



Банк России

EFFECTS OF A TERMS OF TRADE SHOCK ON THE RUSSIAN ECONOMY

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Outline

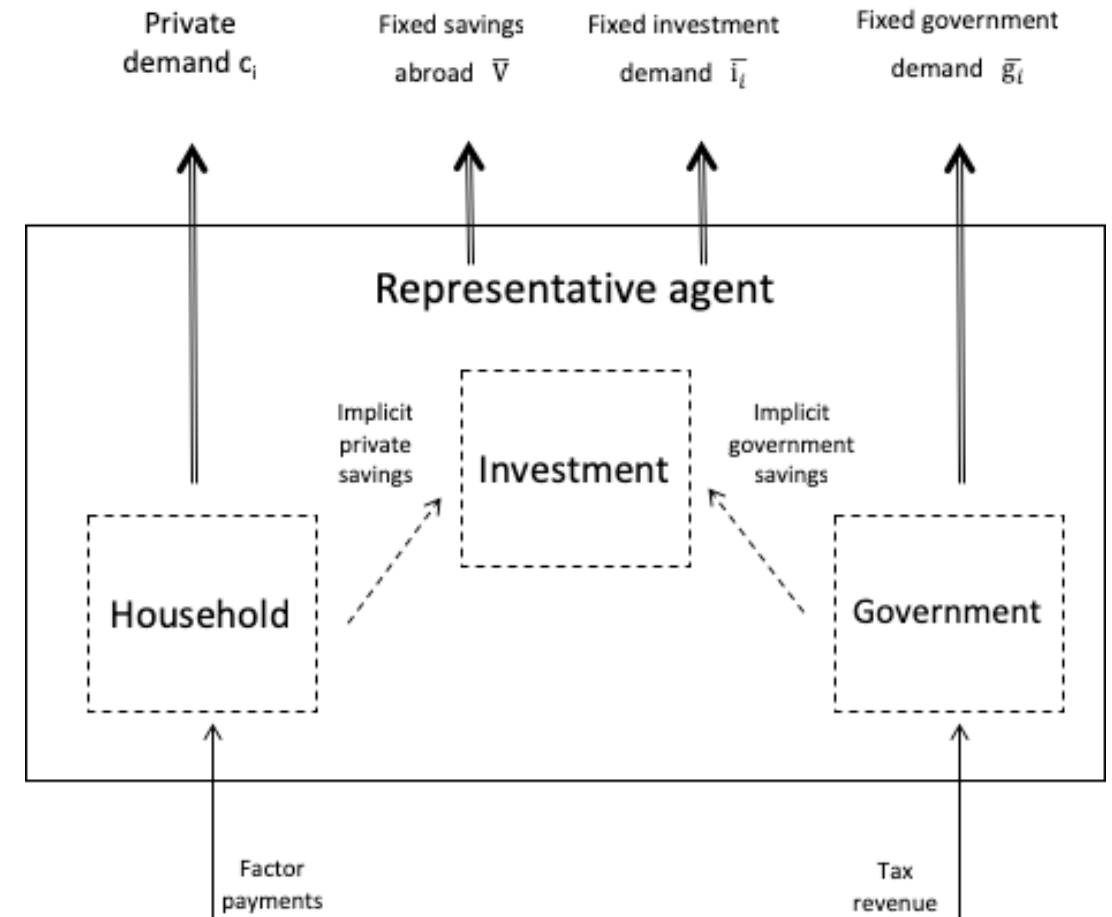
- Structure of the model (static and stationary)
- Results of modeling decrease in energy prices
- Validation of the model on the historical data of 2014-2015 terms of trade shock
 - Design of the “historical experiment”
 - Results of “historical” scenarios
 - Role of change in oil export tax (tax maneuver) in behavior of oil and gas producers



Key modeling assumptions

- Static / stationary general equilibrium models
- Russia is presented as a small open economy (exogenous world prices)
- Goods and services are manufactured using factors (labor and capital, both mobile and specific) and intermediate goods
- Full employment
- Perfect competition
- Home and imported goods are imperfect substitutes (Armington assumption, CES)
- Domestically produced goods are distributed between home market and export (CET)

- Consumes "retail" goods, i.e. Armington mix of domestic goods and imports
- Cobb-Douglas utility
- Receives income from factors of production (sole owner)
- Pays consumption taxes
- Saving in the static model: fixed savings covering the base year investment
- The stationary model: capital stock and savings are adjusted until rental price of capital equals the price index of investment goods
 - optimal capital stock ($p_{inv} = r_k$)



- The state/government
 - Collects taxes
 - Factor taxes
 - Consumption/Excise tax (final and intermediate goods)
 - Export taxes/Import duties
 - Production taxes
 - Consumes goods (government procurement) - fixed physical volume at base year level
- Investment demand:
 - The static version is fixed at the benchmark level, payed from the budget of a representative agent

- Fixed labor supply
- Capital stock
 - Static model: fixed capital stock
 - Stationary model: optimal capital stock ($p_{inv} = r_k$)
- Labor and capital are imperfectly mobile between industries.
- Part of labor and capital are “specific” and cannot move between sectors.
- Full employment of both factors
- All factor income is transferred to a representative agent.

- External closure:
 - Fixed CA (benchmark CA surplus)



- Core “Input-output” tables for 2011
 - Resource table
 - Use tables at basic prices and consumer prices
 - Use tables of imported and household goods
 - Table of transport and trade margins
 - Net tax table
- The dimension of the core tables is 248 products and 178 activities
- The dimension of the model: 52 X 52

Data: sectors in the model (NACE rev 1)

s01	s17	s28	s45	s73
s02	s18	s29	trd	s74
s05	s19	s30	s55	s75
s10	s20	s31	trn	s80
oil	s21	s32	s63	s85
gas	s22	s33	s64	s90
s112	s23	s34	s65x (65 + 66)	s91
s12x (12 + 13)	s24	s35	s67	s92
s15	s25	s36x (36 + 37)	s70	s93x (93 + 95)
s15x (15-9)	s26	s40	s71	
s16	s27	s41	s72	



- Oil scenario: decline in world prices for crude oil by 10%;
- “Natural Gas” scenario: decrease in world prices for natural gas by 3%);
 - Changes in long-term oil and gas price ratios (Ramberg, Henry Chen, Paltsev, & Parsons, 2017), (Nick & Thoenes, 2014): (Zhang & Ji, 2018) A 10% decline in world oil prices is accompanied by a 3% changes in world prices for natural gas;
- Oil products (“Oil products” scenario: decrease in world prices for oil products by 8%)
 - Technological parameters determine a strong link between world prices for oil and oil products for Russian exports (Ramberg et al., 2017), (Polanco Martínez, Abadie, & Fernández-Macho, 2018). In our central scenario, a 10% decline in world oil prices is accompanied by a 8% decline in world prices for petroleum products.

Terms of trade shock: the static model

	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
Aggregate welfare				
Welfare (EV as % of consumption)	-3,552	-2,265	-0,213	-1,033
Welfare (EV as % of GDP)	-1,757	-1,113	-0,104	-0,505
GDP decomposition				
GDP (% change)	-1,727	-1,101	-0,104	-0,502
Real private consumption (C % change)	-3,552	-2,265	-0,213	-1,033
Real government consumption (G % change)	0,000	0,000	0,000	0,000
Real investment demand (I % change)	0,000	0,000	0,000	0,000
Real aggregated exports (E % change)	-4,265	-2,598	-0,419	-1,286
Real aggregated imports (M % change)	-6,357	-3,871	-0,625	-1,917

Terms of trade shock: the static model

	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
RER and CPI				
Real exchange rate (% change)	3,917	2,297	0,375	1,124
Consumer price index (% change)	0,000	0,000	0,000	0,000
Return to primary factors				
Labor (w % change)	-0,202	-0,052	-0,061	-0,097
Mobile capital (r % change)	-1,247	-0,707	-0,096	-0,434
Crude oil resources (% change)	-4,925	-3,874	0,489	-1,517
Natural gas resources (% change)	3,769	6,211	-4,552	2,754
Coal resources (% change)	3,236	2,035	0,414	0,635
Other mining resources (% change)	4,841	2,845	0,507	1,322

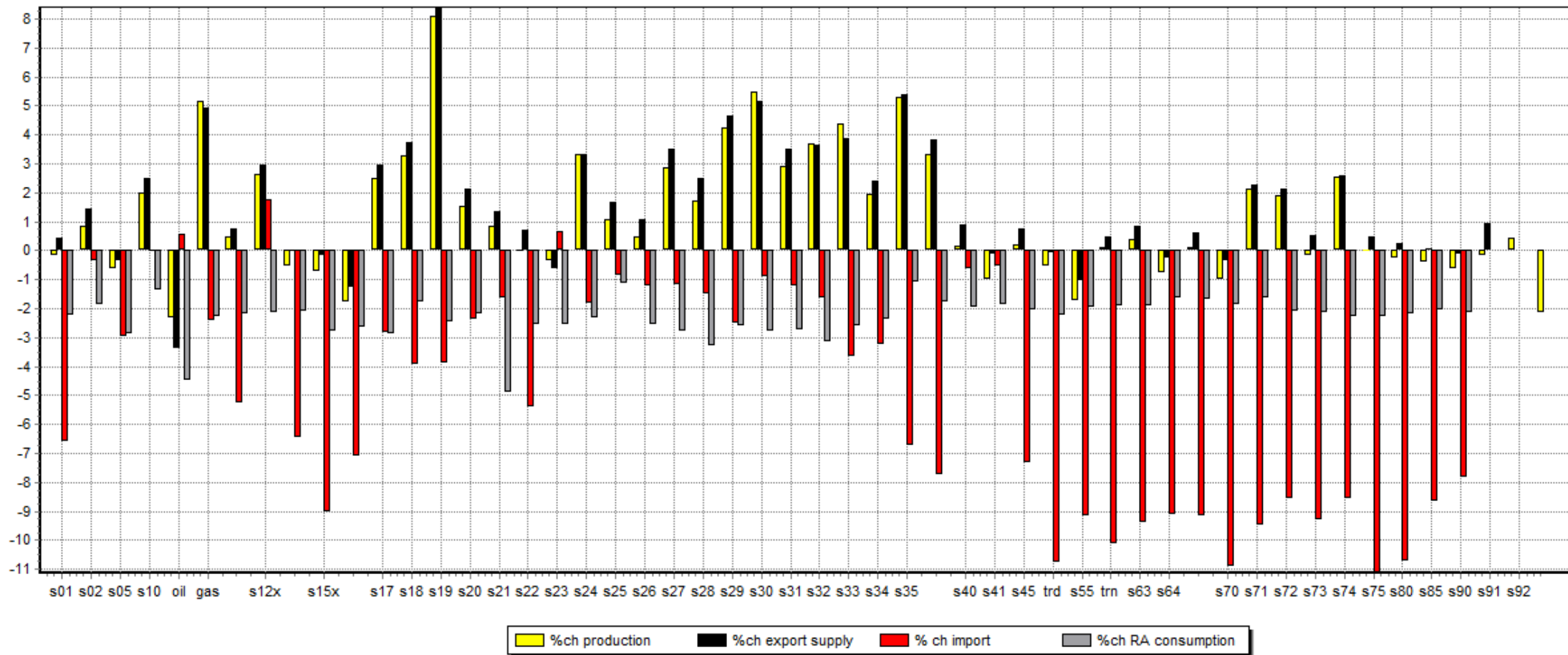
Terms of trade shock: the static model

	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
Aggregated production				
Aggregated production index (% change)	0,416	0,262	0,056	0,086
Agriculture production index (% change)	0,000	-0,005	0,007	0,001
Extraction production index (% change)	-0,046	-0,045	0,011	-0,010
Manufacturing production index (% change)	0,640	0,390	0,103	0,125
Services production index (% change)	-0,178	-0,078	-0,065	-0,029
Factor adjustment				
Mobile capital (% changing sectors)	0,870	0,536	0,153	0,264
Labor (% changing sectors)	0,801	0,480	0,110	0,234



Changes in production, export supply, imports and RA consumption

The Central scenario, comparative static model



Terms of trade shock: the stationary model

	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
Aggregate welfare				
Welfare (EV as % of consumption)	-5,787	-3,621	-0,385	-1,793
Welfare (EV as % of GDP)	-2,918	-1,800	-0,188	-0,882
GDP decomposition				
GDP (% change)	-3,592	-2,230	-0,246	-1,133
Real private consumption (C % change)	-5,787	-3,621	-0,385	-1,793
Real government consumption (G % change)	0,000	0,000	0,000	0,000
Real investment demand (I % change)	-3,188	-1,921	-0,240	-1,068
Real aggregated exports (E % change)	-6,089	-3,721	-0,564	-1,922
Real aggregated imports (M % change)	-9,074	-5,545	-0,840	-2,864

Terms of trade shock: the stationary model

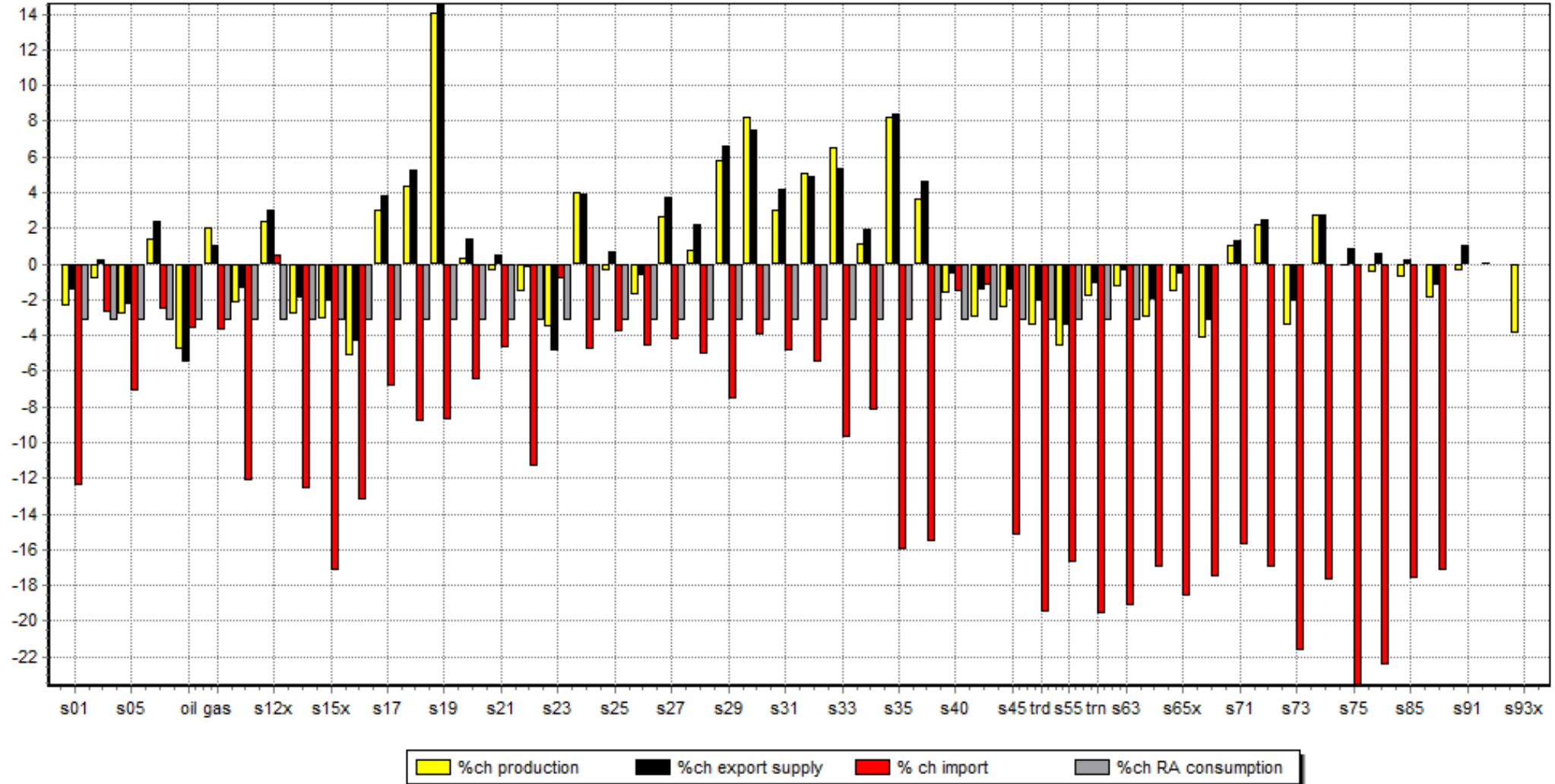
	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
RER and CPI				
Real exchange rate (% change)	4,025	2,354	0,381	1,153
Consumer price index (% change)	0,000	0,000	0,000	0,000
Return to primary factors				
Labor (w % change)	-2,381	-1,363	-0,225	-0,825
Mobile capital (r % change)	-0,116	-0,029	-0,012	-0,059
Crude oil resources (% change)	-6,928	-5,103	0,329	-2,214
Natural gas resources (% change)	1,863	5,042	-4,687	2,116
Coal resources (% change)	0,673	0,499	0,224	-0,210
Other mining resources (% change)	1,775	1,023	0,283	0,319

Terms of trade shock: the stationary model

	Central scenario	Oil scenario	Natural gas scenario	Petroleum products scenario
World price change				
Crude oil	-10%	-10%		
Natural gas	-3%		-3%	
Petroleum products	-8%			-8%
Aggregated production				
Aggregated production index (% change)	-1,477	-0,876	-0,085	-0,544
Agriculture production index (% change)	-0,092	-0,060	0,000	-0,030
Extraction production index (% change)	-0,198	-0,137	-0,001	-0,062
Manufacturing production index (% change)	0,146	0,096	0,067	-0,037
Services production index (% change)	-1,334	-0,774	-0,151	-0,416
Factor adjustment				
Mobile capital (% changing sectors)	3,435	2,086	0,311	1,135
Labor (% changing sectors)	0,860	0,513	0,112	0,255

Changes in production, export supply, imports and RA consumption

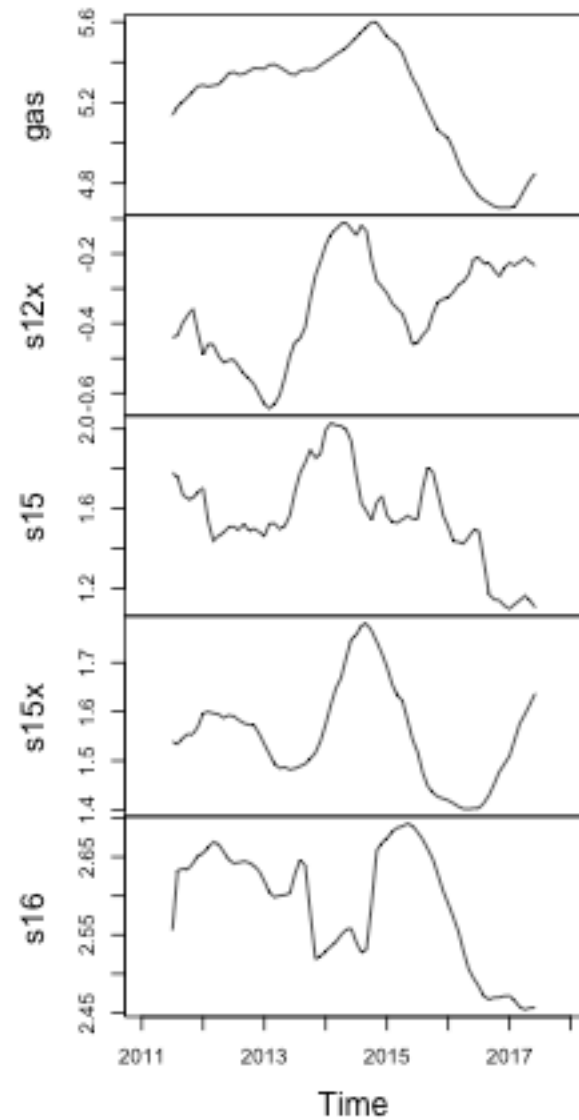
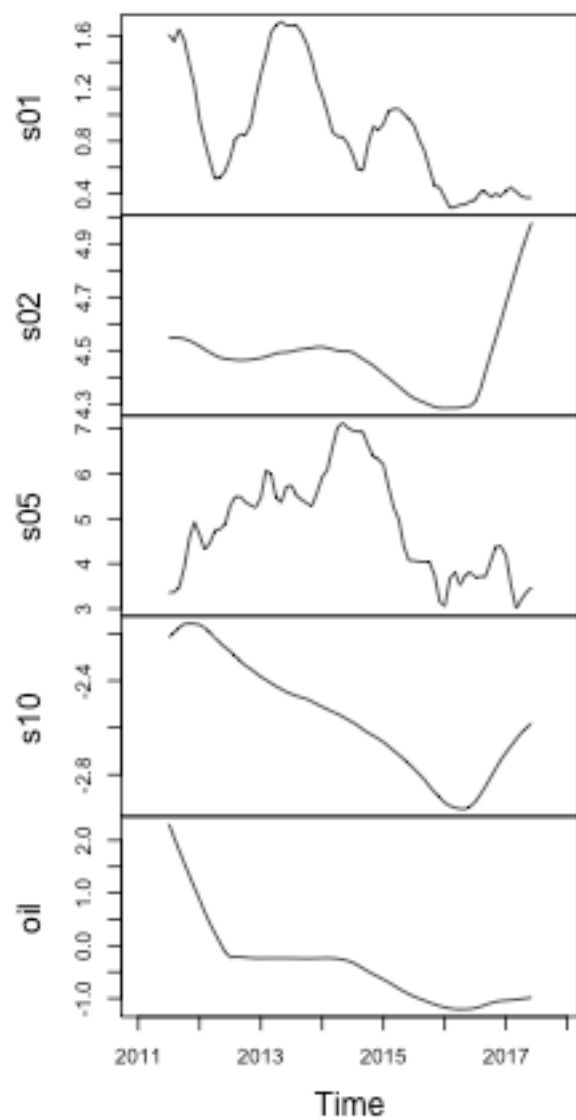
The Central scenario, steady-state model



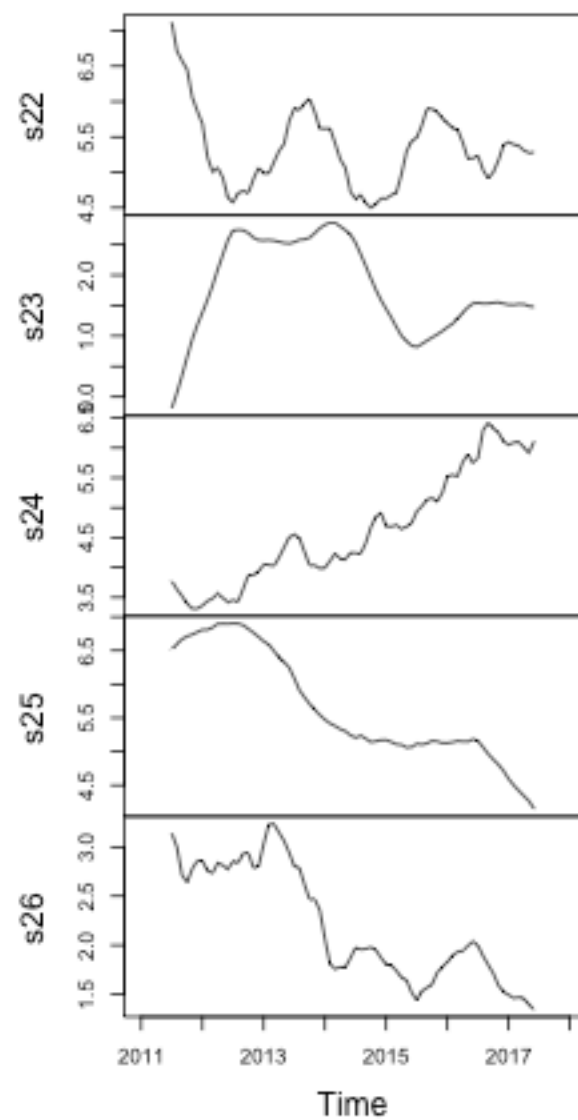
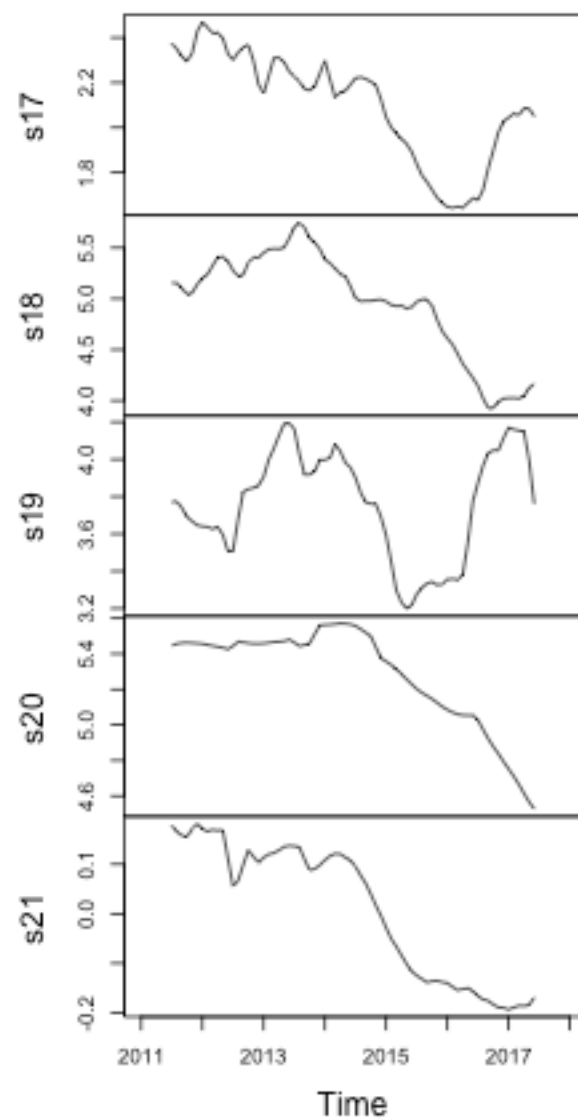
- World prices
- Economic policy parameters (export taxes)
- Elasticity of substitution of domestic and imported goods
- Mobility factors in the model
- Shock terms of trade 2011-2016
- Prices for main export goods declined faster than import prices
- Trade balance surplus varied from + 10% to -30% (at 2011 home prices)

- TUV CEPII (trade unit value) database data (Berthou, Emlinger (2011))
 - Detail: 6 characters HS
- COMTRADE data on trade flows
 - Average weights for each 6-digit HS position in each product group, for the entire period (from 2011 to 2016)
 - Correspondence between HS and product groups in the model
 - Change in weighted average prices for each year (2012-2016) and for each group of export goods
- Eurasian Economic Commission trade data:
 - 10 digit level trade data for the EAEU as a whole

Trends in export prices



Trends in export prices





Changes in export prices

	<i>Change in export prices to 2011</i>				
	2012	2013	2014	2015	2016
01 Agriculture	101%	143%	-11%	-22%	-36%
02 Forestry	-2%	1%	-2%	-19%	-24%
05 Fishing	29%	49%	80%	84%	80%
10 Mining of coal	-5%	-19%	-27%	-41%	-50%
11101 Crude petroleum	5%	2%	-5%	-50%	-61%
11102 Natural gas	18%	10%	32%	9%	-35%
12 Mining of metal ores	50%	35%	38%	35%	26%
15 Food	54%	48%	42%	19%	18%
15 -9 Beverages	19%	14%	10%	-19%	-21%
16 Tobacco products	40%	45%	55%	39%	16%
17 Textiles	66%	62%	53%	32%	23%
18 Wearing apparel	19%	72%	-75%	-90%	-91%
19 Leather	49%	59%	65%	20%	23%
20 Wood products	3%	6%	35%	-24%	-19%
21 Paper products	55%	49%	52%	17%	8%
22 Publishing	93%	59%	100%	46%	39%
23 Refined petroleum	14%	-74%	-74%	-78%	-77%
24 Chemicals	-10%	-10%	-13%	-20%	-95%
25 Plastic products	24%	7%	-11%	-29%	-31%
26 Non-metallic products	40%	37%	66%	3%	-6%
27 Basic metals	16%	7%	0%	-19%	-17%

Changes in import prices

	<i>Change in import prices to 2011</i>				
	2012	2013	2014	2015	2016
01 Agriculture	-9%	-25%	-6%	-21%	-18%
02 Forestry	2%	13%	-2%	3%	-11%
05 Fishing	-1%	12%	17%	-68%	-66%
10 Mining of coal	37%	33%	-44%	-53%	-63%
15 Food	9%	12%	11%	-20%	-24%
15 -9 Beverages	0%	8%	-3%	-24%	-25%
16 Tobacco products	-6%	1%	-7%	-12%	-20%
17 Textiles	17%	16%	19%	9%	12%
18 Wearing apparel	23%	32%	34%	22%	21%
19 Leather	4%	11%	21%	23%	36%
20 Wood products	56%	60%	76%	34%	24%
21 Paper products	11%	4%	-1%	-16%	-17%

	<i>Change in import prices to 2011</i>				
	2012	2013	2014	2015	2016
22 Publishing	2%	8%	-10%	2%	11%
23 Refined petroleum	55%	87%	37%	50%	48%
24 Chemicals	-4%	-1%	-8%	-33%	-30%
25 Plastic products	8%	0%	2%	-9%	-6%
26 Non-metallic products	22%	33%	19%	16%	22%
28 Metal products	54%	51%	26%	12%	13%
29 Machinery	6%	8%	8%	0%	2%
30 Office machinery	-6%	15%	21%	22%	27%
31 Electrical machinery	14%	14%	10%	3%	0%
32 Radio television	0%	0%	0%	0%	0%
33 Medical instruments	1%	6%	4%	-15%	-13%
34 Motor vehicles	0%	4%	-3%	-22%	-17%

Goodness of fit for several “historical” scenarios

	Model validation scenarios							
	#1	#2	#3	#4	#5	#6	#7	#8
Scenario design								
Change in export prices	*	*	*	*	*	*	*	*
Change in import prices	*		*		*			
Change in export taxes	*	*		*	*	*	*	*
Share of specific capital in all industries	0	0	0	30%	30%	50%	50%	50%
Share of specific capital in extraction	30%	30%	30%	30%	60%	50%	30%	70%
GTAP elasticities							*	*
Average error								
AE	17,6	19,8	20,0	16,4	20,3	17,3	17,3	20,4
Oil and gas output indicator								
Real output (% difference, model to statistics)	-1,98	0,53	-7,09	0,40	-4,96	-1,90	-1,90	-2,60

Source: Author's calculations

$$AE = \left(\frac{1}{N}\right) * \sum_c |f_c - a_c| / \left(1 + \frac{a_c}{100}\right), \quad \text{USAGE AE} = 19\% \text{ (Dixon, Rimmer 2003)}$$

- Detailed sectoral CGE model
- Verification on historical data
 - The impact of changes in world prices, but it is necessary to develop a methodology for cleaning price data from outliers
 - Volatility of changes in import prices worsens the quality of the historical scenario
- Essential value of changes in the parameters of domestic economic policy - export duties



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