

# Linking Climate Change, Rice Yield, and Migration: *The Philippine Experience*

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# Rationale

- Climate change and Philippines
  - warmer nights, more rainy days, prolonged drought
  - tropical storms, floods, landslides, and drought
  - ➔ DECLINE in agri output
- Rice
  - spikelet sterility, flower abortion, higher transpiration, submergence, less energy for photosynthesis
  - ➔ LOWER yield & income
  - ➔ People migrate to cope





# Objectives

- Measure responses of international and domestic migration to rice productivity changes induced by CC;
- Examine gender dimension of migration;
- Hindcast of yield & migration if climate had not changed.





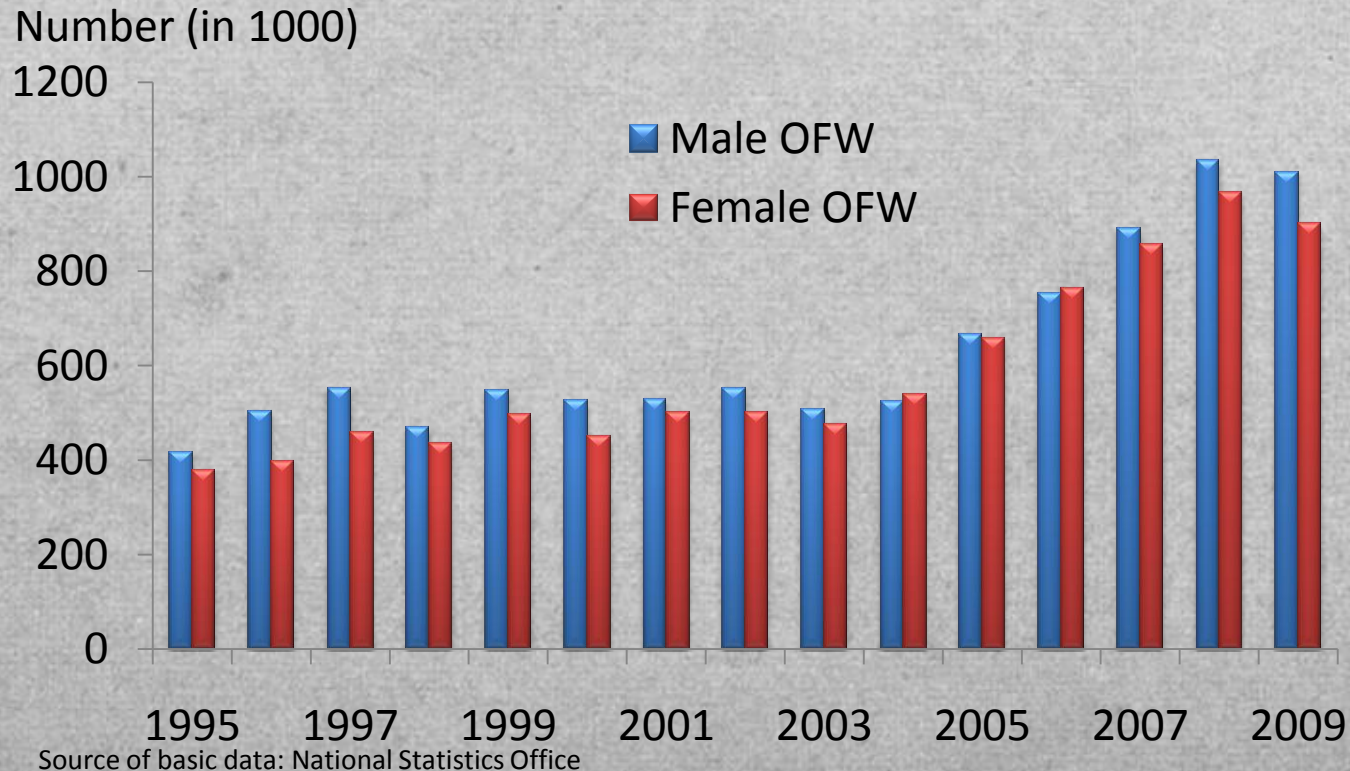
# Data and Methods

- 1) International Migration: Survey of Overseas Filipinos (NSO); Domestic migration rate – 2000 Census of Population
- 2) Rice data: Palay and Corn Survey (BAS)
- 3) Weather data: PAGASA
- 4) Methods: Fixed Effects – Two Stage Least Squares Estimation → Migration - dependent variable; Yield & Income - explanatory variables; Weather – instrumental variable



# Trends

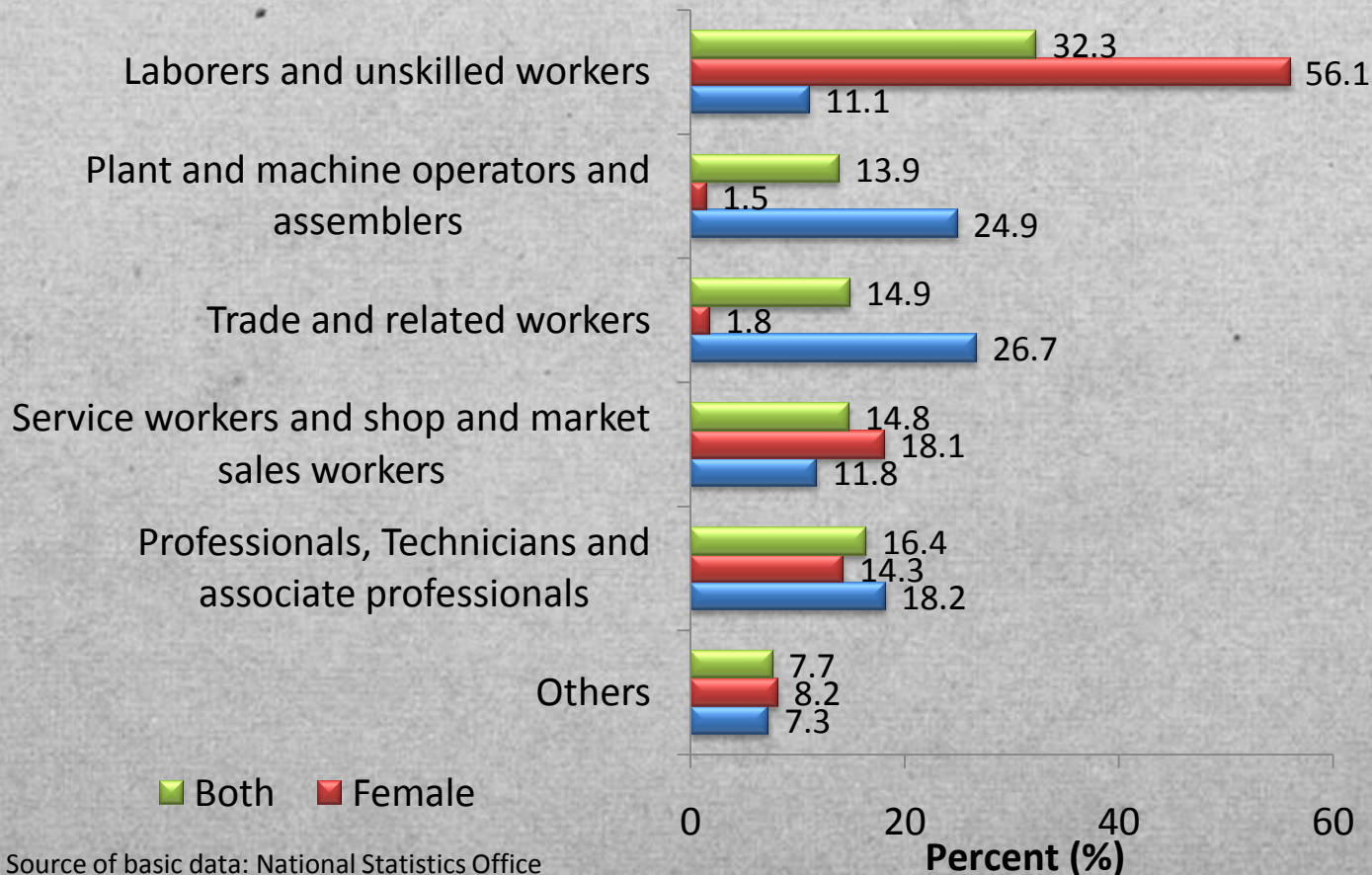
## Overseas Filipino Workers by Sex, 1995-2009



Male OFWs ↑ from 406,000 to 1,010,000;  
Female OFWs ↑ from 379,000 to 901,000



# Overseas Filipino Workers by Work, 2009



Majority of women OFWs are unskilled workers;  
 This includes domestic housekeeping services

## Five-year Average of Weather Variables

Particulars	1995	2009	Change
Minimum Temperature ( $^{\circ}\text{C}$ )			
Jan-Jun	18.12	19.05	0.93
Jul-Dec	18.91	19.73	0.82
Maximum Rainfall (mm)			
Jan-Jun	109	127	18
Jul-Dec	156	169	13
Total Rainfall (mm)			
Jan-Jun	640	927	287
Jul-Dec	1381	1553	172
Share of Wetdays in a Year (%)	23.00	26.80	3.80

Nights became warmer and days became wetter in the last 15 years



## Five-year Average of Rice Productivity Variables

Particulars	1995	2009	Percent Change
Production (M mt)	9.62	15.50	61
Area Harvested (ha)	3.38	4.22	25
Yield (mt/ha)	2.85	3.67	29
Value of Production (PhP billion)	86.83	137.95	59
Gross Revenue (PhP/ha)	25,742	32,683	27

Yield and gross revenue increased in the last 15 years



# Estimation Results

- ✓ A one-degree increase in ave. min temperature during the dry season decreases ave. yield by 64 kg/ha;
- ✓ A one percent increase in share of wet days diminishes ave. yield by 36 kg/ha and ave. gross revenue by PhP 356/ha;
- ✓ A one mt decline in ave. yield increases number of OFWs by 6.24 persons per 1000 population
- ✓ A PhP 1000 decline in ave. gross revenues increases number of OFWs by 0.93 person per 1000 population



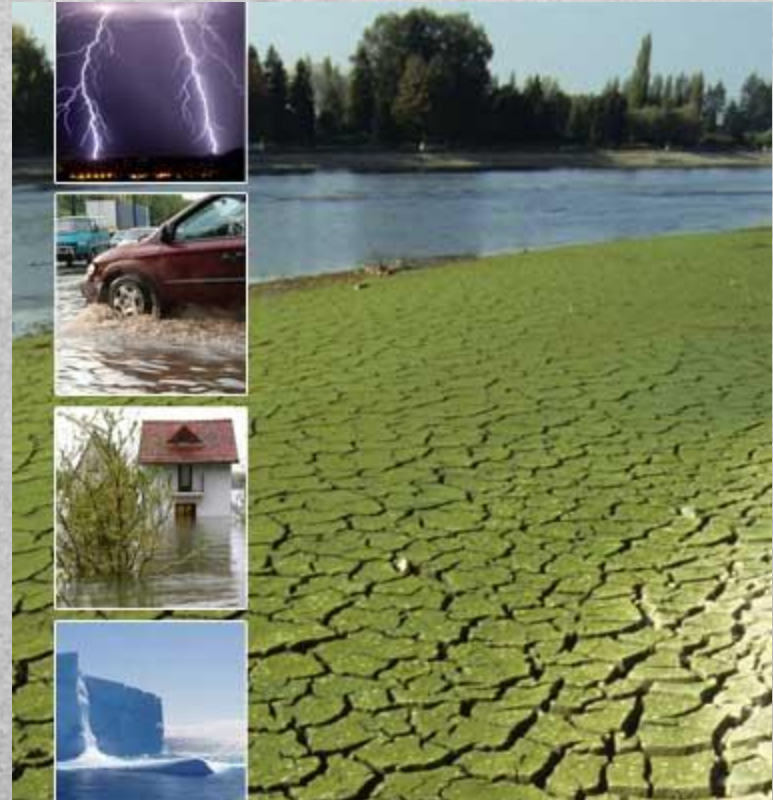
# Estimation Results

- ✓ A one mt decline in ave. yield induces migration of 7.09 female OFWs per 1000 population; effect on male migration is not significant
- ✓ A PhP 1000 decline in ave. gross revenue leads to migration of 1.10 female OFWs per 1000 population;
- ✓ A PhP 1000 decline in ave. gross revenue leads to reduction in regional out-migrants by 0.18 person per 1000 population



# Estimation Results

- ✓ The actual increase in min temp and share of wet days in the last 15 years led to decline in yield by **195 kg/ha** or in aggregate **742,000 mt** or **PhP 5.14 billion** revenues lost
- ✓ This has led about **99,000-102,000 OFW** to migrate, of which 57% are female





# Conclusion & Implications

- ✓ The impact of climate change, via reduction in rice productivity, on migration is real and already happening;
- ✓ With climate change effects expected to be more severe until the end of 21<sup>st</sup> century, we expect overseas migration to intensify;
- ✓ Policies on migration should consider this as well as social programs to counteract negative social effects of migration;
- ✓ Safety nets for poor households who cannot migrate inter-regionally and diversify income sources.



**T**hank **Y**ou



# Regression Results

Explanatory Variables	Dependent Variable			
	Yield		Gross Revenue per Hectare	
	Model 1	Model 2	Model 1	Model 2
Minimum Temperature (Semester 1)	0.60635**	0.58207**	3.02425	2.30944
Minimum Temperature (Semester 1) <sup>2</sup>	-0.01783**	-0.01744**	-0.0852	-0.06846
Minimum Temperature (Semester 2)	-0.55581	-0.61072	-3.25016	-2.99011
Minimum Temperature (Semester 2) <sup>2</sup>	0.01646	0.01788	0.08938	0.08427
Share of Wetdays	-0.03844***	-0.03570***	-0.36598***	-0.35588***
Share of Irrigated Area	-0.21337		17.93986*	
Share of Irrigated Area x Total Rainfall	-0.00029		-0.0068	
Constant	2.69415	3.39667	19.58266	36.05072*
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
F-Statistic (Joint Significance Test of All Weather Variables)	22.27***	26.78***	18.63***	11.62***
R-squared	0.889	0.885	0.894	0.887
Number of regcode	20	20	20	20
Observations	216	216	216	216

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



# Regression Results

Explanatory Variables	Dependent Variable: Total OFWs/1000 Population			
	Yield		Gross Income per Hectare	
	Model 1	Model 2	Model 3	Model 4
Yield	-4.76570** [0.03302]	-6.24139*** [0.00696]		
Gross Revenue per Hectare			-0.72369** [0.01985]	-0.92964*** [0.00410]
Constant	17.36179*** [0.00073]	20.72297*** [0.00009]	19.80468*** [0.00062]	23.58906*** [0.00008]
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic	43.06***	37.95***	40.06***	36.48***
Hansen J statistic	24.77**	17.90	21.41*	15.00
R-squared	0.939	0.937	0.938	0.936
Observations	216	216	216	216

Note: Robust p-values in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



# Regression Results

Explanatory Variables	Dependent Variable: Female OFWs/1000 Female Population			
	Yield		Gross Income per Hectare	
	Model 1	Model 2	Model 3	Model 4
Yield	-5.49324** [0.04388]	-7.09157** [0.01525]		
Gross Revenue per Hectare			-1.17834*** [0.00414]	-1.09822** [0.01017]
Constant	18.52544*** [0.00327]	22.16599*** [0.00085]	27.66546*** [0.00035]	26.19316*** [0.00106]
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic	43.06***	37.95***	40.06***	36.48***
Hansen J statistic	25.69**	11.75	15.66	9.35
R-squared	0.937	0.936	0.936	0.937
Observations	216	216	216	216

Note: Robust p-values in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



# Regression Results

Explanatory Variables	Dependent Variable: Male OFWs/1000 Male Population			
	Yield		Gross Income per Hectare	
	Model 1	Model 2	Model 3	Model 4
Yield	-4.11519 [0.16247]	-5.38409* [0.07067]		
Gross Revenue per Hectare			-0.24743 [0.50817]	-0.73932* [0.05963]
Constant	16.32150** [0.01579]	19.21168*** [0.00542]	11.49486* [0.09761]	20.53326*** [0.00472]
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic	43.06***	37.95***	40.06***	36.48***
Hansen J statistic	30.28***	23.36**	31.86***	20.58*
R-squared	0.922	0.92	0.922	0.917
Observations	216	216	216	216

Note: Robust p-values in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



# Regression Results

Explanatory Variables	Dependent Variable: Domestic Migrants/1000 Population			
	Yield		Gross Income per Hectare	
	Model 1	Model 2	Model 3	Model 4
Yield	2.05493*** [0.00077]	1.75133*** [0.00022]		
Gross Revenue per Hectare			0.18353** [0.01853]	0.17539*** [0.00294]
Constant	19.54413*** [0.00000]	20.23564*** [0.00000]	20.85227*** [0.00000]	21.00194*** [0.00000]
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Kleibergen-Paap rk LM statistic	43.06***	37.95***	40.06***	36.48***
Hansen J statistic	23.95**	22.07**	25.82**	20.80*
R-squared	0.98	0.981	0.979	0.979
Observations	216	216	216	216

Note: Robust p-values in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1