
LeatherShoes	-10.5	9.2	36.8	-2.7	32.6
WoodProducts	-8.5	3.0	8.9	1.1	4.5
PulpPaperPrt	0.3	2.3	3.6	0.4	6.5
CokeRefPetrl	-28.0	-1.5	4.3	0.2	-25.0
Chemicals	-37.3	2.3	6.0	-0.6	-29.6
PlasticRubbr	-16.6	2.5	7.6	0.3	-6.2
OtNonMtlcMin	-26.5	1.8	5.7	-0.1	-19.1
BasFabMetals	-43.1	2.4	7.0	-0.5	-34.1
Machinery	-24.6	3.9	9.8	-1.2	-12.1
ElectOpticEq	-25.9	4.6	14.6	-1.1	-7.7
TransportEqp	-4.4	3.3	8.4	0.3	7.6
ManufactNec	-16.3	3.8	11.5	-0.8	-1.8
ElecGasWater	-0.1	1.9	5.4	0.7	7.9
Construction	1.9	2.2	7.6	1.1	12.8
MVPdealers	2.8	2.2	8.6	1.1	14.6
WholesaleTrd	4.3	1.7	9.3	0.5	15.8
Retail	3.2	1.9	7.8	1.4	14.3
HotelsRestnt	6.6	2.3	15.6	1.8	26.3
InlandTransp	2.6	2.6	5.4	1.1	11.7
WaterTransp	3.1	2.1	2.0	0.7	8.0
AirTransp	2.9	3.9	4.3	1.1	12.2
OtherTransp	4.0	2.5	2.5	0.9	9.9
PostTelecoms	3.7	2.0	13.1	0.7	19.5
FinancInterm	4.1	1.4	7.3	0.6	13.4
RealEstate	5.7	2.2	7.4	0.8	16.0
OthrBusiness	1.7	2.3	11.6	0.6	16.2
PubAdminDfnc	3.2	2.3	8.3	1.3	15.1
Education	3.5	2.3	8.1	1.2	15.0
HealthSocial	3.3	2.2	8.2	1.2	15.0
OthComSocPer	4.5	2.4	15.0	0.8	22.6
Servants	6.1	1.9	5.9	0.6	14.5