



UNITED NATIONS UNIVERSITY

World Institute for Development Economics Research



Economic Impacts of Climate Change for South Africa: An Economywide Perspective to 2050

Channing Arndt (UNU-WIDER)
with many others

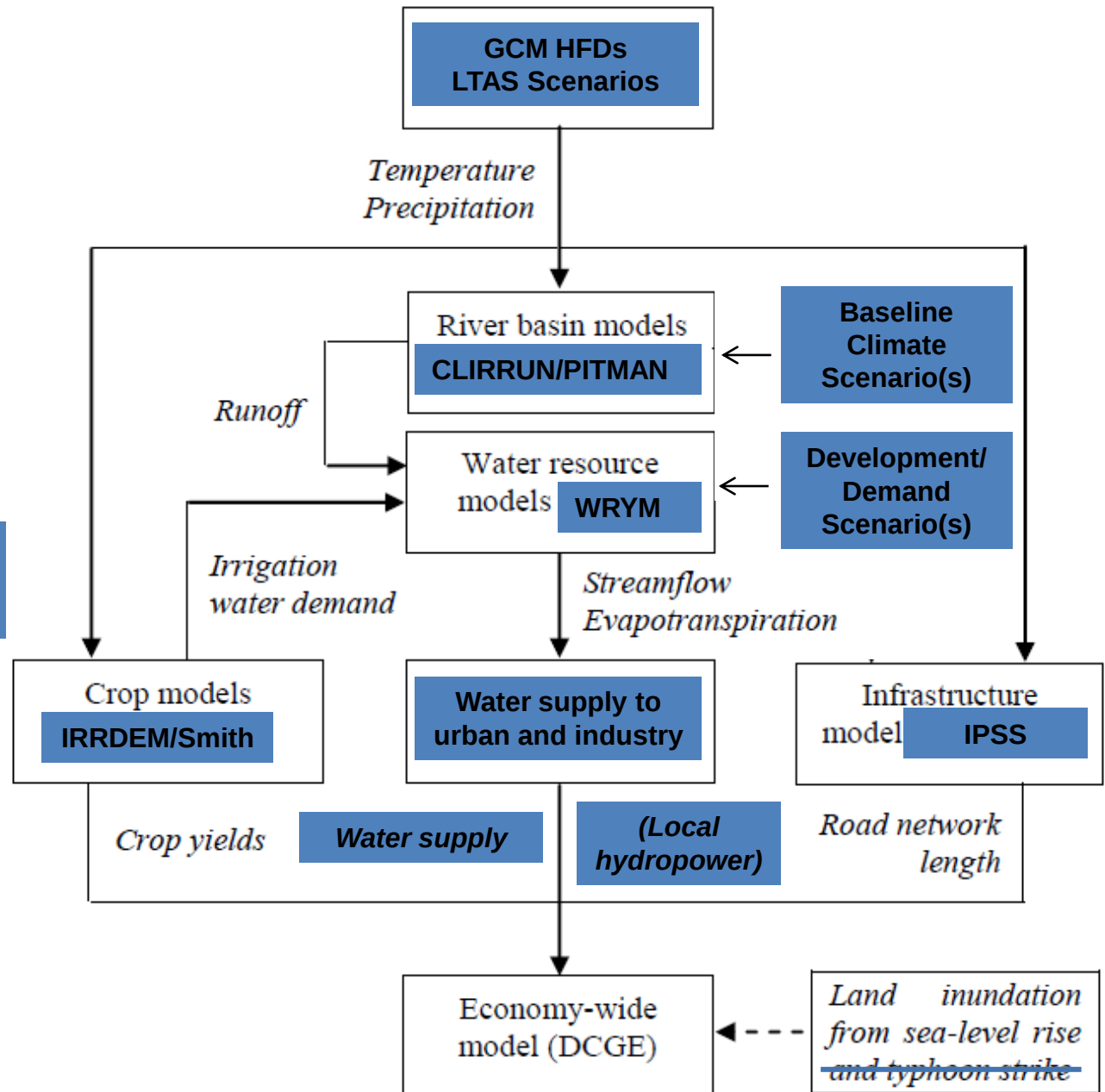
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Development Under Climate Change

- Analytical work completed for:
 - Zambeze River Valley
 - Vietnam
 - Carbon tax in collaboration with NT
- Current collaborative process in South Africa to consider climate change impacts and potential adaptation strategies.

Integrated Modeling Framework

**ADJUSTED FOR
RSA MODELS**

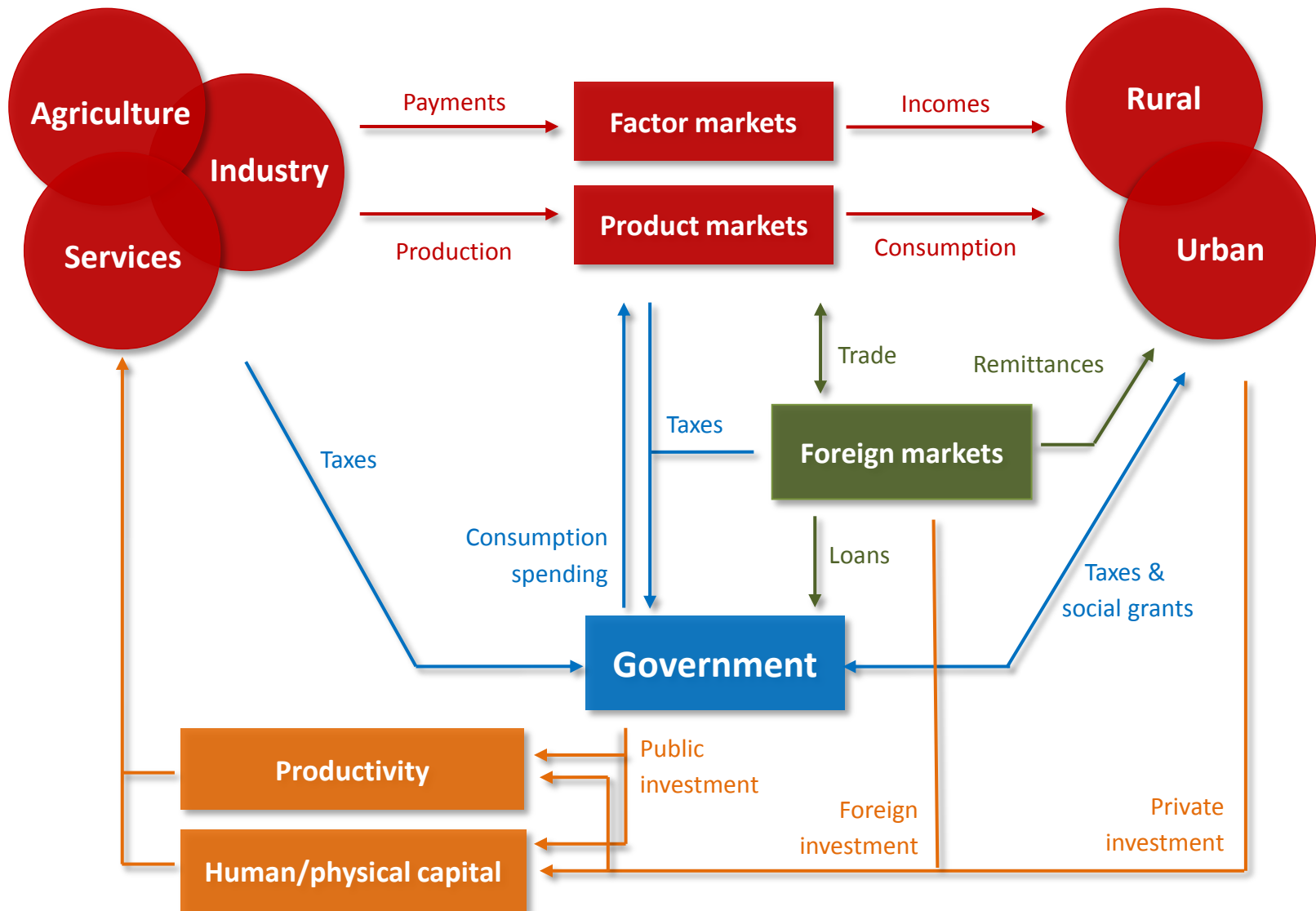


Perspective on Work

- Questions:
 - What are the implications of climate change for growth and development prospects?
 - What are the potentially large impact channels?
 - How much should the National Treasury allocate to climate change adaptation over the next two decades in order to offset negative economic impacts?
 - How do we meet development goals in the context of climate change?
- State of progress in modeling :
 - System is functioning (mechanically)
 - Needs refinement, QC & QA
 - A series of illustrative results are available
 - On a good timeline for report completion by end March

Economic growth

Household welfare



Benchmark Data

- 2002 Social Accounting Matrix
 - 2002 Supply-Use Table
 - 2002 Census of Commercial Agriculture (large-scale farms)
 - 2000 Population Census
 - 2000 Income and Expenditure Survey
 - 2002 Standard Industrial Database (SASID)
- 2000/2005 Water Accounts

Sectors

Agriculture

Field crops

- 1 Summer cereals (maize, sorghum)
- 2 Winter cereals (wheat, barley)
- 3 Oil crops & legumes (groundnuts, beans)
- 4 Fodder crops (Lucerne, grain maize)
- 5 Sugarcane
- 6 Cotton & tobacco (incl. other field crops)

Horticultural crops

- 7 Vegetables
- 8 Citrus fruits
- 9 Subtropical fruits
- 10 Deciduous fruits and viticulture
- 11 Other horticulture (tea, nuts)

Livestock

- 12 Livestock sales (cattle, sheep, pigs)
- 13 Dairy
- 14 Poultry (chickens, eggs)
- 15 Other livestock products (wool, game)

Other agriculture

- 16 Fisheries
- 17 Forestry

Industry

- 18 Mining (coal, gold)
- 19 Food & agricultural processing
- 20 Textiles, clothing & footwear
- 21 Wood & paper products
- 22 Chemicals & petroleum
- 23 Nonmetallic mineral products
- 24 Metals & machinery
- 25 Electrical machinery
- 26 Scientific equipment
- 27 Transport equipment (incl. vehicles)
- 28 Other manufacturing (incl. furniture)
- 29 Electricity generation
- 30 Domestic & light industrial water distribution
- 31 Heavy industry water distribution
- 32 Construction

Services

- 33 Retail & wholesale trade
- 34 Hotels & catering
- 35 Transport
- 36 Communication
- 37 Financial & insurance services
- 38 Business services & real estate
- 39 Community & other private services
- 40 Government services

Economic Structure

	Share of total (%)				Export intensity	Import intensity
	GDP	Employment	Exports	Imports		
<u>Total GDP</u>	100.00	100.00	100.00	100.00	13.48	13.31
<u>Agriculture</u>	4.32	7.87	3.65	2.17	15.05	9.27
Field crops	1.79	2.93	0.59	1.46	5.93	13.53
Horticultural crops	1.00	1.85	2.16	0.23	42.05	7.08
Livestock	1.28	2.80	0.85	0.27	10.88	3.46
Other agriculture	0.26	0.29	0.05	0.21	3.89	13.53
<u>Industry</u>	33.38	29.27	75.84	83.46	22.17	21.96
Mining	8.72	4.96	33.72	10.28	71.10	43.45
Manufacturing	19.90	17.65	42.12	73.18	16.87	23.30
Electricity generation	2.03	0.98	0.00	0.00	0.00	0.00
Water distribution	0.45	0.17	0.00	0.00	0.00	0.00
Construction	2.27	5.50	0.00	0.00	0.00	0.00
<u>Services</u>	62.30	62.86	20.51	14.37	5.46	4.13

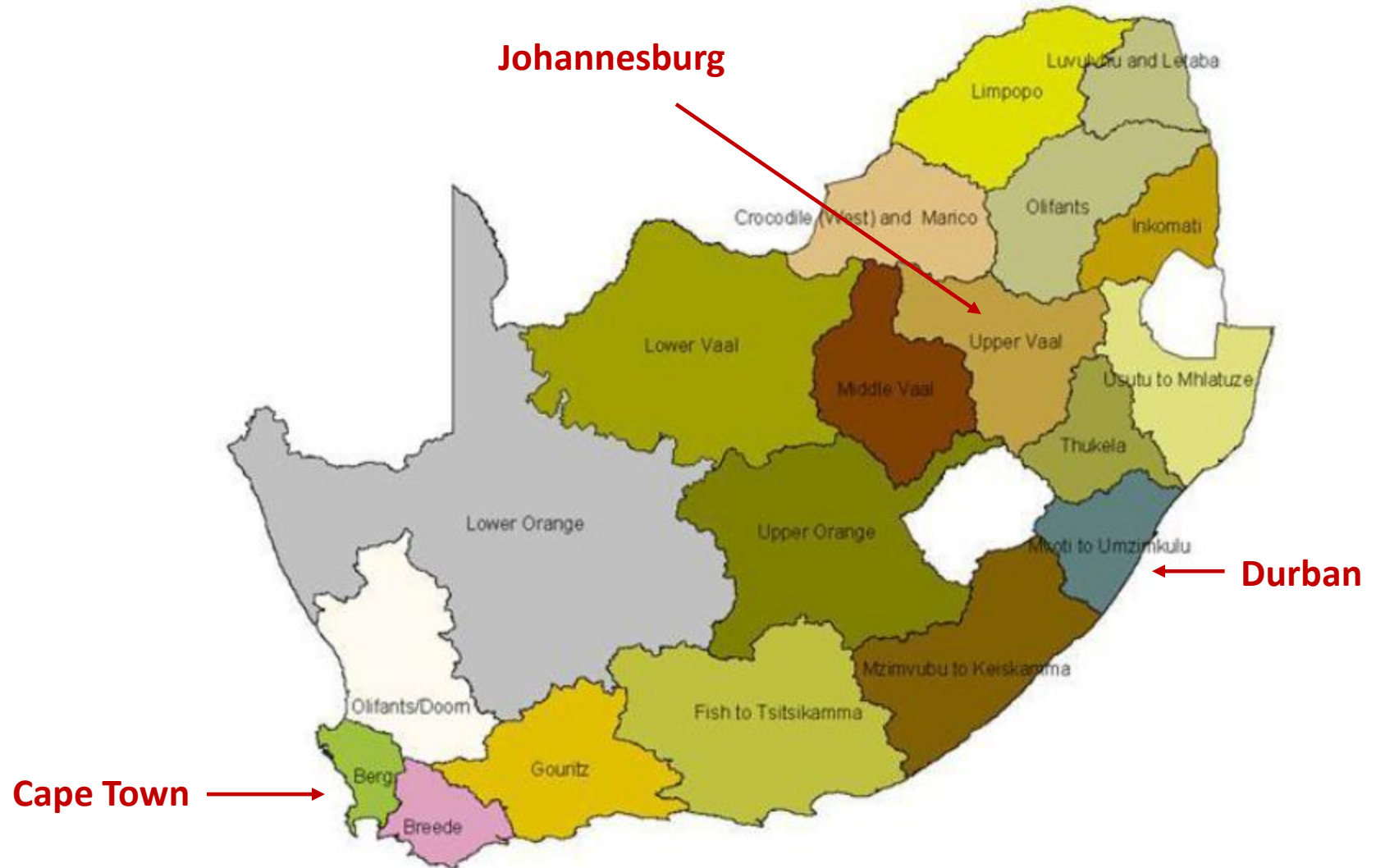
Source: South Africa 2002 Water-SAM. Import intensity is the share of imports in total domestic demand. Export intensity is the share of exports in total domestic output.

Crops and Water Use

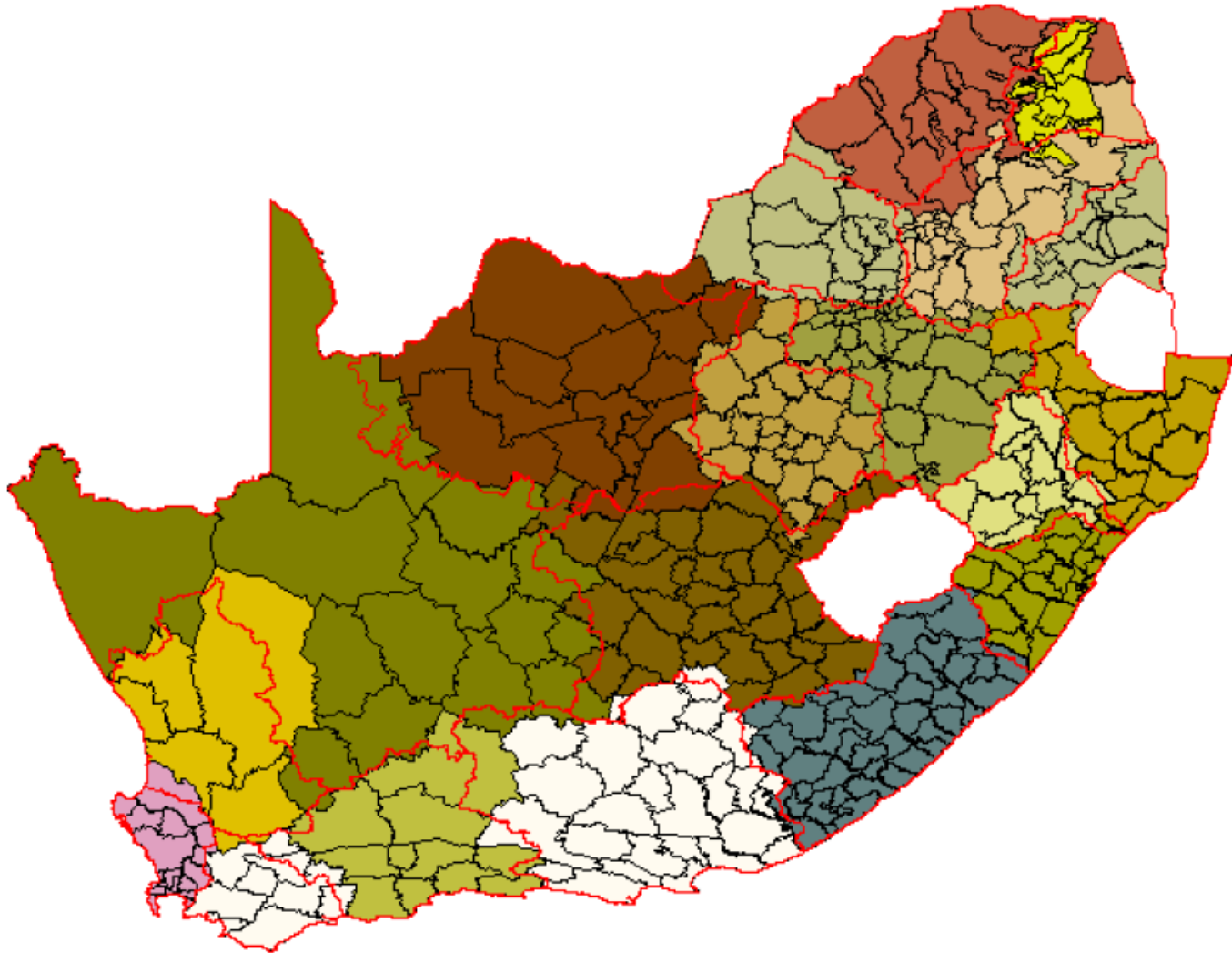
	Production quantity (1000 mt)	Land area		Yields		Irrigation water use	
		Total (1000 ha)	Irrigated (%)	Dryland (mt / ha)	Irrigated (mt / ha)	Volume (mil m ³)	(1000 m ³ / ha)
Total	-	7,629	20.46	-	-	7,274	4.66
Summer cereals	10,377	3,356	8.99	2.82	5.83	1,242	4.12
Winter cereals	2,689	1,047	15.57	2.17	4.72	593	3.63
Oils & legumes	1,422	1,103	5.31	1.24	2.14	190	3.24
Fodder crops	2,943	956	24.66	2.49	4.86	655	2.78
Sugarcane	21,157	470	28.30	41.30	54.43	1,386	10.42
Cotton & tobacco	150	59	53.31	1.86	3.10	91	2.87
Vegetables	4,482	187	100.00	-	24.02	796	4.27
Citrus fruits	1,472	63	100.00	-	23.22	451	7.12
Subtropical fruits	602	51	100.00	-	11.77	375	7.33
Deciduous fruits	3,339	249	100.00	-	13.43	1,293	5.20
Other horticulture	171	87	100.00	-	1.95	203	2.32

Source: South Africa 2002 Water-SAM and CGE model.

Water Management Areas



Matching Water and Economic Data



	Population		GDP per capita (R)	Share of national GDP (%)			Share of region GDP (%)	
	Total	Rural		Total	Agric.	Industry	Agric.	Industry
	(1000s)	(%)						
National	44,770	43.70	23,282	100.00	100.00	100.00	4.31	24.66
Limpopo	868	76.56	16,344	1.36	2.24	0.59	7.09	10.77
Luvuvhu-Letaba	2,330	95.17	13,113	2.93	4.12	1.01	6.06	8.53
Crocodile-Marico	3,830	35.47	35,913	13.20	4.29	9.88	1.40	18.46
Olifants	2,934	70.02	22,629	6.37	4.20	5.95	2.84	23.03
Inkomati	1,177	77.48	16,041	1.81	4.82	1.54	11.46	20.91
Usutu-Mhlatuze	2,153	83.44	10,554	2.18	7.13	2.10	14.10	23.78
Thukela	1,747	71.05	9,042	1.52	4.59	1.97	13.06	32.09
JHB Upper Vaal	8,354	13.22	33,620	26.94	7.67	34.21	1.23	31.31
Middle Vaal	1,647	19.54	20,592	3.25	8.96	1.43	11.87	10.85
Lower Vaal	1,721	57.51	13,768	2.27	4.86	0.80	9.22	8.73
DBN Mvoti-Umzimkulu	6,091	42.45	22,797	13.32	17.68	16.96	5.72	31.39
Mzimvubu-Keiskamma	4,202	76.23	8,142	3.28	1.25	2.38	1.65	17.87
Upper Orange	1,013	21.67	21,930	2.13	2.13	1.30	4.32	15.03
Lower Orange	429	20.58	25,932	1.07	4.18	0.23	16.89	5.30
Fish-Tsitsikamma	1,798	19.36	25,789	4.45	3.35	4.96	3.25	27.51
Gouritz	435	16.78	19,171	0.80	1.71	0.88	9.24	27.14
Olifants/Doorn	239	44.73	18,497	0.42	3.22	0.33	32.65	18.98
Breede	437	33.44	20,418	0.86	7.19	0.63	36.19	18.07
CPT Berg	3,367	3.93	36,639	11.83	6.39	12.85	2.33	26.77

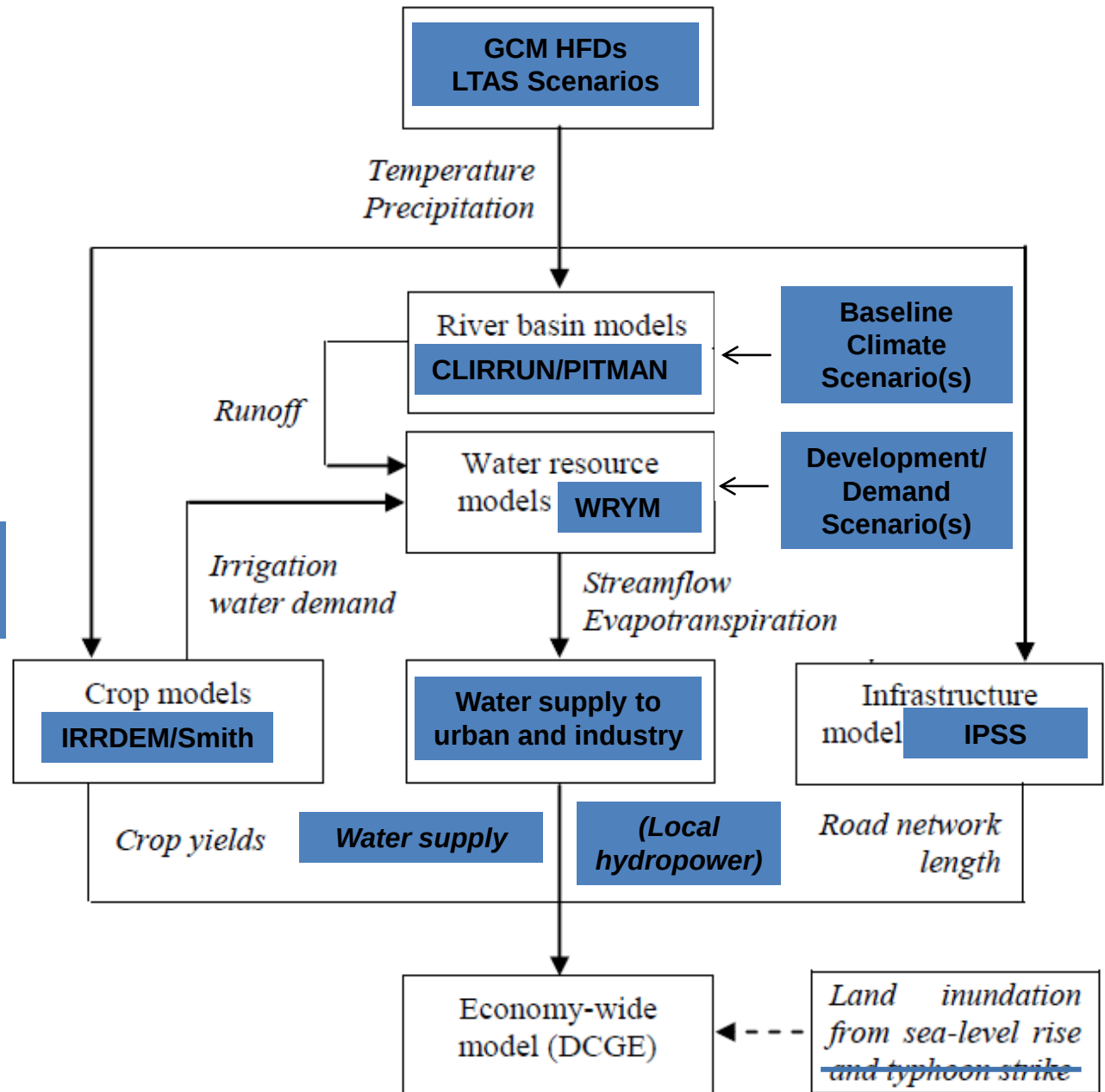
Source: South Africa 2002 Water-SAM and CGE model. 'Industry' includes manufacturing, energy and construction, but excludes the mining sector.

	Mean per capita consumption			Share of population in consumption quintiles (%)				
	Total (R)	Urban (R)	Rural (R)	1 (low)	2	3	4	5 (high)
National	16,382	23,016	7,834	20.0	20.0	20.0	20.0	20.0
Limpopo	7,360	15,103	4,989	26.7	22.8	23.6	14.7	12.3
Luvuvhu-Letaba	6,933	20,016	6,269	33.6	27.3	22.0	12.1	5.1
Crocodile-Marico	25,716	32,423	13,513	9.2	12.2	22.6	25.8	30.1
Olifants	8,920	15,987	5,895	20.9	25.1	24.2	19.3	10.4
Inkomati	9,659	20,552	6,492	23.0	30.1	21.2	16.4	9.3
Usutu-Mhlatuze	7,796	20,898	5,196	35.1	31.7	16.6	10.7	5.9
Thukela	6,771	12,523	4,427	46.1	24.9	15.6	7.7	5.7
JHB Upper Vaal	26,465	26,724	24,767	11.8	15.1	20.6	23.9	28.5
Middle Vaal	11,252	10,823	13,018	20.1	19.5	15.8	16.0	28.6
Lower Vaal	8,275	10,975	6,280	26.7	25.9	18.9	14.1	14.4
DBN Mvoti-Umzimkulu	14,521	20,947	5,808	21.1	21.1	19.8	20.2	17.8
Mzimvubu-Keiskamma	7,505	17,783	4,301	37.4	26.9	15.1	11.3	9.5
Upper Orange	14,107	13,554	16,107	24.2	19.2	15.4	15.1	26.1
Lower Orange	12,558	11,959	14,869	19.4	18.3	22.0	18.0	22.3
Fish-Tsitsikamma	16,052	17,465	10,161	13.7	23.7	19.9	18.4	24.2
Gouritz	19,865	19,645	20,952	6.8	12.0	35.1	30.5	15.7
Olifants/Doorn	16,993	18,817	14,740	7.9	14.9	31.7	29.3	16.3
Breede	18,377	20,434	14,283	3.8	18.0	31.8	22.3	24.1
CPT Berg	30,636	30,437	35,496	2.6	7.8	17.0	28.4	44.2

Source: South Africa 2002 Water-SAM and CGE model.

Integrated Modeling Framework

**ADJUSTED FOR
RSA MODELS**



Climate Change Impact Channels

- World commodity prices
- Agriculture
 - Crop yield deviations; and irrigation water supply
- Non-irrigation water supplies
 - Affect non-agriculture production and households
- Road infrastructure
 - Costs to maintain the same road network
- Sea level rise
 - SLR reduces crop land and damages coastal infrastructure
- Energy
 - Domestic and regional hydropower supply?

Agriculture and Irrigation

- CGE measures direct and indirect impacts
 - Reallocation of crop land in response to changing crop productivity and water resource constraints
 - Change in food imports in response to changing domestic production and world food prices
 - Effects on downstream processing

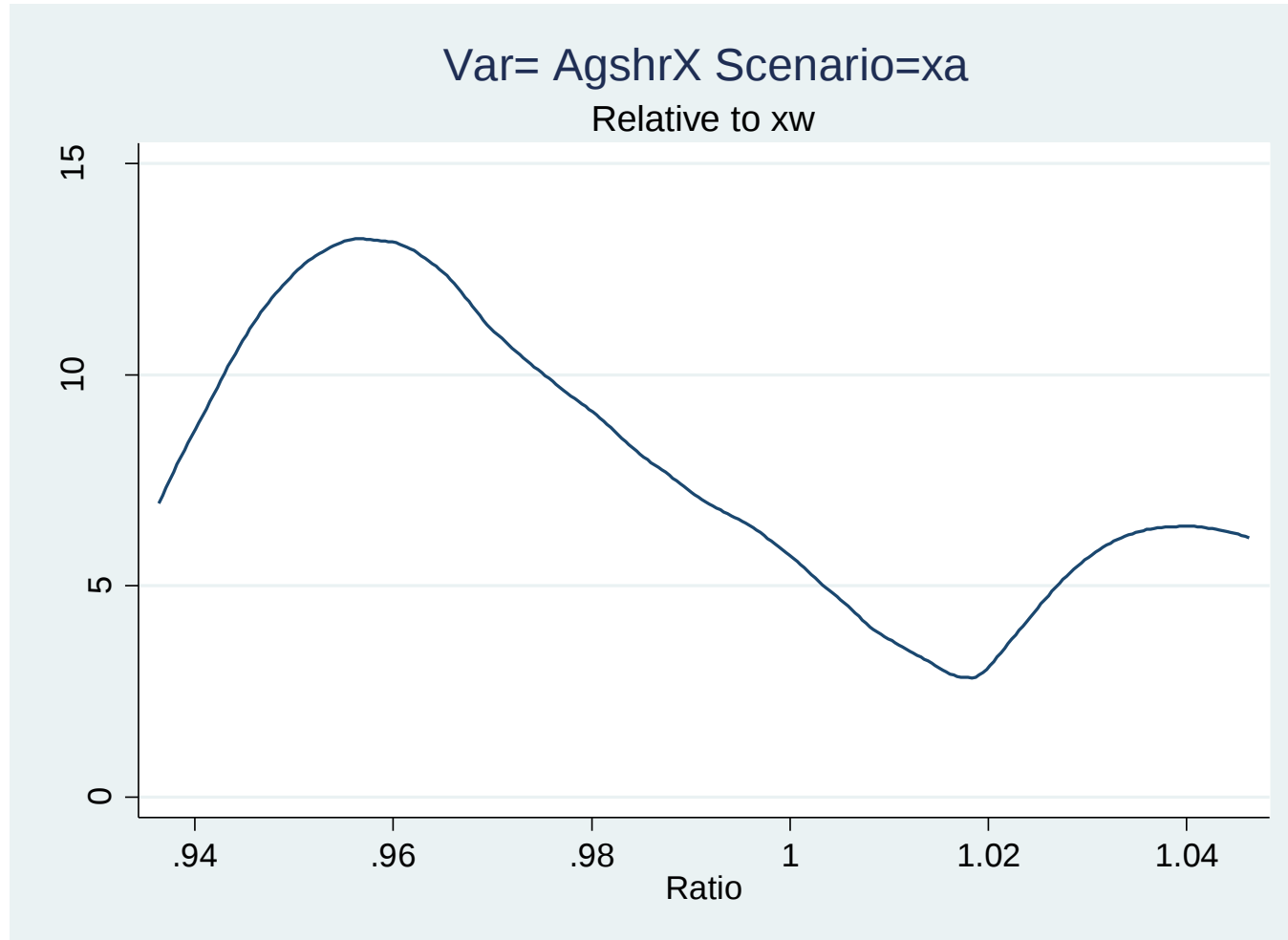
Baseline “No Climate Change” Scenario

- Define a baseline growth scenarios (or a set of scenarios)
 - Population and labor supply growth (by skill groups)
 - Urbanization rates
 - Sector and WMA-level productivity growth
- Water demand projections
 - Fix industrial, commercial and residential water demand
 - Residual allocated to irrigated agriculture
- Historical weather repeats itself (50 years)

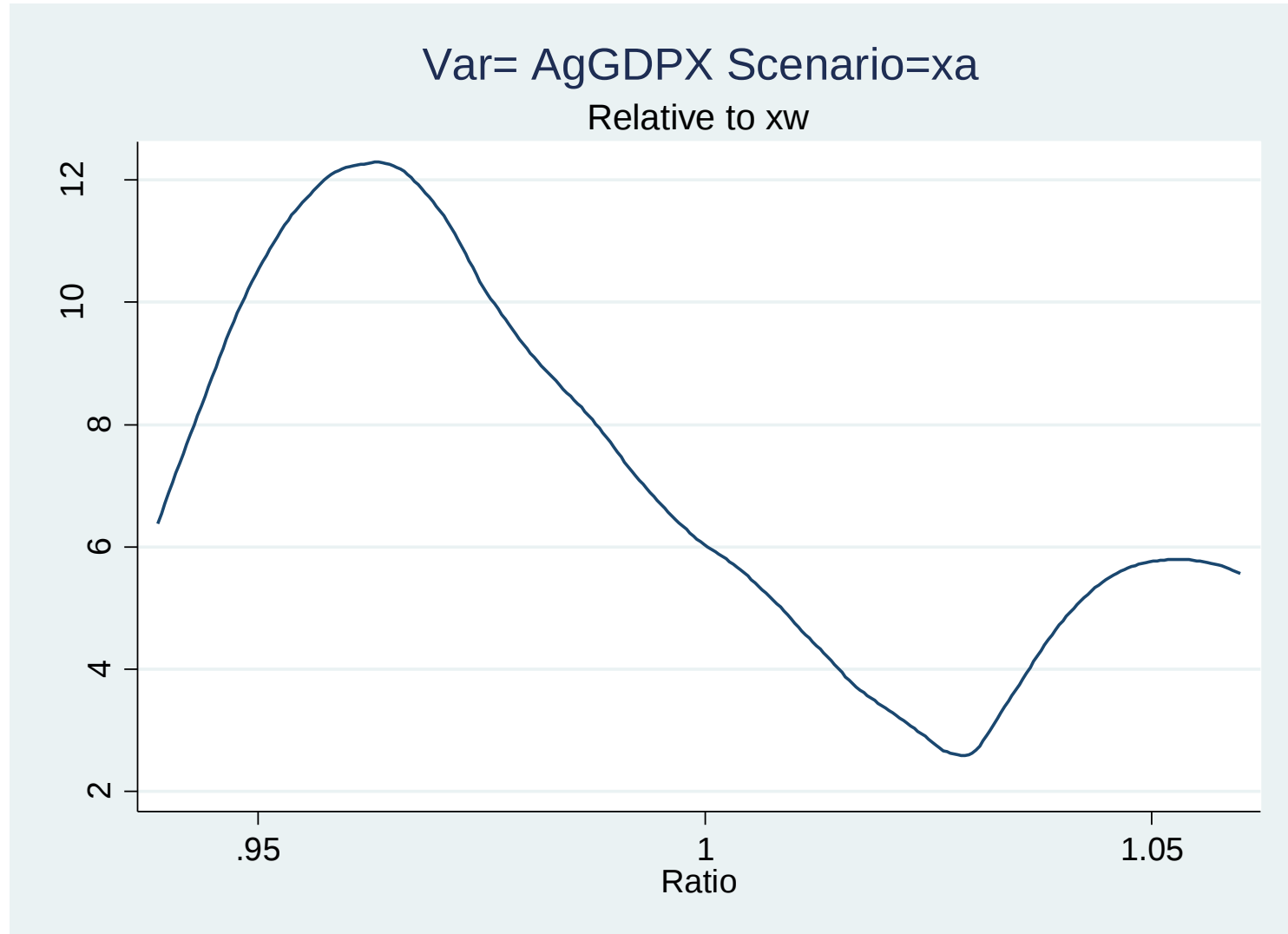
PRELIMINARY RESULTS

FOCUS ON AGRICULTURE/WATER IMPACT
CHANNEL UNDER UNCONSTRAINED
EMISSIONS

Agricultural Share of GDP



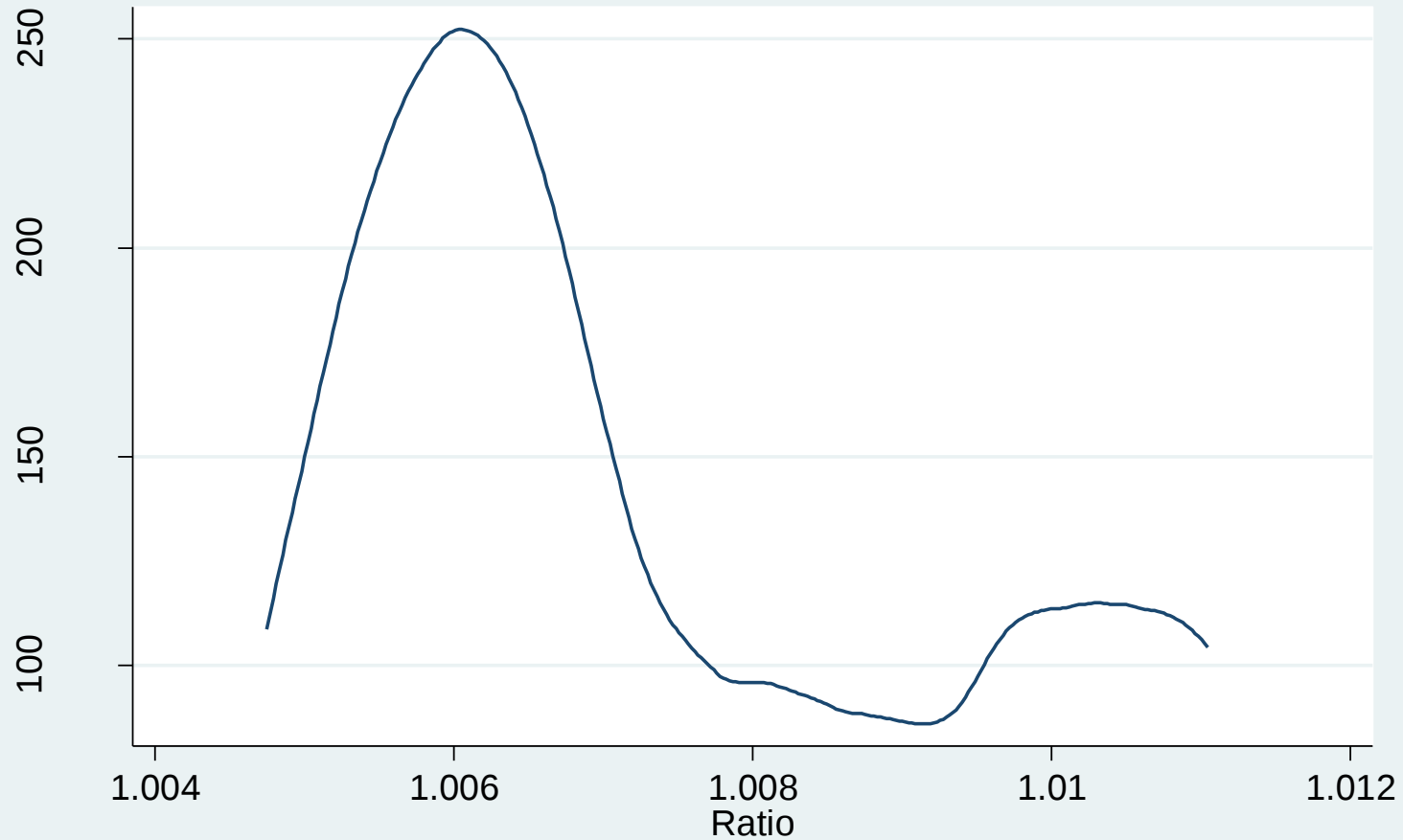
Agricultural GDP



Non-Agricultural GDP

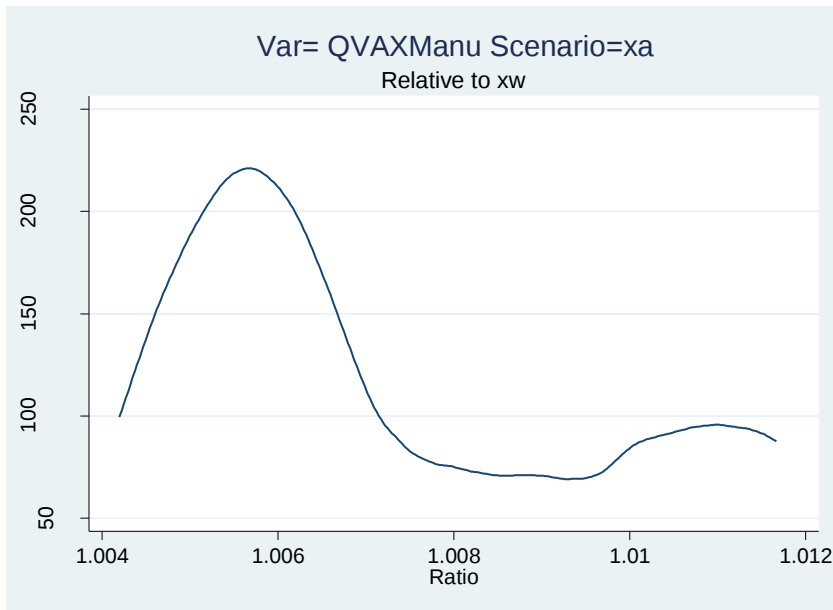
Var= QVAXNonAg Scenario=xa

Relative to xw

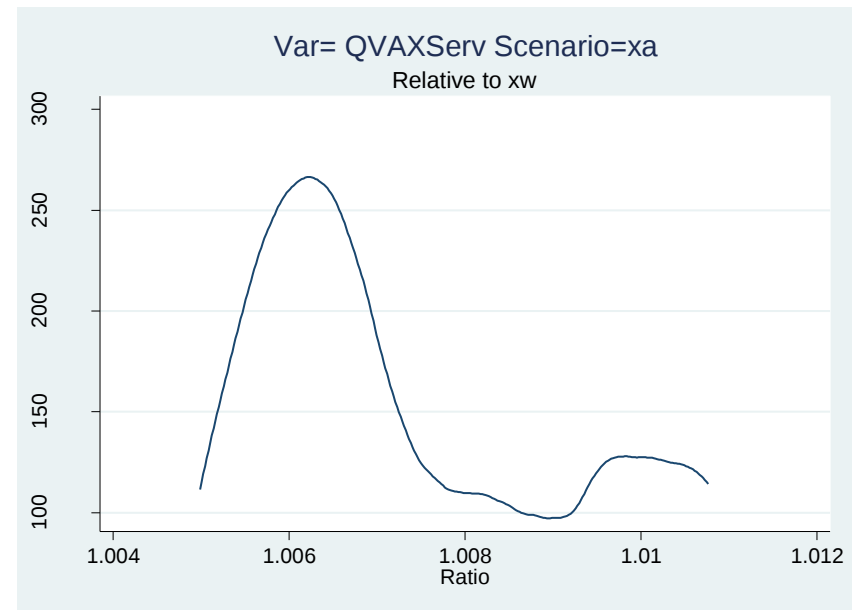


Both Industry and Services Expand Slightly as Agriculture Releases Resources

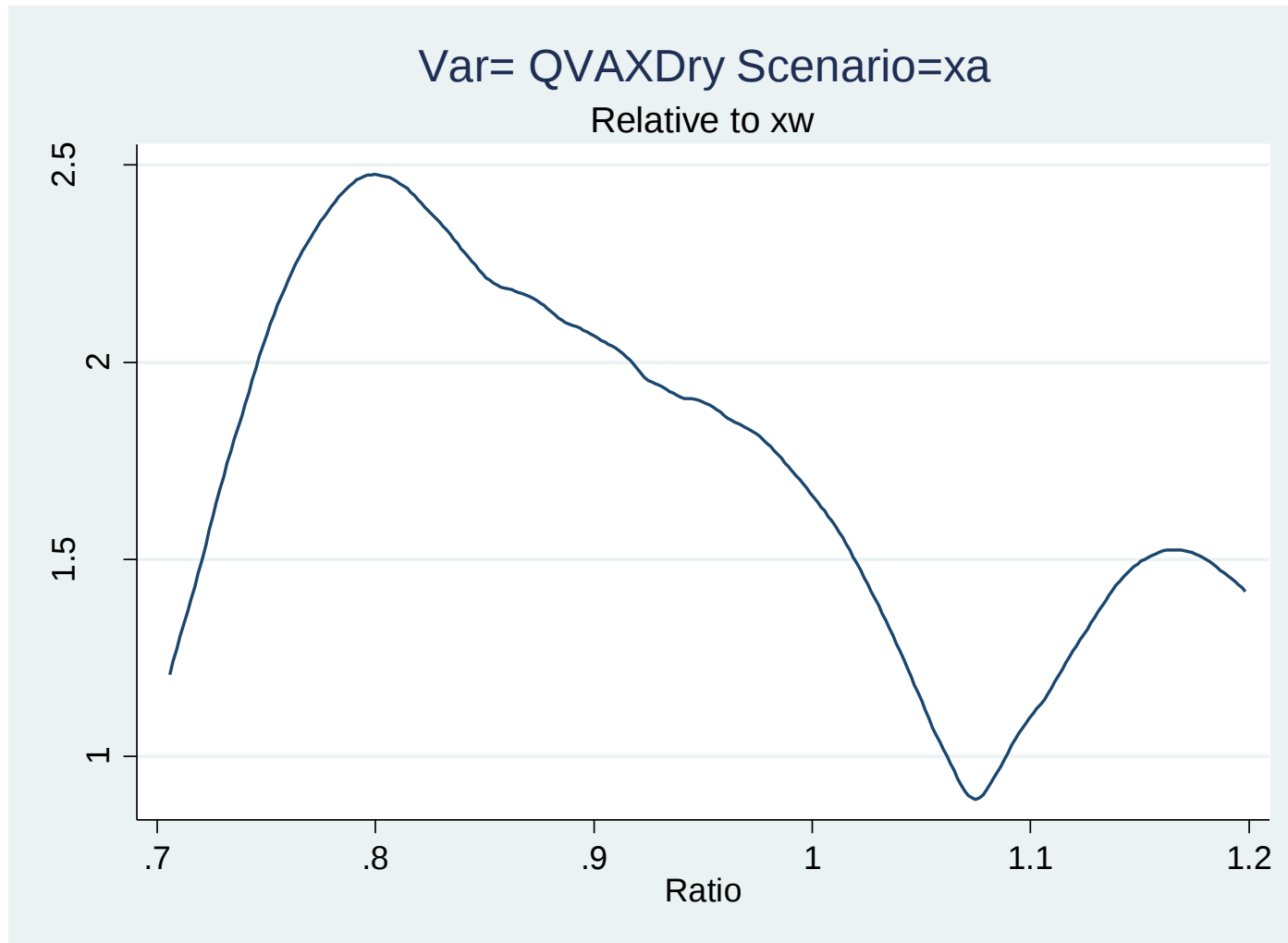
Industry



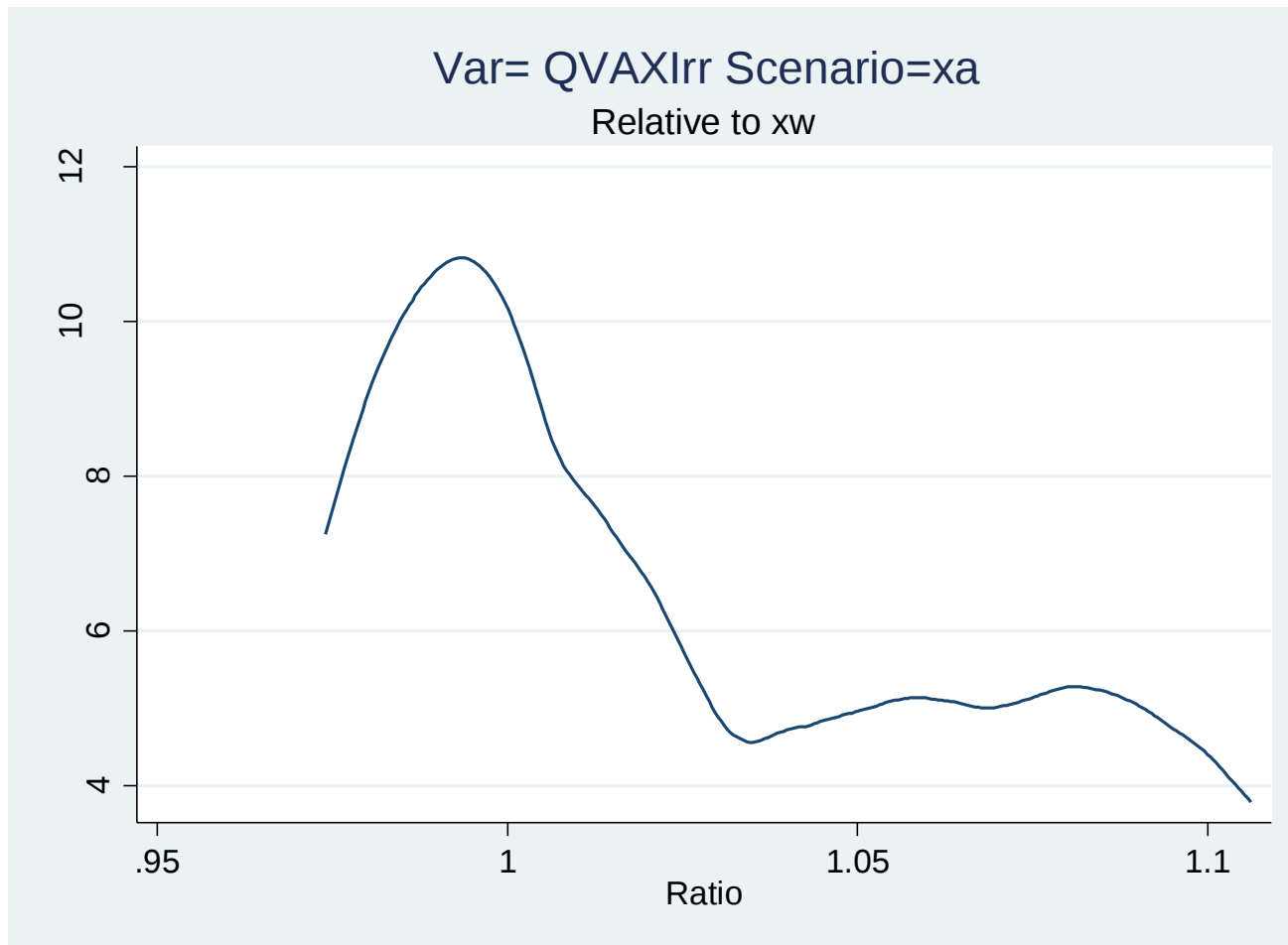
Services



Real Value Added in Agriculture (Dry Land)



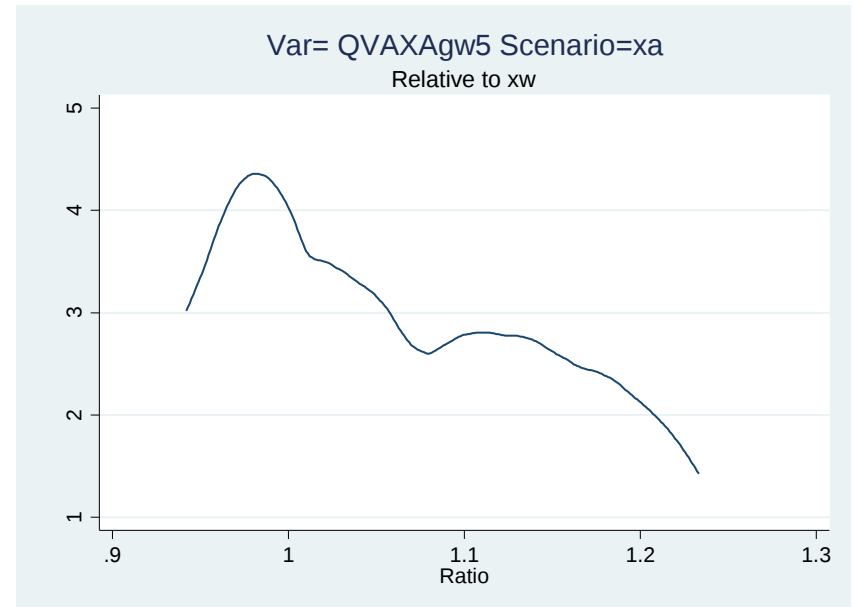
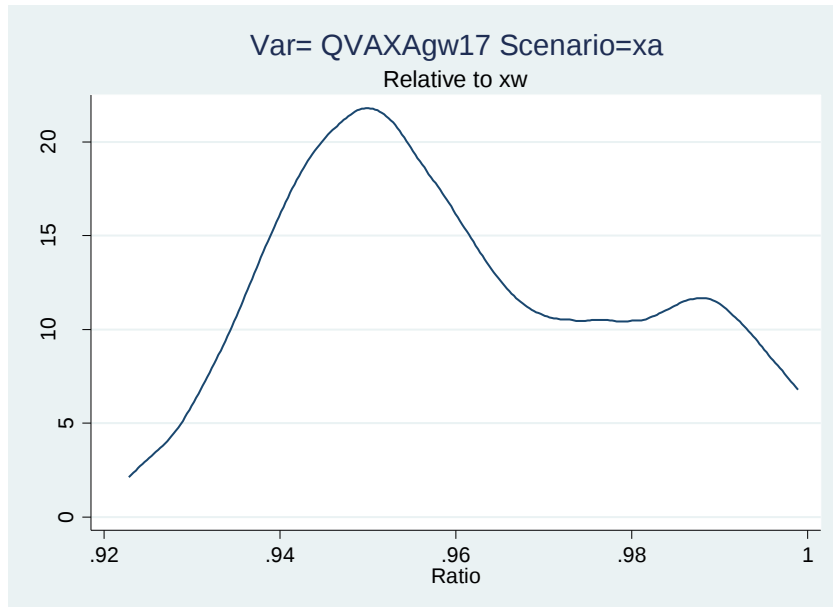
Real Value Added in Agriculture (Irrigated Land)



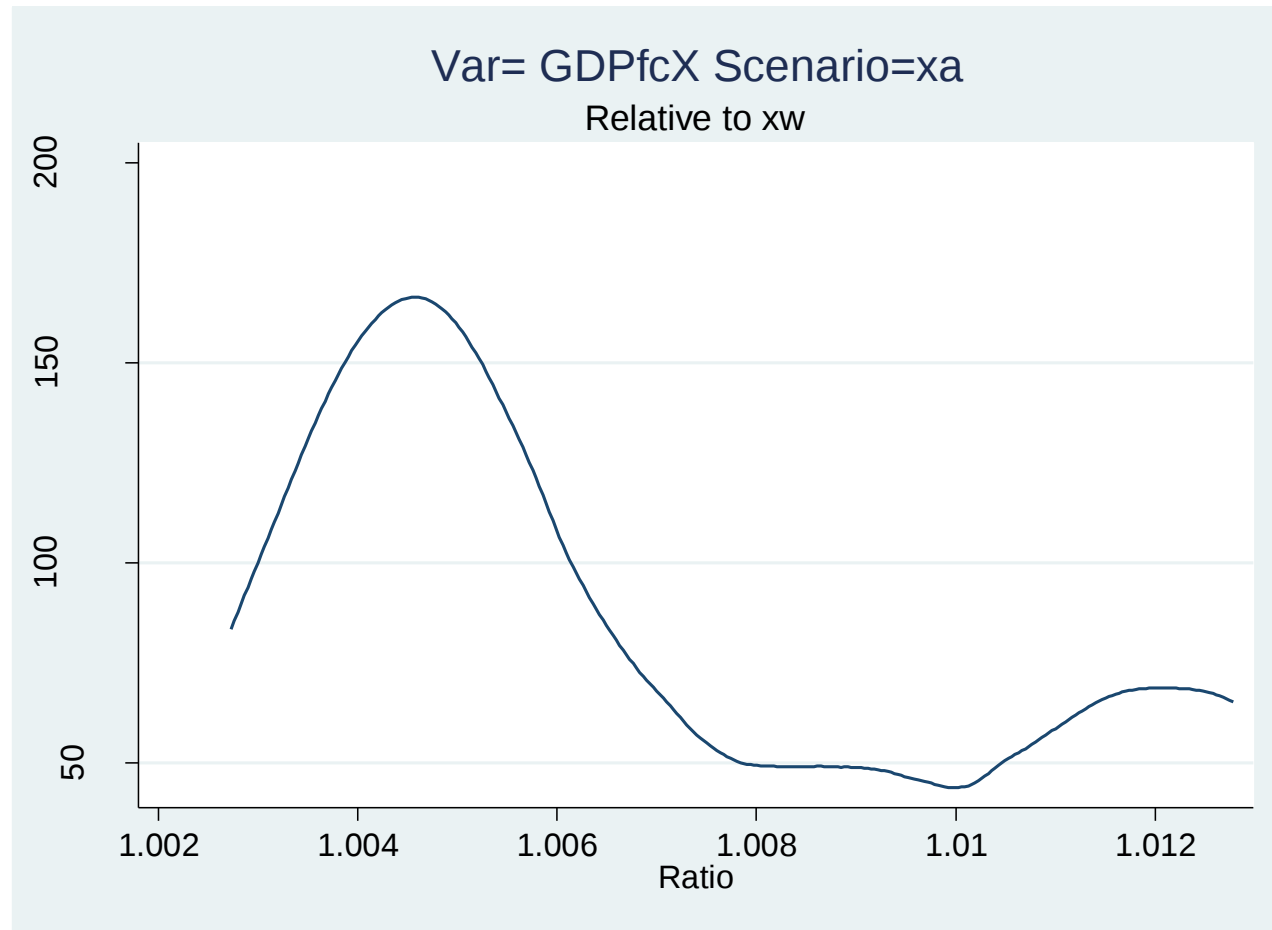
Diversity of Impacts on Agriculture Across WMAs

WMA 17 – Consistent Losses

WMA 5 – Mostly Gains



GDP Impact



This distribution will likely shift to the left when other channels, such as roads and SLR are incorporated.

Expectations at this Point

- Based on the impact channels considered, we expect:
 - Mild negative implications for overall GDP growth
 - Increased costs to maintain the same transport infrastructure
 - Potentially strong economic impacts for
 - Dry land agriculture (broad confidence intervals)
 - Water availability in certain WMAs
 - Infrastructure on a localized basis
 - Particular zones vulnerable to sea level rise
- The cumulative economic impact of excluded impact channels is likely negative but not very large in a macroeconomic sense