Effect of Rural Infrastructure and Capacity-Building on Agricultural Production and Agricultural Prices

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Outline

- Motivation

- Spatiotemporal Model

- Household Production Frontier Model

- EM Algorithm for Missing Data

- Results

- Implications

- Policy Directions

Income Class		FIES 2006		FIES 2012	
		Philippines	HH Head in AFH	Philippines	HH Head in AFH
All HH	Number of Families ('000)	14,532	5,127 (35%)	17,169	6,344 ⬆(37%)
	Income Reported (M)	2,371,221	485,120 (20%)	3,870,962	852,784 (22%)
Income <40,000	Families Reporting('000)	1,170	836 (71%)	472	357 (76%)
	Income Reported (M)	35,458	25,273 (71%)	14,640	11,086 (76%)
40,000-59,00	Families Reporting('000)	2,077	1,288 (62%)	1,152	831 (72%)
	Income Reported (M)	104,694	64,414 (62%)	59,065	42,493 (72%)
60,000-99,99	Families Reporting('000)	3,664	1,614 (44%)	3,470	2,113 (61%)
	Income Reported (M)	287,237	123,519 (43%)	279,011	167,443 (60%)

Source: PSA

2012 FIES, PSA

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
Philippines	21,426	2,174	2,183	2,262	7,887	6,921
Under 40,000	676	162	145	115	199	54
40,000 - 59,999	1,400	357	365	226	357	96
60,000 -99,999	4,057	847	819	679	1,302	409
100,000 - 249,999	9,065	730	753	1,022	3,610	2,950
250,000 and over	6,228	77	101	219	2,419	3,412
National Capital Region	2,917	3	3	14	144	2,752
Under 40,000	9	-	-	-	-	9
40,000 - 59,999	21	-	-	-	3	18
60,000 -99,999	109	-	0	0	8	101
100,000 - 249,999	1,160	3	2	7	46	1,101
250,000 and over	1,617	-	1	7	87	1,523

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
Cordillera Administrative Region	375	48	52	59	134	82
Under 40,000	8	2	2	2	1	1
40,000 - 59,999	22	7	8	4	2	0
60,000 -99,999	66	16	18	15	14	3
100,000 - 249,999	157	20	19	31	60	27
250,000 and over	122	3	5	8	56	51
I - Ilocos Region	1,105	75	107	167	660	95
Under 40,000	38	6	3	6	17	6
40,000 - 59,999	67	12	11	10	31	3
60,000 -99,999	195	20	29	37	99	8
100,000 - 249,999	558	33	60	96	324	45
250,000 and over	247	4	3	18	189	32

Source: PSA

Region / Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
II - Cagayan Valley	771	185	151	134	270	30
Under 40,000	17	3	4	2	7	1
40,000 - 59,999	44	16	15	7	6	1
60,000 -99,999	167	63	44	21	37	1
100,000 - 249,999	388	91	73	77	133	14
250,000 and over	155	12	16	27	87	13
III - Central Luzon	2,386	102	165	222	1,027	870
Under 40,000	20	1	-	4	11	5
40,000 - 59,999	80	12	14	11	30	13
60,000 -99,999	282	35	53	39	104	51
100,000 - 249,999	1,164	44	81	126	511	403
250,000 and over	840	11	16	42	371	399

Source: PSA

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
IVA - CALABARZON	3,082	115	133	154	972	1,709
Under 40,000	44	6	6	6	19	7
40,000 - 59,999	104	14	15	10	38	27
60,000 -99,999	355	57	49	50	112	87
100,000 - 249,999	1,376	34	55	76	475	736
250,000 and over	1,203	4	7	13	328	851
IVB - MIMAROPA	638	114	119	108	240	58
Under 40,000	31	9	7	8	5	2
40,000 - 59,999	57	19	18	9	10	0
60,000 -99,999	167	39	42	36	46	4
100,000 - 249,999	267	41	46	43	112	25
250,000 and over	116	6	4	11	67	27

Source: PSA

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
V - Bicol Region	1,165	83	180	212	593	97
Under 40,000	44	6	5	10	22	2
40,000 - 59,999	111	16	32	23	35	5
60,000 -99,999	357	32	91	87	135	12
100,000 - 249,999	477	29	50	87	272	39
250,000 and over	175	1	1	5	129	39
VI - Western Visayas	1,604	174	210	230	831	158
Under 40,000	70	16	15	13	23	2
40,000 - 59,999	138	37	30	32	38	2
60,000 -99,999	410	70	88	75	163	15
100,000 - 249,999	623	50	68	93	336	77
250,000 and over	363	2	9	18	271	62

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
VII - Central Visayas	1,577	112	139	166	783	377
Under 40,000	94	18	22	19	31	4
40,000 - 59,999	139	27	39	27	42	4
60,000 -99,999	325	46	49	58	139	34
100,000 - 249,999	617	20	25	57	348	166
250,000 and over	402	1	4	5	224	169
VIII - Eastern Visayas	902	104	169	159	394	77
Under 40,000	59	12	16	13	14	4
40,000 - 59,999	116	25	34	27	27	3
60,000 -99,999	293	44	88	64	89	8
100,000 - 249,999	286	23	30	48	152	33
250,000 and over	148	0	2	7	112	27

Source: PSA

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
IX - Zamboanga Peninsula	772	140	134	120	252	125
Under 40,000	51	12	16	11	10	2
40,000 - 59,999	88	25	29	13	16	5
60,000 -99,999	231	60	53	43	59	16
100,000 - 249,999	287	42	32	45	108	59
250,000 and over	115	1	4	9	59	42
X - Northern Mindanao	976	158	134	117	461	106
Under 40,000	55	23	13	7	12	1
40,000 - 59,999	108	36	32	14	24	2
60,000 -99,999	261	64	52	39	95	11
100,000 - 249,999	364	30	35	48	207	43
250,000 and over	188	5	2	8	123	49

Source: PSA

Region Income Class	Number of Families	Percent of Total Income from Agriculture				
		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
XI - Davao Region+A96	1,078	195	175	132	403	173
Under 40,000	39	14	9	3	9	3
40,000 - 59,999	95	32	33	9	15	6
60,000 -99,999	226	64	53	36	55	18
100,000 - 249,999	485	76	65	65	199	80
250,000 and over	234	9	15	19	124	66
XII - SOCCSKSARGEN	988	225	165	141	367	90
Under 40,000	73	28	20	9	13	3
40,000 - 59,999	129	50	37	17	20	5
60,000 -99,999	269	84	53	42	71	20
100,000 - 249,999	349	54	48	56	151	39
250,000 and over	168	9	7	17	111	23

Source: PSA

Region	Number of Families	Percent of Total Income from Agriculture				
Income Class		75% -100%	50 % - 74.9%	25% - 49.9%	Below 25%	None
Autonomous Region in Muslim Mindanao	557	282	70	47	93	65
Under 40,000	4	3	1	0	0	0
40,000 - 59,999	36	23	6	3	3	1
60,000 -99,999	209	131	31	13	26	8
100,000 - 249,999	269	120	32	29	49	40
250,000 and over	39	5	2	1	15	15
XIII - Caraga	532	57	76	81	263	56
Under 40,000	20	5	5	3	5	1
40,000 - 59,999	47	9	11	10	16	2
60,000 -99,999	134	22	26	25	52	9
100,000 - 249,999	236	20	31	38	126	21
250,000 and over	96	2	3	5	64	23

Source: PSA

Motivation

- Rural sector ⟺ agriculture

- Those who generate bigger income are not sourced from agriculture

- Rural is most vulnerable because of too much dependence from agriculture.
  - Susceptible to weather volatility

- Implications
  - Strategies towards achievement of Rural Development?
  - Where to start?
  - Food Security Issues?

Framework (Barrios, 2008)

Rural Development
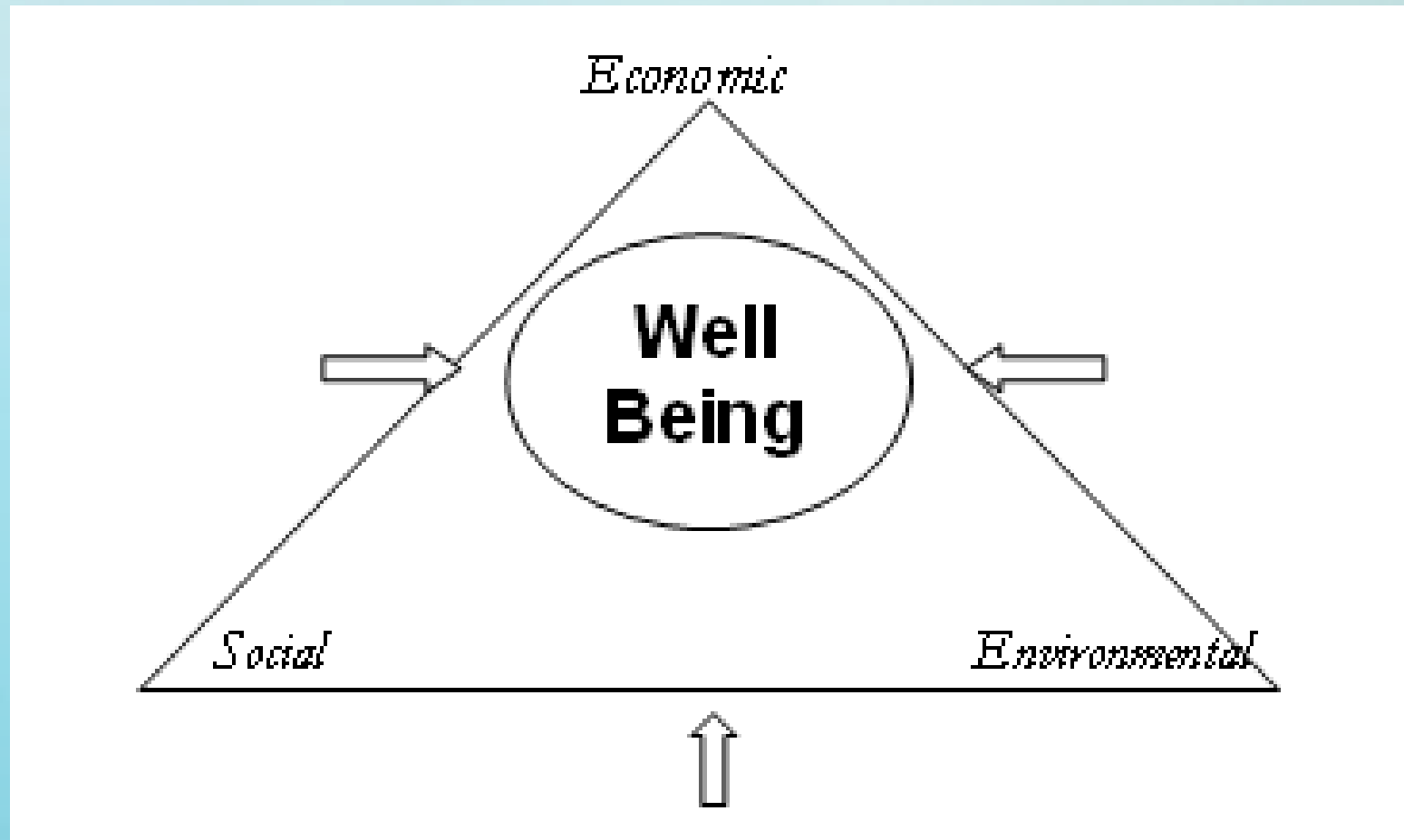
Framework

- Rural roads
  - Increased accessibility=>Lower transportation cost
  - Input, Marketing=>Higher production, Earnings
  - Access to outside community=>Social Development
  - Provision of social services=>Capability building
    Empowerment
- Catalyst to other infrastructure=> public investment
- Access to outside community=>increased desire for development
- Community Building

Framework

- ↑ Demand for other infrastructure, Support services

- ↑ Participation of individual households in sourcing for infra/support services

- Private investments, diversity of income sources

- Participation of local government

- Sustainability strategies
  - Increased production, better post-production handling, viable inputs sourcing

- **Poverty Alleviation, Rural Development**

Motivation

- Agriculture and Fisheries Modernization Act (AFMA)-RA 3485: lead the farmers and fisherfolk into a modernized agriculture and fisheries sector leading towards:
  - poverty alleviation and social equity
  - food security
  - rational use of resources
  - global competitiveness
  - sustainable development
  - people empowerment, and protection from unfair competition.

- SAFDZ- Strategic Agriculture and Fisheries Development Zone (?)

Motivation

- Since 2000, corn sufficiency ratio ≈ 95% until 2013.

- Rice sufficiency ratio continued to decline, especially in 1998 (worst El Nino of the century).
  - Since 2011, rice sufficiency ratio has crossed beyond the 90% mark and reached near-sufficient level in 2013 at 96.8%.
  - 28% of domestically-consumed rice is sourced through importation in 1998
  - 1996 rice crisis, import dependency ratio at 10.51%.
  - Even a higher ratio was observed in 2002, and continues to increase until it reached 19% in 2010.

- Substantial volume of import of coffee, garlic, peanut, mongo, and beef.

- Fishery product is not imported (in general).

Motivation

- Agrarian reform program
  - Land distribution (facilitate market access)
  - Support services
    - Economic; Physical (incl. Infrastructure); Marketing; Microcredit, Livelihood, Capacity Building, BSS
  - ARB
  - ARC
  - Intervention at ARC level (no one in the community will be denied of these services-even the non-ARBs)

  Goal:

  Convert communities into a viable rural enterprise, the catalyst to rural development!

Spatiotemporal Models

$$y_{it} = x_{it}\beta_i + z_{it}\gamma_t + \epsilon_{it}$$

x_{it} - factors of production, price determinants

      Effects: β_i vary over provinces

z_{it} - production; marketing; post-harvest; transportation-related infra.

   - capacity-building

      Effects: γ_t vary over time

Has there been a strategic zoning?

- Identify production areas
- Investments are bundled in areas suitable for cultivation of specific crops/commodities

Stochastic Frontier Model

Cross-Sectional Production Frontier

$$y_i = f(x_i; \beta) \exp(v_i) \, TE_i \Rightarrow$$

$$TE_i = \frac{y_i}{f(x_i; \beta) \exp(v_i)} = \frac{Actual\ Production}{Frontier\ Production}$$

Suppose $TE_i = e^{-u_i} \Rightarrow$ Production Stochastic Frontier Model

$$y_i = f(x_i; \beta) \exp(v_i) \exp(u_i)$$

- 2 error component model!

- Production Function [Area, Inputs]

- Cost Function-Prices

Household Production Frontier

$$lny_i = lnf(x_i; \beta) + \delta D[lny_i - lnf(x_i; \beta)] + v_i - u_i$$

$$u_i = \frac{1}{1 + e^{(-z\varphi)}} + \epsilon_i$$

- Has the intervention (infrastructure specifically) been efficiency-enhancing among the farmers/rural households?

EM Algorithm

- An iterative optimization strategy
  - Notion of missingness
  - conditional distribution of what is missing given what is observed

- Can be very simple to implement. Can reliably find an optimum through stable, uphill steps.

- Difficult likelihoods often arise when data are missing. EM simplifies such problems.

- EM is a conceptual simplification of the MLE problem

- Notation
  - X : Observed variables; Z : Missing or latent variables;
  - Y : Complete data Y = (X, Z)

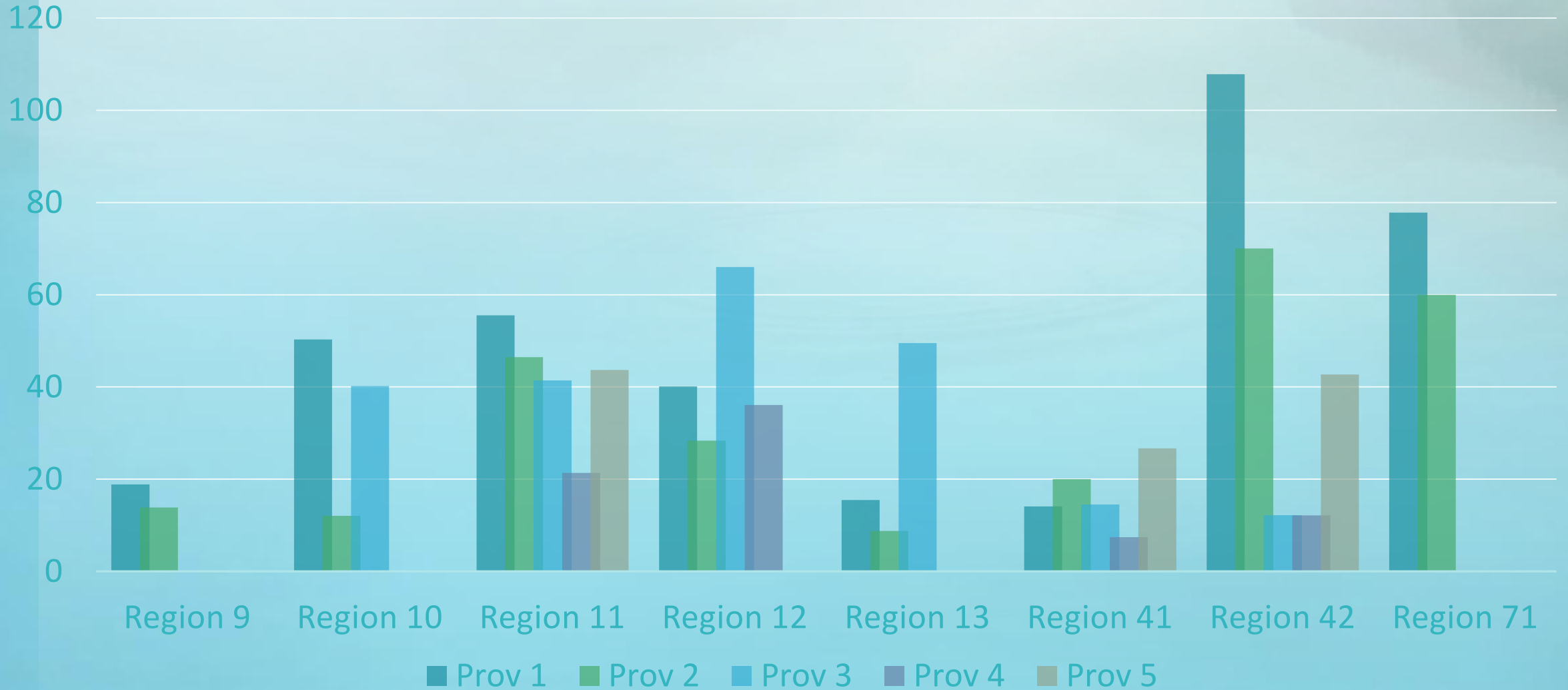- In Bayesian settings, X, Z, and Y often refer to sets of parameters, rather than data.

Results – Is there any strategic zoning?

Palay Production on Harvest Area
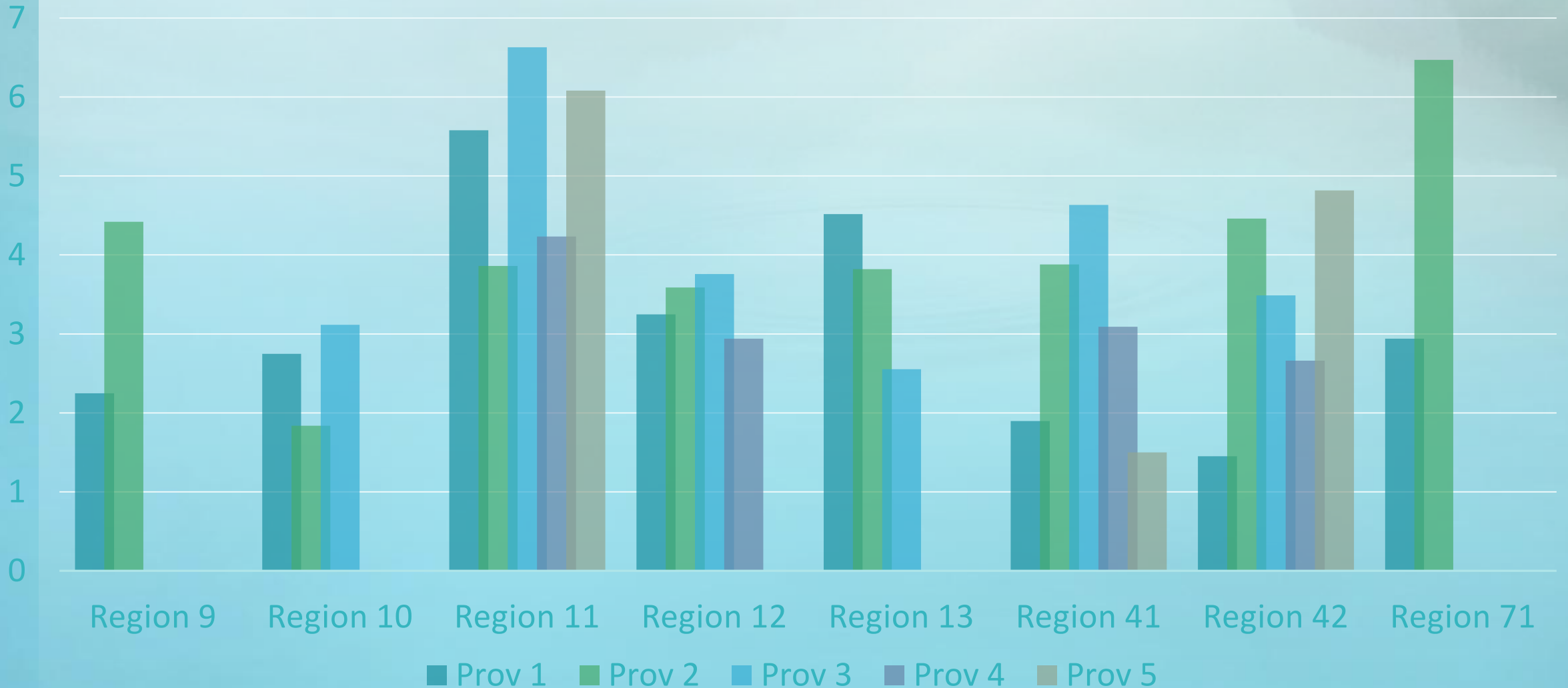
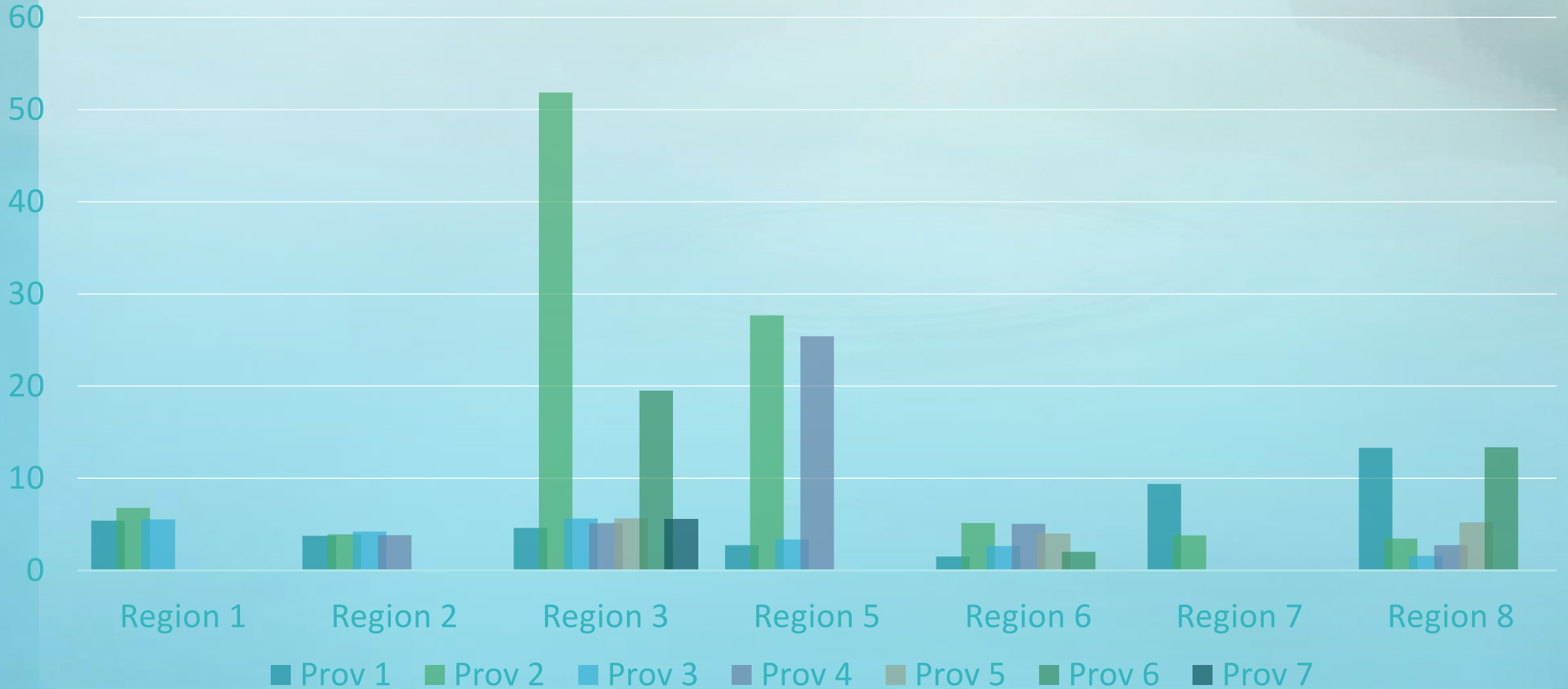# Results – Is there any strategic zoning?

Banana Production on Harvest Area
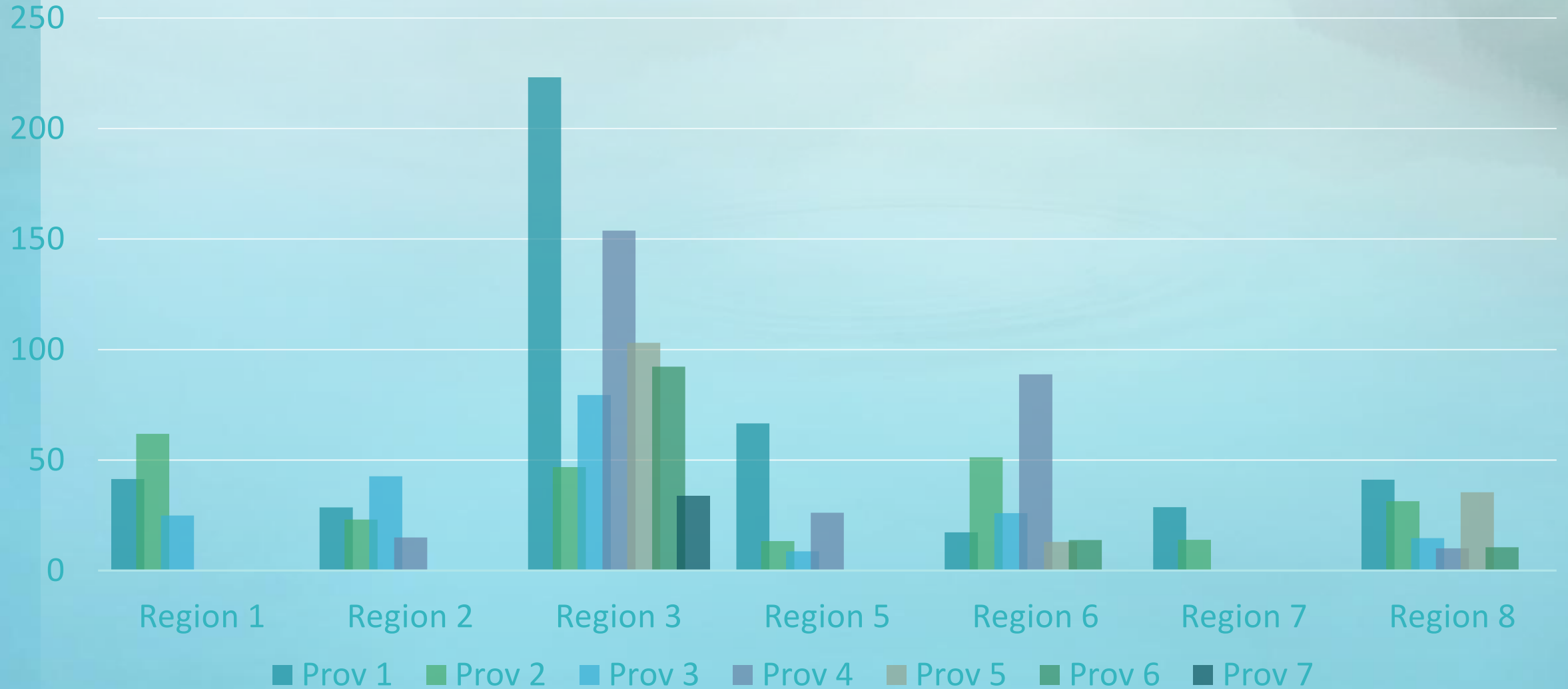
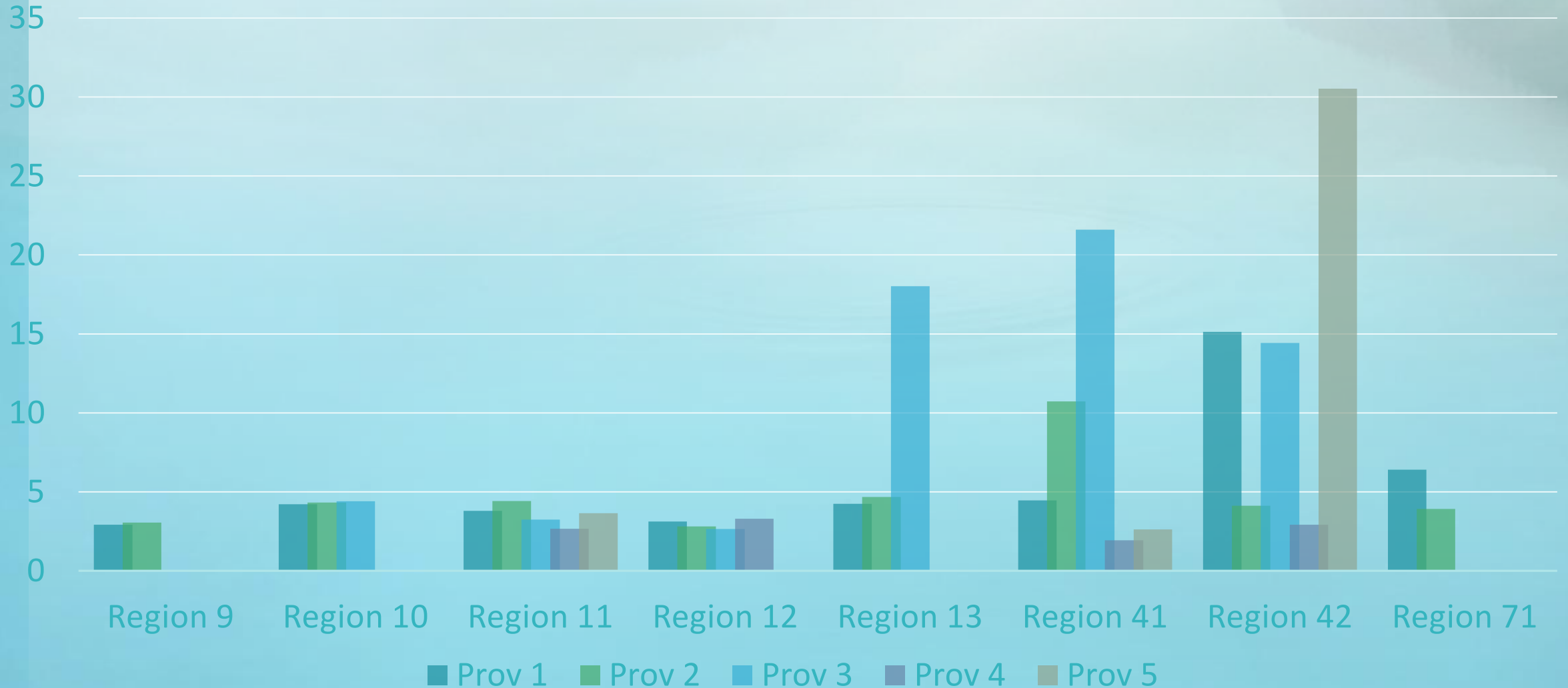Results – Is there any strategic zoning?

Banana Production on Harvest Area

Results – Is there any strategic zoning?
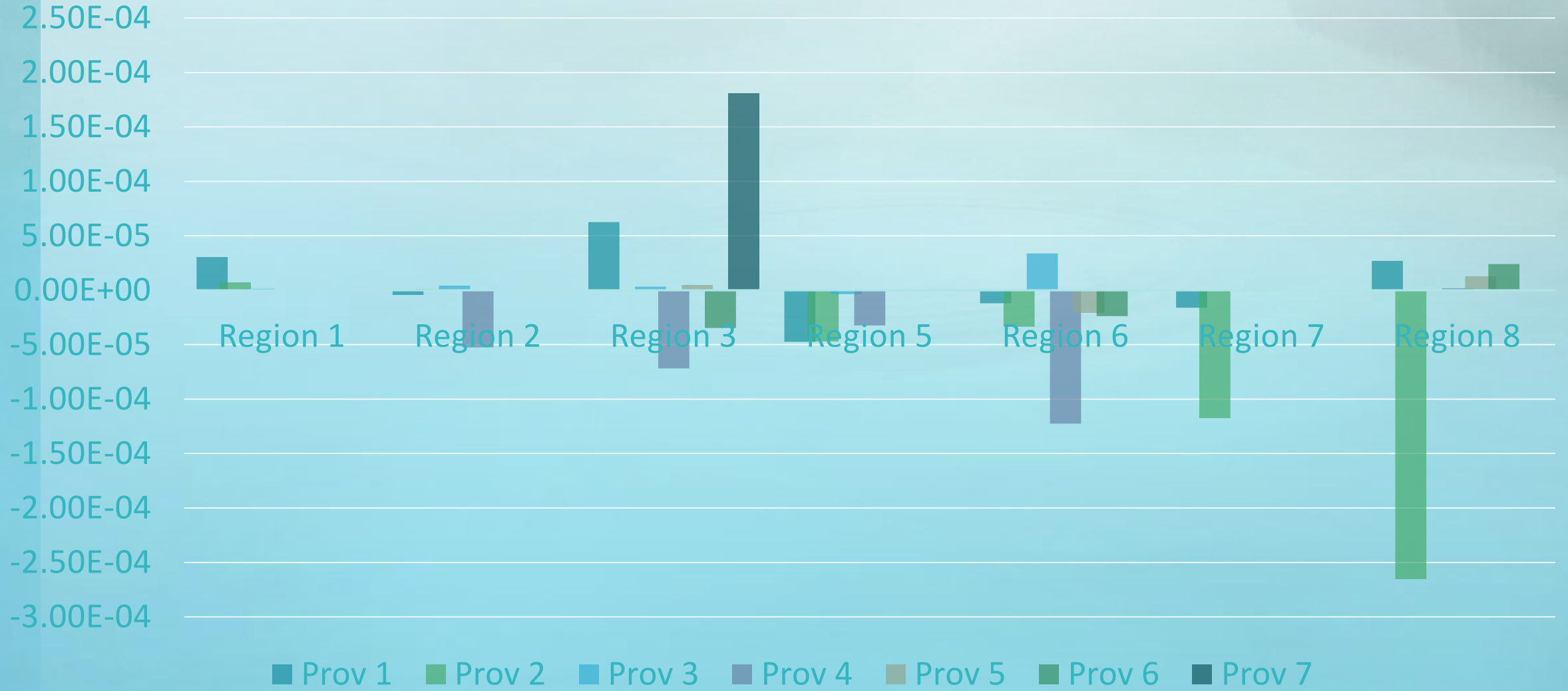
Yellow Corn Production on Harvest Area

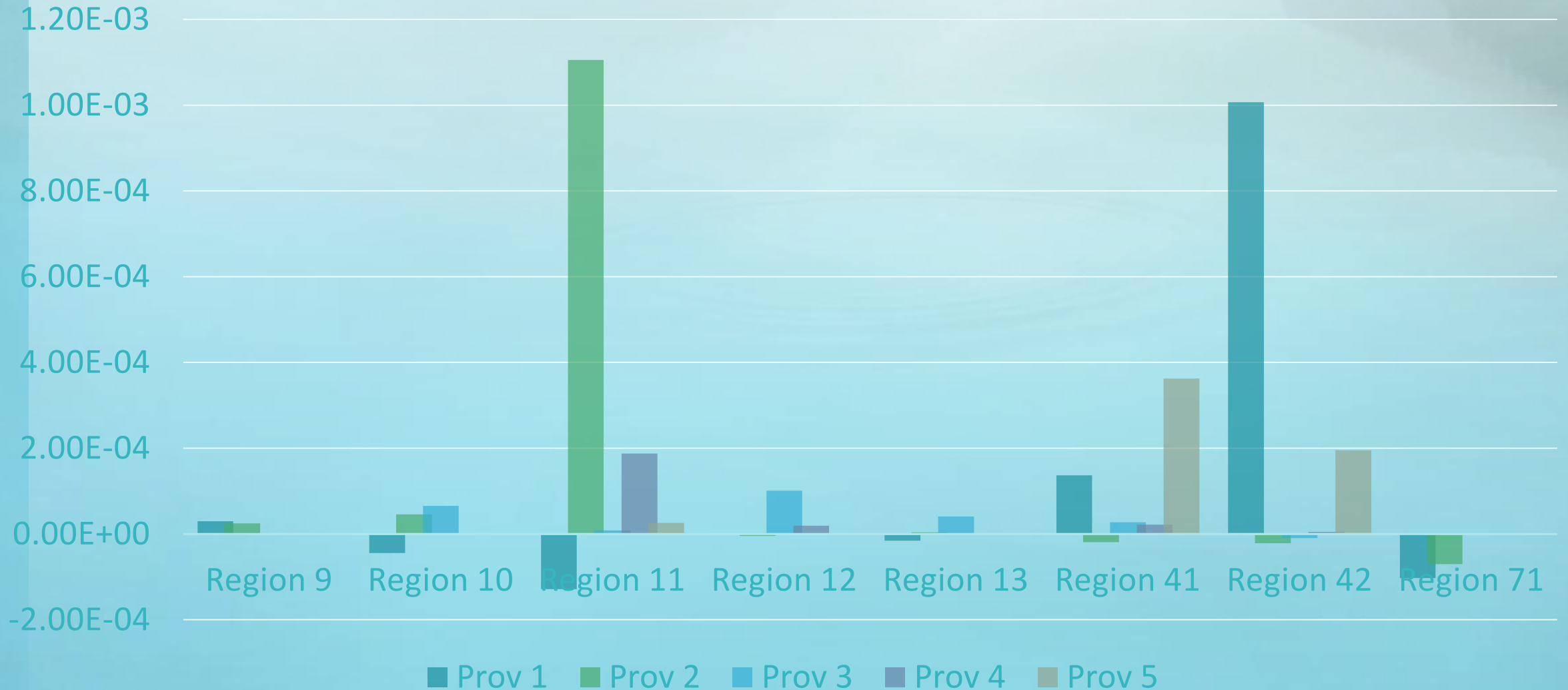Results – Is there any strategic zoning?

Yellow Corn Production on Harvest Area

Results – Has the Producers Been Linked with the Traders?

Palay Farmgate Prices on Production

Results – Has the Producers Been Linked with the Traders?

Palay Farmgate Prices on Production

Legend: Prov 1, Prov 2, Prov 3, Prov 4, Prov 5

Regions: Region 9, Region 10, Region 11, Region 12, Region 13, Region 41, Region 42, Region 71

Results – Has the Producers Been Linked with the Consumers?

RM Palay Retail Prices on Production

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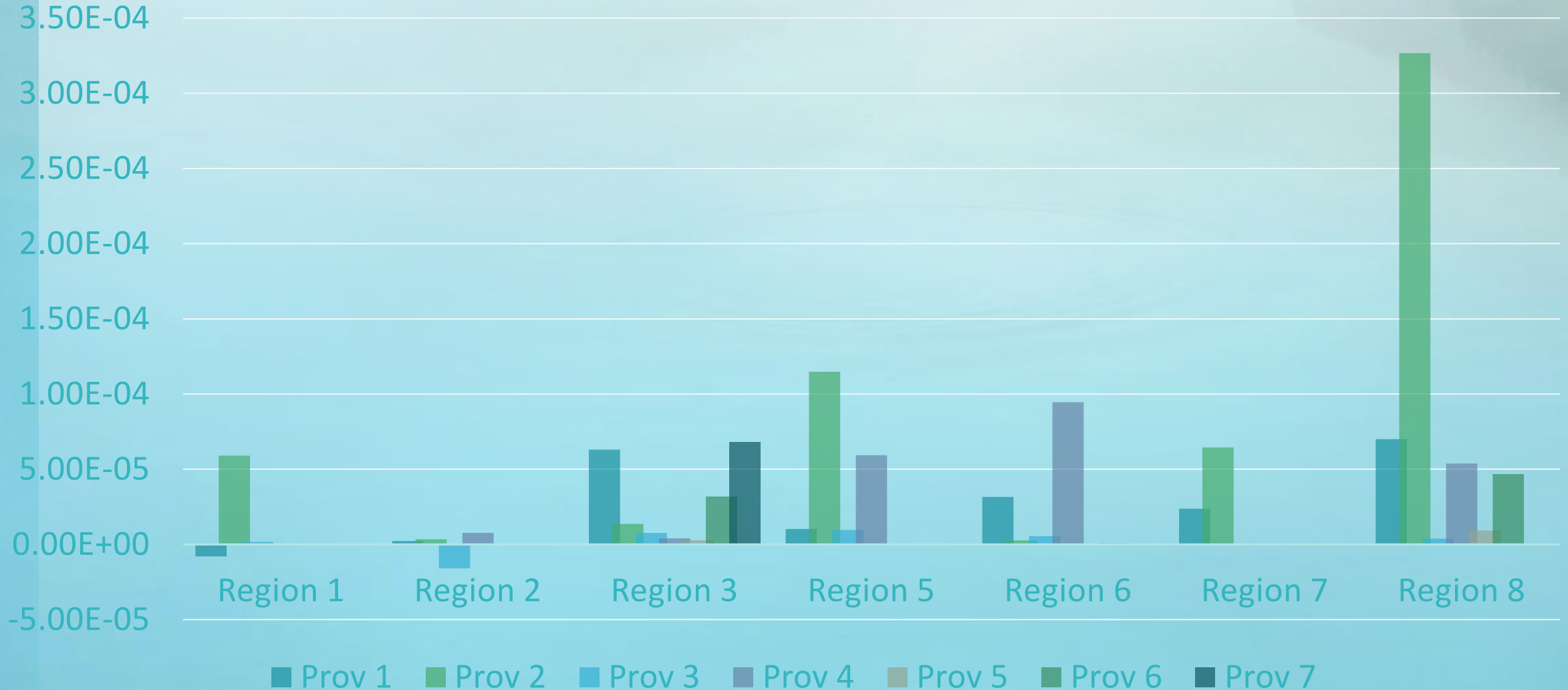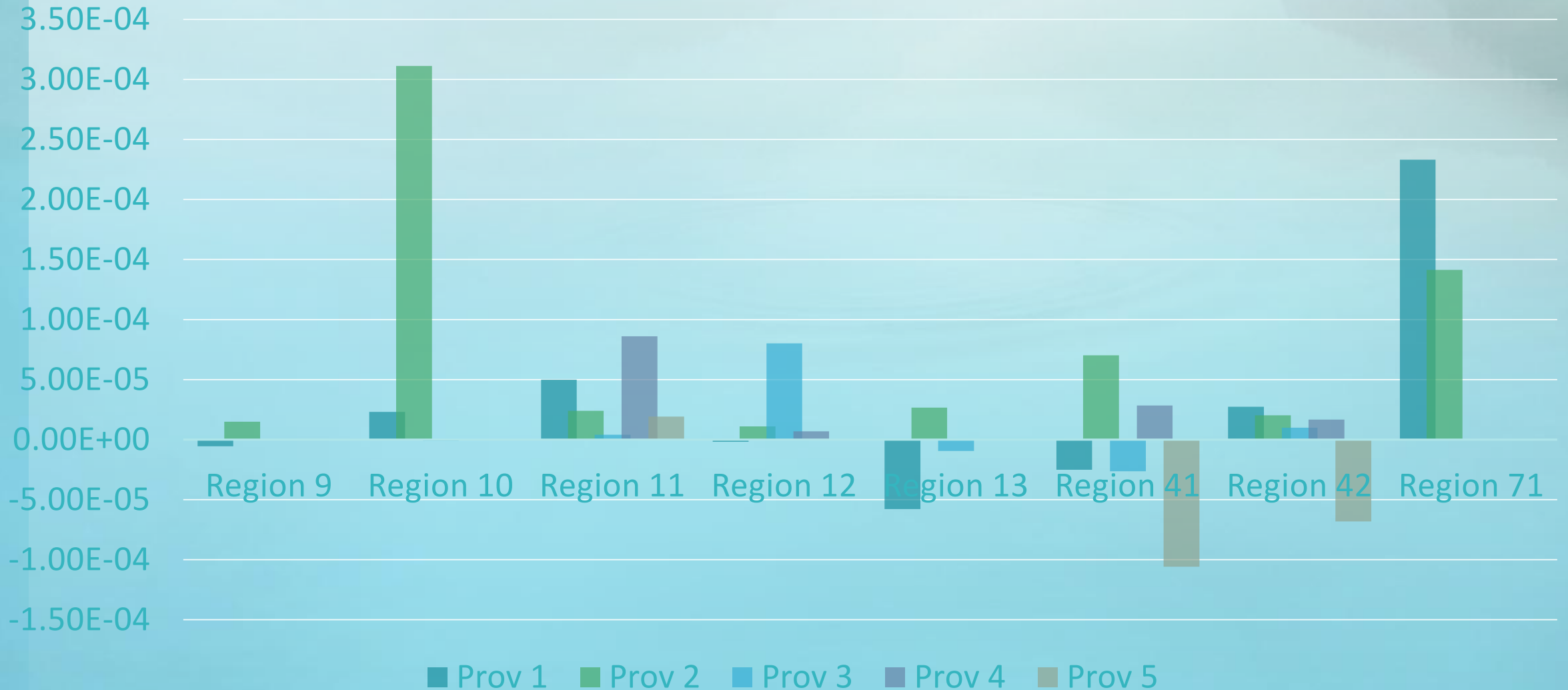
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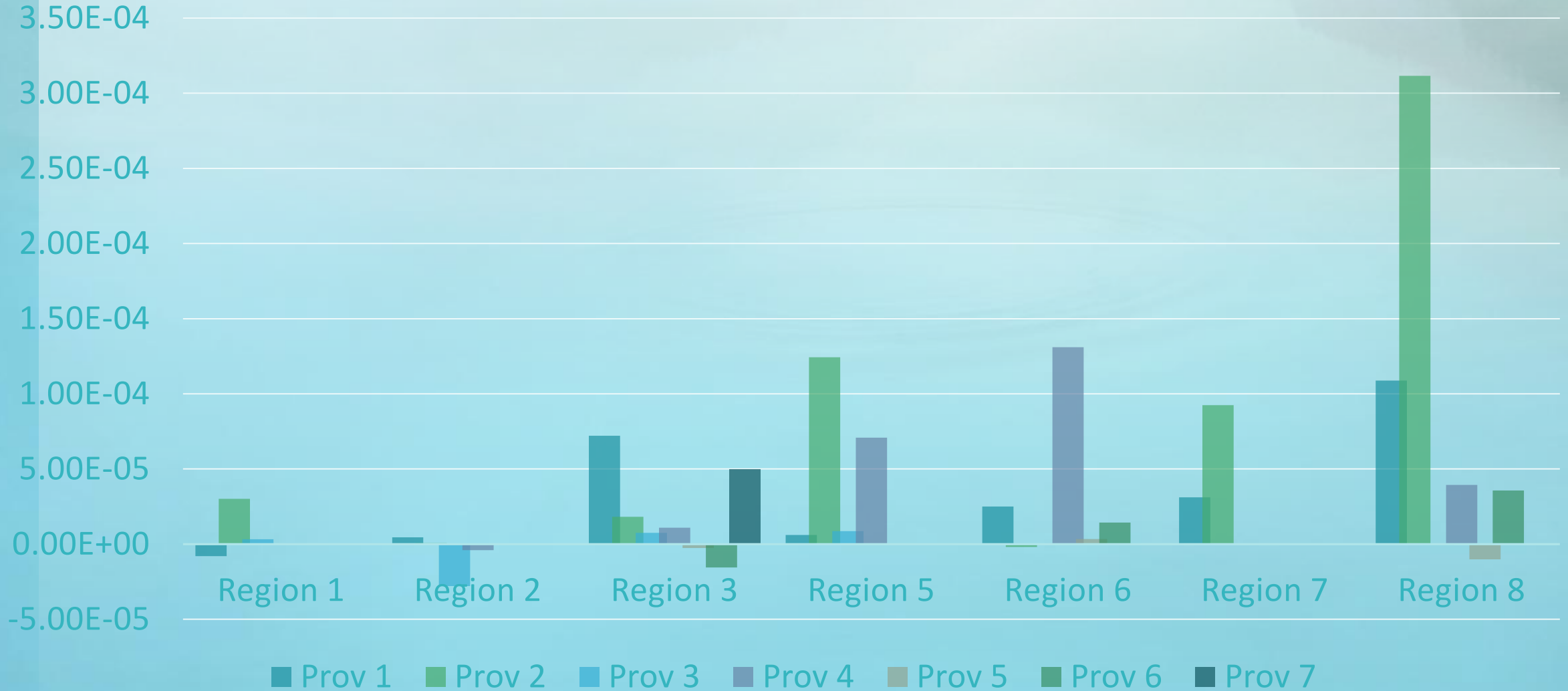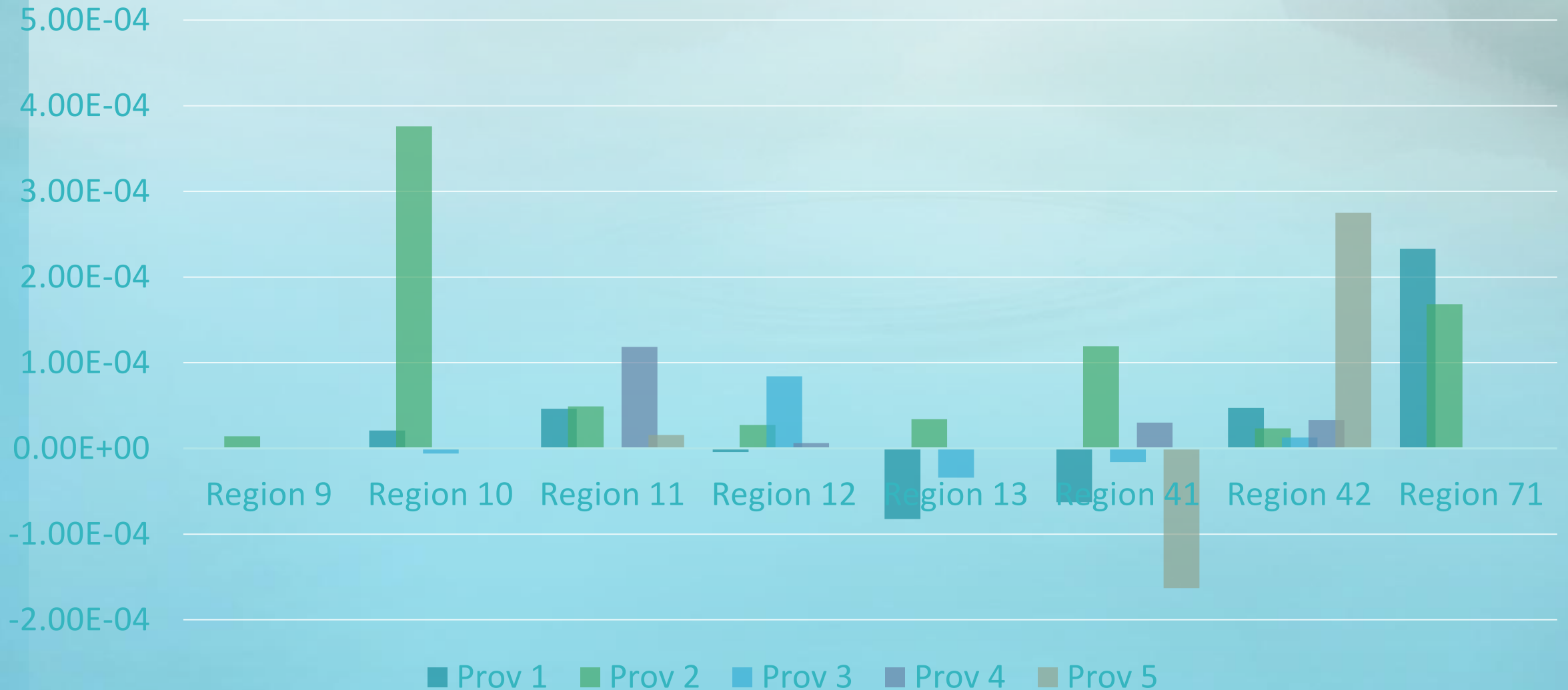
WM Palay Retail Prices on Production

Results – Has the Producers Been Linked with the Consumers?

WM Palay Retail Prices on Production

Results – Has the Producers Been Linked with the Consumers?

Pork Retail Prices on Farmgate Prices

Results – Has the Producers Been Linked with the Consumers?

Pork Retail Prices on Farmgate Prices

Would Infrastructure, Capacity-Building Enhance Production Efficiency of Farmers?-Palay Prod

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.966	.362	.951	Irrig Service Area
2004	.969	.328	.954	
2005	.966	.353	.940	Irrig Service Area
2006	.971	.311	.956	
2007	.975	.362	.952	Irrig Service Area
2008	.979	.370	.958	Irrig Service Area
2009	.982	.378	.972	
2010	.981	.453	.965	Irrig Service Area
2011	.986	.354	.972	FMR
2012	.986	.396	.959	Irrig Service Area
2013	.989	.368	.971	FMR

Results – Has Infrastructure Made the Market More Efficient?-Retail Palay Prices

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.002	.367	.987	
2004	.047	.178	.989	
2005	.032	.306	.989	Marketing Info/Linkages
2006	.018	.325	.992	
2007	.014	.270	.990	
2008	.057	.267	.987	FMR
2009	.010	.274	.980	FMR
2010	.010	.203	.991	
2011	.021	.266	.991	
2012	.054	.283	.988	
2013	.102	.360	.983	Marketing Info/Linkages

Would Infrastructure, Capacity-Building Enhance Production Efficiency of Farmers?-Y Corn Prod

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.935	.673	.861	Marketing Info/Linkages
2004	.942	.648	.890	FMR
2005	.967	.541	.908	
2006	.969	.424	.910	Livelihood Loans
2007	.976	.370	.933	
2008	.974	.313	.908	Livelihood Loans, Marketing Info/Link
2009	.973	.430	.943	
2010	.980	.454	.944	
2011	.981	.467	.933	FMR
2012	.981	.453	.925	Livelihood Loans
2013	.980	.543	.931	

Results – Has Infrastructure Made the Market More Efficient?-Retail Y Corn Prices

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.004	.341	.601	Marketing Info/Linkages, PH
2004	.005	.282	.598	PH
2005	.024	.278	.596	PH
2006	.034	.290	.614	PH
2007	.018	.352	.433	FMR, PH, Marketing Info/link
2008	.007	.412	.501	FMR
2009	.030	.405	.468	
2010	.076	.362	.546	
2011	.056	.349	.569	
2012	.025	.355	.493	PH
2013	.014	.371	.577	PH, FMR

Would Infrastructure, Capacity-Building Enhance Production Efficiency of Farmers?-Pork Prod

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.040	.407	**.876**	FMR, Marketing Info
2004	.003	.414	**.886**	
2005	.018	.392	**.832**	
2006	.037	.459	**.849**	FMR
2007	.206	.258	**.849**	FMR, Marketing Info
2008	.036	.415	**.826**	FMR
2009	.006	.485	**.833**	FMR, Marketing Info
2010	.088	.378	**.829**	
2011	.094	.421	**.802**	
2012	.082	.408	**.863**	
2013	.044	.436	**.844**	FMR

Results – Has Infrastructure Made the Market More Efficient?-Retail Pork Prices

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.199	.261	**.284**	
2004	.314	.248	**.266**	
2005	.373	.229	**.274**	
2006	.282	.333	**.266**	Marketing Info
2007	.247	.297	**.187**	
2008	.352	.313	**.135**	Marketing Info, FMR
2009	.357	.296	**.127**	Marketing Info, FMR
2010	.056	.370	**.274**	FMR
2011	.185	.348	**.289**	FMR
2012	.211	.323	**.357**	
2013	.416	.259	**.287**	

Would Infrastructure, Capacity-Building Enhance Production Efficiency of Farmers?-Chicken Prod

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.203	.326	**.810**	FMR, Livelihood Loans, Prod Tech Updates
2004	.253	.281	**.792**	FMR
2005	.198	.142	**.747**	FMR
2006	.082	.244	**.748**	FMR
2007	.240	.217	**.790**	FMR
2008	.188	.345	**.811**	FMR
2009	.143	.382	**.830**	
2010	.382	.483	**.765**	
2011	.296	.535	**.755**	FMR
2012	.317	.547	**.807**	
2013	.387	.447	**.762**	FMR

Results – Has Infrastructure Made the Market More Efficient?-Retail Chicken Prices

Year	Prod R^2	Auto R^2	TE	Det of Eff
2003	.146	.513	**.257**	FMR
2004	.249	.346	**.299**	
2005	.291	.379	**.305**	
2006	.268	.422	**.337**	
2007	.265	.410	**.394**	
2008	.249	.475	**.341**	
2009	.191	.497	**.241**	FMR, Marketing Info/Linkage
2010	.127	.553	**.257**	FMR
2011	.055	.618	**.349**	
2012	.066	.594	**.272**	
2013	.199	.534	**.325**	FMR

Implications

- Asymmetric information: Producers-Traders; Consumers-Producers

- Accessibility still important

- Equity in market access is crucial for equilibrium of agricultural market⇒Information
  −producers, traders, consumers

- Capacity-Building, Microfinance can enhance production efficiency.

Policy Directions

- Goal: Production Efficiency, Market Access, Bridging of Information Gap

- Infrastructure
  - Type vs. Needs of Beneficiaries
  - Sense of ownership
  - Maintenance: transfer of responsibility to whom?
    - LGU vs. People's Organization/Cooperative

- Bundle intervention, do not spread resources too thin
  - Infrastructure and capacity building

- ARC-Type of Modality in Development Intervention

- Implement the true essence of AFMA
  - Package investments on commodities where it can be most efficiently produced **(SAFDZ)**
  - National Information Network **(NIN)**

Thank you.