Evaluation for the Climate Services in Agriculture: A Case Study of Economic Benefits for Taiwanese Farmers
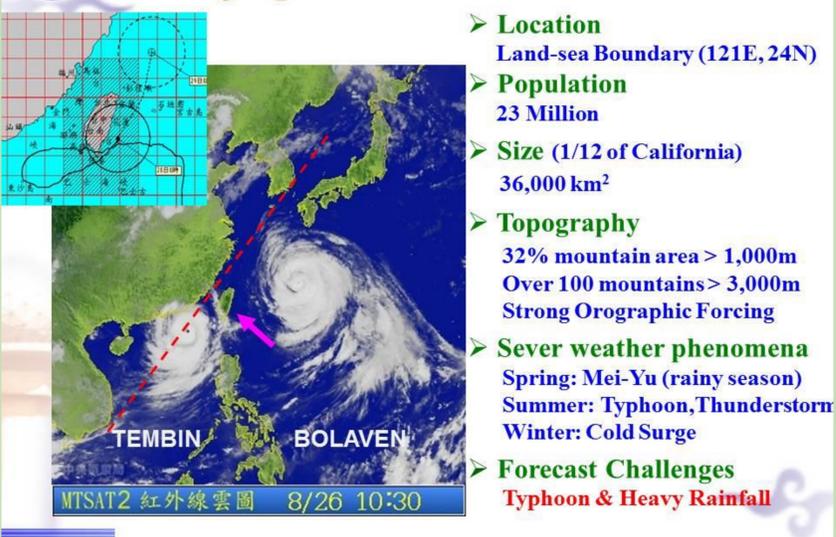
Hen-I Lin[1], Je-Liang Liou[1], Chia-Ping Cheng[2]
[1]Chung-Hua Institution for Economic Research
[2]Meteorological Information Center, Central Weather Bureau

Abstract

Central Weather Bureau (CWB) is the only legitimate government's agency to issue important weather forecasts and warnings in Taiwan. In the last four years, CWB has continuously funded our CIER team to explore the potential social benefits and economic values of CWB's climate services. This study uses contingent valuation method (CVM) to evaluate the economic benefits of CWB's climate services for Taiwanese farmers. We have conducted a national face-to-face survey for 400 registered farmers in 20 municipals in Taiwan in 2013. The data consists of six major agricultural product (including rice, coarse grain, special crops, ornamental plants, vegetables, and fruits) farmers in Taiwan. The significant variables affecting WTP have been identified, such as respondent's subjective score for the weather forecast accuracy, farming size, and first bid price. The estimate of annual economic values for climate services for agricultural farmers is between 883~1,432 million NT dollars (equal to 29~47 million US dollars).

Geographical Environment of Taiwan

- **Location**
  Land-sea Boundary (121E, 24N)
- **Population**
  23 Million
- **Size (1/12 of California)**
  36,000 km²
- **Topography**
  32% mountain area > 1,000m
  Over 100 mountains > 3,000m
  Strong Orographic Forcing
- **Sever weather phenomena**
  Spring: Mei-Yu (rainy season)
  Summer: Typhoon, Thunderstorm
  Winter: Cold Surge
- **Forecast Challenges**
  Typhoon & Heavy Rainfall

TEMBIN   BOLAVEN

MTSAT2 紅外線雲圖 8/26 10:30

Introduction

Project Initiation -

- Due to the characteristics of public goods, most people in Taiwan take the weather information as necessary goods for granted, but most of those services are always free to acquire by many communication sources.
- It is necessary for CWB to investigate the economic value or social benefit of weather information services, especially for those prior sectors recommended by GFCS.
- The result can be used for the cost and benefit analysis of government's investment in the weather information services. In addition, the result also can assist our government to make appropriate decision for future investment.

Purpose -

- CIER team uses an economic valuation methodology to evaluate weather information services, and estimate the potential social benefits created by the CWB's weather information services for agricultural users in Taiwan.
- In addition to knowing the needs of end-users, we also use the results of the economic valuation for weather information services to provide policy recommendations for CWB.

Methodology

Contingent Valuation Method (CVM) is the method we use to estimate the economic values created by the weather information services in agriculture. We establish a bias-corrected model to fix the starting point bias effect for the censored data by Herriges and Shogren (1996), a testing and correction model is created to fix the starting point bias as follow:

$$WTP_i^2 = (1-\kappa_1)WTP_i + \kappa_1 B_i^1$$

$$WTP_i = \frac{WTP_i^2 - \kappa_1 B_i^1}{(1-\kappa_1)}$$

k : anchoring effect
B: bid price presented in questionnaire
WTP: true WTP of the respondents
WTP²: WTP affected by starting bias

Then, we estimate the WTP² by conventional Tobit model, and then correct the starting bias to get the true WTP.

$$WTP_i^2 = (1-\kappa_1)WTP_i + \kappa_1 bid_i$$
$$= (1-\kappa_1)(\beta_1 + \beta_2 grade + \beta_3 p\_effect$$
$$+\beta_4 n\_effect + \beta_5 sex + \beta_6 farmy + \beta_9 edu$$
$$+\beta_{10} disaster + \beta_{11} hectare + \beta_{12} age + \beta_{13} revenue$$
$$+\beta_{14} kind\_1 + \beta_{15} kind\_2 + \beta_{16} kind\_3 + \beta_{17} kind\_4$$
$$+ \beta_{18} kind\_5 + \beta_{19} area\_1 + \beta_{20} area\_2)$$
$$+ \kappa_1 bid_i$$

	Definition
bid	First bid price. In this study we have ten sets of different bidding combination.
grade	Respondent's subjective score for the weather forecast accuracy (0~100)
p_effect	Dummy variable for farm management and production increase with the help of weather information. (yes=1; no=0)
n_effect	Dummy variable for loss prevention with the help of weather information. (yes=1; no=0)
sex	Dummy variable for gender. (male=1; female=0)
farmy	Experience for agricultural activities (in years)
edu	Education indicators. (Illiteracy=1; elementary=2; junior high=3; senior high=4; college=5)
disaster	Dummy variable for experiences of loss due to weather changes
hectare	Plantation Area (in hectare)
age	Respondent's age
revenue	Annual agricultural revenue (in 10,000 NTD)

Acknowledgements

Survey Design

Questionnaire Design -

- The object in this study is meteorological information services provided by CWB.
- A dichotomous choice model with an open-ended elicitation format is used to reduce the strategic bias of respondents.
- The hypothetical key questions include:
  (1) What is the subjective scores of the respondents for the accuracy on weather forecast?
  (2) What are their WTPs for the meteorological information services provided by CWB based on their subjective accuracy judgments?

Sampling Design -

- Sampling assisted by Directorate General of Budget, Accounting and Statistics (DGBAS) in Taiwan.
- 400 door-to-door successful sampling survey of registered farmers' household are conducted with 2,000 replacement samples in the summer of 2013.
- Respondents are consists of six crops farmers (rice, coarse grain, special crops, ornamental plants, vegetables, and fruits) in Taiwan.

Results and Conclusions

- The significant variables affecting WTP have been identified, such as respondent's subjective score for the weather forecast accuracy, farming size, and first bid price.

- The adjusted annual WTP is between 1,764 NT dollars (~59 USD) and 2,861 NT dollars (~92 USD) at 95% confidence interval, and 2,312 NT dollars (~75 USD) in average. The inferred annual economic values for meteorological information services for agricultural producers in Taiwan are between 883 million NT dollars and 1,432 million NT dollars (approximately equal to 29 million US dollars and 47 million US dollars respectively).

- How to improve the effectiveness of weather information and the communication with end users in the agricultural sector (eg. farmers) will be the first priority. CWB will need to establish a pilot study in order to know more details about how farmers use weather information services, identify which measures can improve farmers' knowledge, and finally evaluate how much the potential benefits can come from those extension services.