Factors affecting forest area changes in Cambodia: An econometric approach

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Background and Objectives

- **Background**

Many researches and reports focus on the factors which affect deforestation, but not many for Cambodia, especially by quantitative analysis

- **Objectives**

This research tries to clarify the main factors to affect deforestation in Cambodia quantitatively from a socio-economic view

Some terms

- **Econometrics**

"Econometrics is the application of mathematics, statistical methods, and, more recently, computer science, to economic data and is described as the branch of economics that aims to give empirical content to economic relations."

- **Data**

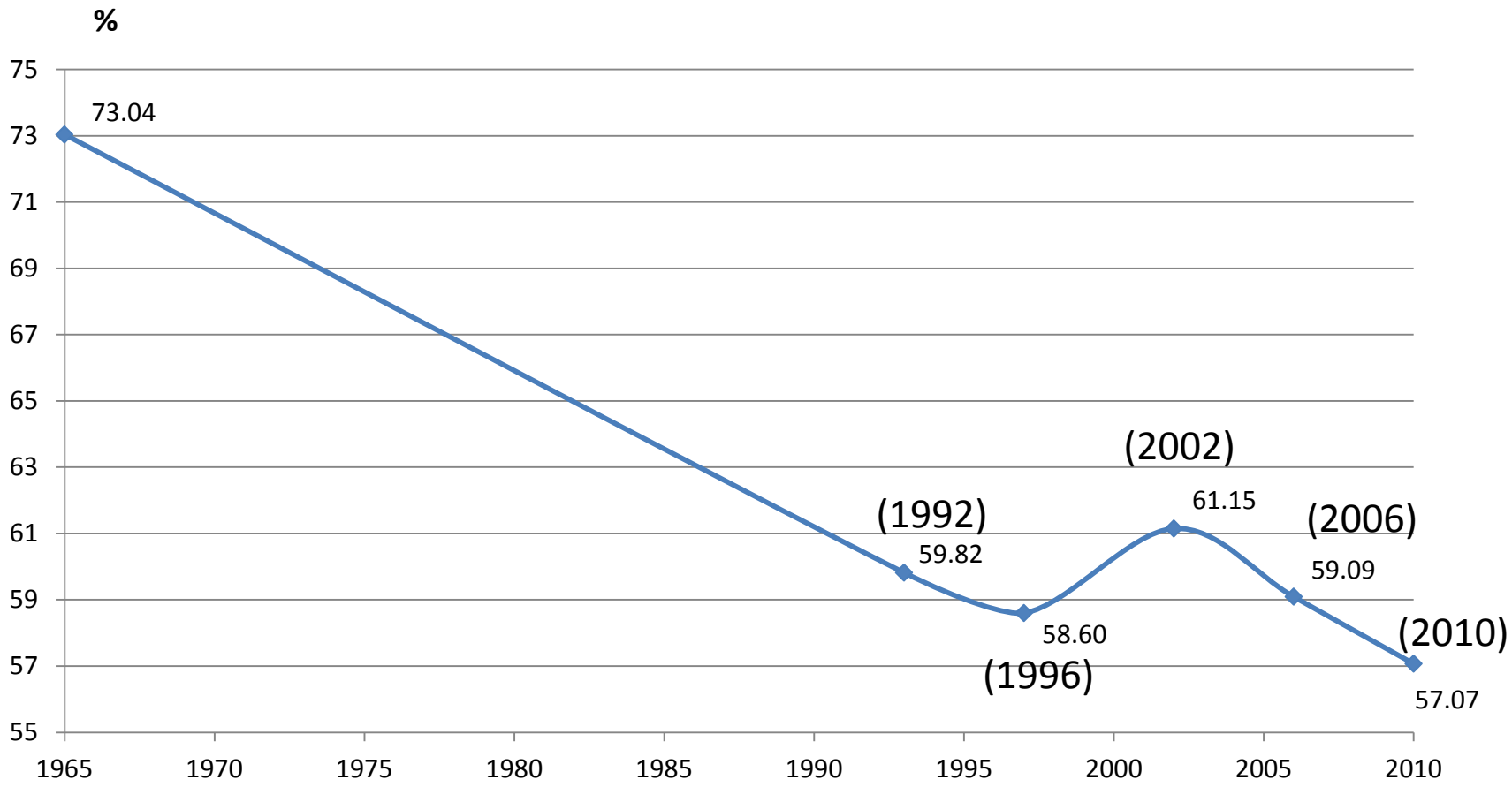
Time series data: observations over time, e.g., annual rice production from 2001 to 2010; Number of observations: t =10

Cross-sectional data: observations at a single point in time, e.g., provincial rice production in 2013; No. of observations: n = 24

Panel data: both time-series and cross-sectional observations, e.g., provincial rice production from 2001 to 2010.

Number of observations: $t \times n = 10 \times 24 = 240$.

Forest cover changes



Source: Forestry Administration, Cambodia

Panel data for 18 provinces in 2002, 2006, and 2010

- Five provinces and Phnom Penh were deleted from the list of provinces in the research because of their small forest area below 20,000 ha: outliers
- By using provincial data in 18 provinces in 2002, 2006, and 2010, the number of observations became 54 -> panel data
- This is still not large, but, it is alright, for statistically-significant results
- This data PANEL is short and wide

Advantages of panel data analysis

- Panel data analysis overcomes the difficulties of data availability faced by time series data analysis.
- It can increase the degree of freedom by using panel data. This is important to get significant results when many variables are dealt with.
- It can improve the efficiency of estimations (Hsiao, 2003; Greene, 2000).

Panel data analysis

$$y_{it} = \alpha + \boldsymbol{x}_{it}\boldsymbol{\beta} + \mu_i + \lambda_t + \varepsilon_{it}$$

i = 1, …, N, the individual (firm, province, country, . . .) index
t = 1, …, T, the time index
μ_i: unobserved cross-sectional (individual) effects for N cross sections
λ_t: unobserved time effects for T time periods
ε_{it}: random disturbances, or, error term
By making some assumptions:

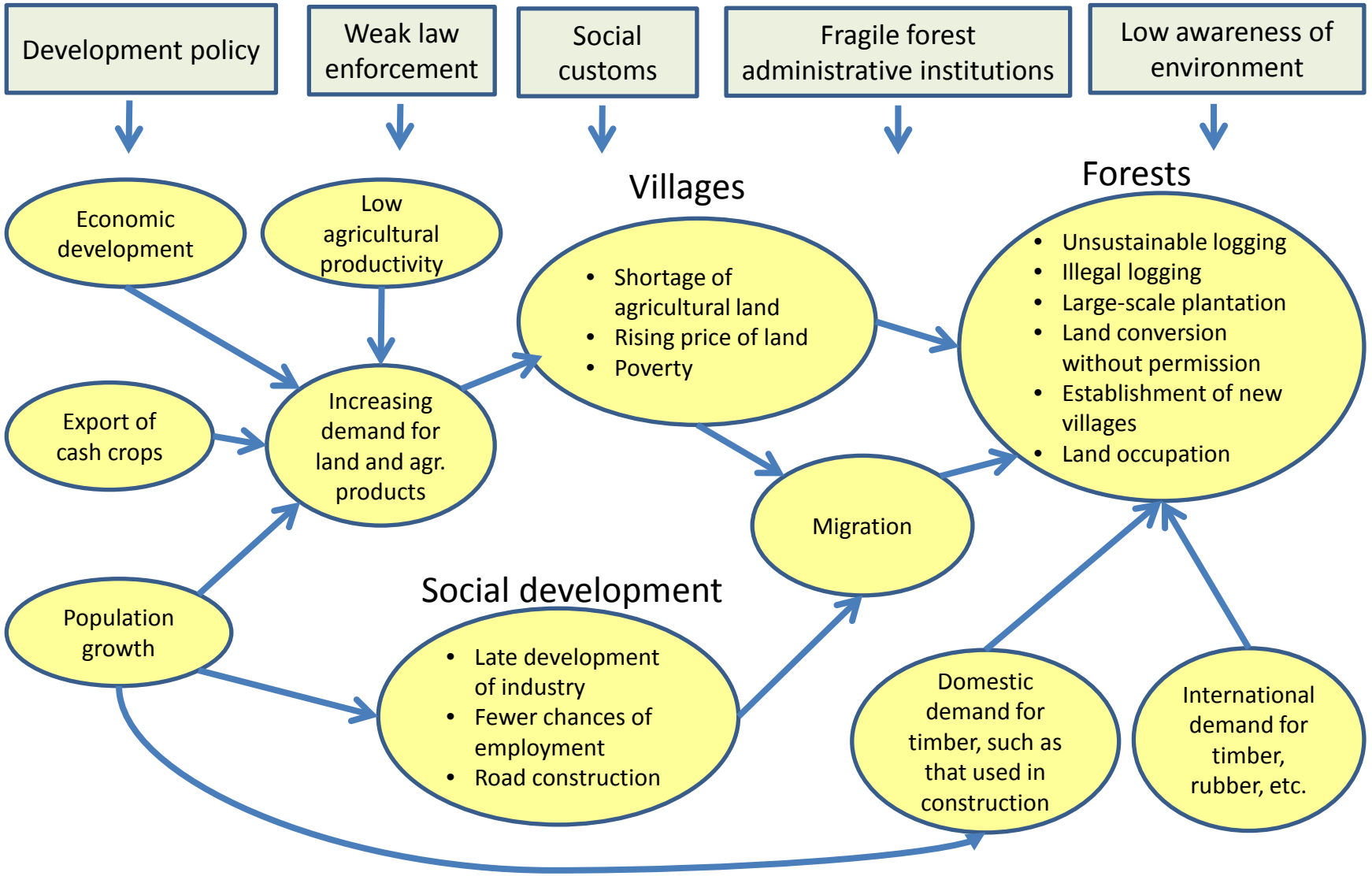
$$y_{it} = \alpha_i + \boldsymbol{x}_{it}\boldsymbol{\beta} + \varepsilon_{it}$$

- Pooled model: $y = \alpha + \boldsymbol{x}\boldsymbol{\beta}$
- Fixed effect model: $y_i = \alpha_i + \boldsymbol{x}\boldsymbol{\beta}$
- Random effect models: $y = \alpha + \boldsymbol{x}\boldsymbol{\beta}$

Tests to choose a better model

- Pooled model, fixed effect model, and random effect models were estimated
- Various tests were implemented
- It was realized that robust covariance matrix estimation are necessary when checking the tests results

Cause Map for deforestation and forest degradation in Cambodia



Factors (variables)

The following factors (variables) are dealt with in the research:

(1) population (‘000 persons);

(2) rice cultivated area (ha);

(3) area of floor of house by household (m^2);

(4) agricultural GVA(million Riel);

(5) industrial GVA (million Riel);

(6) income by household (‘000 Riel).

(7) ELC (economic land concession) is taken as a dummy variable in the estimation. Value 1 is assigned to those provinces implementing ELC in the year; otherwise 0.

Data Source

- Statistical data were collected mainly from various ministries of Cambodia.
- Forest resource data are from Forestry Administration (FA).
- Population, agricultural GVA, industrial GVA, floor area of houses by household, and income are from NIS, Ministry of Planning.
- Rice cultivated area data and ELC are from MAFF, Ministry of Agriculture, Forestry and Fishery.
- GDP deflator data are from World Bank.

Various tests

Test items	Methods	Results	Remarks
(1) Comparing models: within vs pooled	F test for individual effects (alternative hypothesis: significant effects)	F = 715.917, df1 = 17, df2 = 29, **p-value = 0.000**	Fixed effect model is better than pooled model
(2) Comparing models: within vs random	Hausman test	chisq = 31.882, df = 7, **p-value = 0.000**	Fixed effect model is better than random effect model
(3) Comparing models: pooled vs Random	Lagrange Multiplier Test (Breusch-Pagan test)	chisq = 26.064, df = 1, **p-value = 0.000**	Random effect model is better than pooled model
(4) Testing for time effects	a) F test b) Lagrange Multiplier Test (Breusch-Pagan)	F = 1.6677, df1 = 2, df2 = 27, **p-value = 0.208** chisq = 0.6872, df = 1, **p-value = 0.407**	No significant effects
(5) Testing for cross-sectional dependence or contemporaneous correlation	Pasaran CD test (alternative hypothesis: cross-sectional dependence)	Fixed effect: z = -0.808, **p-value = 0.419** Random effect: z = -0.794, **p-value = 0.427**	No cross-sectional dependence
(6) Testing for serial correlation	Breusch-Godfrey/Wooldridge test (alternative hypothesis: serial correlation in idiosyncratic errors)	Fixed effect: chisq = 19.099, df = 3, **p-value = 0.000** Random effect: chisq = 7.507, df = 3, **p-value = 0.057**	Serial correlation in idiosyncratic errors in Fixed effect model; No serial correlation in idiosyncratic errors in Random effect model
(7) Testing for heteroske-dasticity	studentized Breusch-Pagan test	BP = 39.172, df = 24, **p-value = 0.026**	Heteroskedastic

Model results of panel data analysis

$$y = \alpha - 316\mathbf{P} - 1.99\mathbf{I} - 0.28\mathbf{R} - 0.10\mathbf{A} + 0.05\mathbf{IG} + 790\mathbf{F} - 22{,}426\ \mathbf{ELC}$$

Factors	Fixed effect	Random effect	General FGLS (fixed)
Population (1,000 pers.)	**-316.01****	**-317.92****	**-274.19****
Income (million Riel)	-1.99	-2.26	**-2.54****
Rice cultivation area	-0.28	-0.31	-0.28
Agricultural GVA (million Riel)	**-0.10*****	**-0.09****	**-0.08****
Industrial GVA (million Riel)	0.05	0.04	0.010
Floor area of house for household (m^2)	790.93	754.33	597.04
ELC (dummy variable)	**-22,426.10***	**-21,037.00*****	**-21,305.00****

Note: *******: significant at 1% level; ******: at 5% level; *****: at 10% level.

Statistically, “significant” means how sure we can be that it is different from 0.

Findings by panel data analysis

- The increase in population and agricultural gross production give negative impacts to the changes in forest area.
- The increase in income also put pressure on forest area, but disputable.
- ELC is clarified as one of the drivers of deforestation by setting as a dummy variable.
- Rice cultivation, industrial GDP and house construction do not have significant effects on deforestation.

Discussion

- It seems difficult to stop deforestation immediately from the view of the increase in population and the growth of agriculture production. But, if the productivity of agricultural production can be further increased, the pressure on forest from these two factors can be alleviated.
- It is important to develop industry to lessen the reliance on agriculture.
- By using dummy variable, ELC was included in the analysis, but not fully dealt with due to data limitation. Therefore, this research result should be taken with caution.
- Issues of data availability and reliability.


Thank you for your attention!