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Conditions of forest transition in Asian countries☆

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ABSTRACT

This study identifies the important factors that contribute to or inhibit forest transitions in nine Asian countries: China, India, Indonesia, Japan, Laos, Malaysia, Republic of Korea, Philippines, and Vietnam. A qualitative comparative analysis method was used to determine which conditions or combinations of conditions led to or prevented a forest transition. Under the condition of public ownership with no private forest tenure or ownership of forest land, there was no instance of forest transition among the nine countries studied. Under the condition of non-liberal timber trade policies, there was no instance of forest transition in the countries studied. The results of this analysis suggest that for a forest transition to occur, the country should liberalize timber import and provide forest tenure to the private sector. Based on these results, we argue that in order for a forest transition to take place or for REDD+ to be effective, the state should allow for private sector to participate in forest management and create market conditions that meet the demand for timber via trade policy alignment.

1. Introduction

The long history of civilization has seen the decline of forest cover on earth. Human population increase is considered to be the driving force behind deforestation (Clive, 1991). It is commonly understood that there is a strong negative correlation between population density and forest coverage within a country (Rosero-Bixby and Palloni, 1998). However, Japan and the Republic of Korea (ROK) are exceptions to this global trend because both countries have experienced forest decline in the past, but experienced a forest transition in the 20th century. In recent years, a number of other countries have also been experiencing a transition in forest cover, including China, Vietnam, India, and the Philippines. Meanwhile, other countries in Asia are still experiencing deforestation, including Indonesia, Laos and Malaysia. Although several conditions, such as economic development, state policy and scarcity of forest resources, are major factors that result in forest transitions, there are several cases in Asia that require further explanation. In this study, we identify the conditions causing forest transitions with evidence from case studies of nine countries in Asia: China, India, Indonesia, Japan, Laos, Malaysia, Philippines, ROK and Vietnam (APAFRI, 2013).

Section 2 begins with a discussion on the theory of forest transitions and a review of the pertinent studies. Section 3 introduces the method of qualitative comparative analysis (QCA) used in this study. Section 4 describes the forest cover changes and related socio-economic,

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institutional and ecological factors of each of the nine countries included here. Section 5 presents the data used to prepare the truth table for QCA and the results of the analysis. Finally, Section 6 presents the study's conclusions and recommendations for future research.

2. Forest transition theory and the underlying forces

Forests occupy approximately 30% of the world's total land area. Forests have dramatically declined since human societies began interacting with them. In certain countries, however, a shift from losses to gains in forest area has been reported. The term forest transition is defined as the sequential land use change from decreasing to increasing forest area (Mather, 1992). Forest transitions were first reported in developed countries in Europe (Mather and Needle, 1998; Mather and Fairbairn, 2000; Mather, 2004) and North America (Foster et al., 1998). New evidence of forest transitions have also been seen in developing countries in Latin America (Rudel et al., 2000; Aide and Grau, 2004) and Asia (Mather, 2007; Meyfroidt and Lambin, 2008; Bae et al., 2012). Since the first evidence of forest transition, researchers have tried to determine the fundamental causes and mechanisms that lead to forest transitions.

Forest transition theory is an explanatory theory that investigates the pathways of forest transitions. Investigations of different instances of forest transitions in developed countries have suggested that forest transitions arise from economic growth or deficiency in forest resources. These theories are termed the economic development and forest scarcity pathways, respectively (Rudel, 1998; Rudel et al., 2005; Lambin and Meyfroidt, 2010). An economic development pathway occurs when after a period of deforestation, large areas of land that are only marginally suitable for agriculture are abandoned and restored to a forest state either naturally or through reforestation. A forest scarcity pathway occurs when the scarcity of forest products or a decline in forest ecosystem services prompts governments and land managers to establish effective reforestation or afforestation practices. These pathways typically explain the early evidence of forest transitions in developed countries. It turns out, however, that this bimodal forest transition pathway is not sufficient to explain the occurrence of forest transitions in developing countries. Certain countries exhibit relatively low per capita Gross Domestic Product (GDP) and relatively abundant forest resources when the forest transition occurs. China, India, and Vietnam are examples of countries in which the forest transition cannot be explained by neither the economic development pathway nor the forest scarcity pathway (Mather, 2007). These countries intervened with forest-related policies to promote forest rehabilitation. A third forest transition pathway assumes policy instruments rather than economic growth or forest scarcity driving forest transition (Mather, 2007). Forest policies have distinctive features that are radically different than pre-transition policies. Among them are extensive reforestation programs, decentralization of forest management, and logging bans (McElwee, 2009, Park and Youn, 2017).

As modernization continues, more countries are being influenced by globalization, and the forest sector is no exception. The globalization pathway explains forest transition when external impacts are determining the state of the forest in a country (Rudel, 2002). It is well-known that international conservation agendas have a significant impact on the occurrence of forest transitions (Kull et al., 2007). Finally, the smallholder, tree-based, land use intensification pathway describes forest transitions derived from land-use adjustments by smallholders (Lambin and Meyfroidt, 2010). This pathway indicates that smallholders promote the forestation of lands in the margin between forest and cultivated land. The motivation behind this behavior is to decrease their vulnerability to economic or environmental shocks and guarantee their livelihood through ecological and economic diversification.

The occurrence of forest transitions can be explained by the interplay of two underlying forces: socio-ecological feedbacks and socio-economic dynamics (Lambin and Meyfroidt, 2010). First, negative socio-ecological feedbacks take place when natural resources face depletion due to overexploitation. The socio-ecological feedbacks occur endogenously at the local scale to deter further deforestation and induce stabilization of forest cover. Second, socio-economic dynamics directly intervene in forest land use decisions, potentially changing the trend in forest cover from deforestation to forest restoration. The socio-economic dynamics entail exogenous forces and take place at the national scale. While socio-ecological feedbacks seem to better explain the acceleration or stabilization of deforestation, socio-economic dynamics explain reforestation. The forces included in these two categories of dynamics are so complicated that the pathway to forest transition cannot be explained by a single underlying factor. Table 1 shows the relationship between pathways and explanatory frameworks.

3. Qualitative comparative analysis

Qualitative comparative analysis (QCA) is an analytical tool used for rigorous meta-analysis of a limited number of case studies. The method emerged from extensive debates on the analytical merit of using both qualitative and quantitative analysis methods. The qualitative method, which is also called the small-*n* technique, is a case-oriented analysis that handles cases using holistic perspectives to consider specific situations. Conversely, the quantitative method, which is referred to as the large-*n* technique, refers to variable-oriented analysis. The quantitative method is based on two fundamental assumptions, namely, causal competition and causal homogeneity. Causal competition means that factors have independent influences on an outcome, while causal homogeneity implies that single factors work the same way in all cases (Ragin, 1989). QCA combines the quantitative and qualitative analysis methods to try and draw on the advantages of each. It attempts to capture the essential meaning of a single case, and then derives noticeable features by synthesizing larger and broader cases. It relies on two core ideas: (1) causal combination, which means the effects of individual conditions may depend on the presence or absence of other conditions, and (2)

Table 1
Relationships between pathways and frameworks.

	Forest transition pathways				
Explanatory frameworks	Forest scarcity	State policy	Economic development	Globalization	Smallholder intensification
Socio-ecological feedbacks					
Recourse-limited growth	○				
Land scarcity, intensification	○				○
Land use adjustment		○	○		○
Socio-economic changes					
Economic modernization			○	○	
Market access		○	○	○	○
Land ownership		○		○	○
Global trade				○	
Diffusion of conservation ideas		○		○	

equifinality, which means that there may be multiple causal paths with the same outcome.

QCA became prominent as a method to analyze research observations through the work of Ragin (1987, 2000). Ragin's original version of QCA was called crisp-set QCA (csQCA). This method's core analytical tool is the truth table, which is a data matrix that contains all values of the causal conditions and outcomes. All conditions are assessed in strictly binary fashion as either absent/false (0) or present/true (1) for a specific case. The threshold between absence/false and presence/true is defined for each condition theoretically and assessed based on knowledge of the case.

One major criticism of csQCA is its binary approach. csQCA requires the assessment of factors to be either true or false leaving no room for gradual assessments. Even continuous variables, such as economic development, unemployment or age, have to be classified as true or false, which means they must be converted to binary variables. In response to this criticism, Ragin himself (2000, 2008) developed a fuzzy-set QCA, which allows researchers to define the value of conditions dichotomously and in gradual variations. This brings QCA analysis closer to a statistical analysis using continuous variables. Multi-value QCA also resolves the overarching limitations of crisp-set QCA and fuzzy-set QCA (Cronqvist and Berg-Schlosser, 2009). Multi-value QCA makes it possible to give variables any number of values, allowing for the inclusion of multi-categorical conditions in the analysis (Sehring et al., 2013). In this paper, we use csQCA to analyze forest transitions in nine countries in Asia because csQCA can be easily manipulated and understood, and has less rigorous data requirements than the analysis of quantitative data or multi-value QCA. To reduce possible errors by converting continuous variables into dichotomous ones, a sensitivity analysis was employed in this study.

The QCA method has three steps required to achieve meaningful results (Krook, 2010). First, it is necessary to construct the population to be examined. The elements for building the population come from case study investigations (Ragin, 2000). Each element relevant to the case has its own rationale and these can be formulated as a hypothesis. So, the size of the population is related to the number of hypotheses, which is derived from the narratives of the case studies. Second, the population must be dichotomized to construct a truth table. Using comprehensive knowledge regarding the subjects under study, researchers make two sets of values that represent the information for a specific condition that affects a particular outcome of interest. The set of values is then converted into dichotomized values that express the presence or absence of the condition. Finally, Boolean algebra is applied to reduce causal complexity in order to identify, (1) if conditions exist in relationships of logical 'and' or logical 'or', (2) if they join together with other conditions in causal combinations, and (3) if some redundancies can be minimized by subsuming some conditions and combinations into others. This analysis does not result in mathematical functional relationships, as a regression analysis does, but it does identify how conditions and combinations of conditions are causally linked to the outcome of interest.

In QCA analysis, when the truth table is extended to contain all of the possible combinations of factors, some rows or combinations of conditions remain empty because those outcomes are not attainable through observation. If these rows, called logical remains, are considered when applying Boolean algebra, the causal combinations are reduced to parsimonious solutions which show multiple causal paths and account for the necessary and sufficient conditions or combinations (Ragin, 1987).

There are many types of software solutions available to apply the QCA method, such as Tosmana, Kirq, fs/QCA, fuzzy, QCA3, and QCA. For this paper, QCA software was used because it has more benefits in terms of functionality. QCA software is a free package that runs on the statistical software, R. It provides various solution types, including complex, intermediate, and parsimonious solutions, as well as functional procedures facilitating QCA, such as necessity tests, calibration, and others. After building the population for QCA, the data are dichotomized into a truth table according to the thresholds using QCA software. Then, complex and parsimonious solutions are attained by computing the truth table in the QCA software.

4. QCA model and data: forest transitions of nine Asian countries

The concept of forest transition emerged from case studies of developed countries in Europe and North America (Mather, 1992; Mather and Needle, 1998). Several Asian countries have also experienced forest transitions in recent years, but these have not been fully examined to understand how the forest transitions occurred. Ecological and economic conditions are different in Asian countries than in Western countries during the forest transition process. Among the Asian cases, there are many differences in the history of ecological and socio-economic conditions. A comparative analysis of medium-*n* cases is an opportunity to explain the conditions behind forest transitions, when there is significant heterogeneity in ecological, social and economic settings. Nine Asian countries were chosen to find out on what conditions the forest transition occurred or did not occur. The countries include six countries which have experienced, or have recently started to experience, forest transitions: India, China, Japan, Philippines, ROK, and Vietnam; and three countries which are still experiencing deforestation and forest degradation: Indonesia, Laos and Malaysia. This study, however, analyzed fifteen total individual cases. For the six countries that have experienced, or are currently experiencing, forest transition, both the periods of increase and decrease of forest cover are considered, resulting in 12 cases. The remaining three case studies are of three countries that are still experiencing deforestation and forest degradation. We chose six factors considered to influence the change in forest land use based on previous research and to represent each forest transition pathway: GDP per capita and food provision as factors of the economic development pathway; food provision as a surrogate variable for the consequence of agricultural policy; forest cover to represent forest scarcity, and regulation on timber import, forest ownership, and forest rehabilitation policies for the state policy and smallholder intensification pathways (Mather and Needle, 1998; Rudel et al., 2005; Mather, 2007; Meyfroidt and Lambin, 2009; Lambin and Meyfroidt, 2010; Barbier et al., 2010; Bae et al., 2012). The globalization pathway is not considered as a factor in this paper as others (Liu et al., 2017) investigated the hypothesis. There could be other factors influential in forest transition, but we restrict our analysis to the six variables mentioned above to focus on the six hypotheses. For example, even though a log export ban policy was implemented for a certain period of time in some of countries studied in this article, the real effect of a log export ban is not known due to the poor capacity of law enforcement in those countries. Therefore we did not select log export ban as a conditional factor of forest transition. The study period of each case is different because forest transitions occurred at different time periods in each country. Table 2 shows the representative values or conditions of the factors considered to influence forest land use change for each case.

4.1. Variables: the outcome of forest transition and influential factors

4.1.1. Outcome

The outcome variable refers to the forest transition. It is registered as yes or no based on the restoration trend of forest cover. If there is a change from decreasing to increasing forest area, then it was coded that a forest transition occurred. Here, forest transition was measured as increased forested area as a quantitative indicator, not a qualitative state of the forest, such as forest stock volume per unit of land. In cases where forest transition occurred, the period is divided into two parts, before and after the turning point of forest transition.

Table 2
Information table for the nine Asian countries in this study.
Sources. GDP per capita: Maddison Project (http://www.ggdc.net/maddison/). Food Provision: FAO (http://faostat3.fao.org/). Forest cover: China — the Institute of Geographic Science and Natural Resources Research (1949, 1950–1962), First to Seventh China National Forest Inventories (1973–2008) cited in Country Report of China (Liu et al., 2013); India — Food and Agriculture Organization and Forest Survey of India cited in Country Report of India (Bhojvaid et al., 2013); Japan — Forest Agency of Japan; Philippines — Department of Environment and Natural Resources, Philippines and FAO; Republic of Korea — Bae et al. (2012); Vietnam — VNFOREST (VNFOREST, 2013); Indonesia, Laos, Malaysia — FAO. Timber trade, forest ownership, forest policy: reports of comparative analysis of transitions to sustainable forest management and rehabilitation in Asia Pacific region (APAFRI, 2013) (available at http://www.apafri.org/activities/Forest%20Transitions/reports.html).

		Explanatory conditions						Outcome
Country	Period	GDP per capita (1990GK$)	Food provision (kcal/day)	Forest cover (percent)	Regulation on timber import	Forest ownership	Forest policy	Forest transition
China	1971–1979	853 (1976)	1896 (1976)	12.7 (1976)	Regulated import	Public	None	No
	1980–2010	3759 (2001)	2819 (2001)	18.2 (2003)	Opening-up policy (1980)	Private community	National Quota System (1986), Six Key Forest Programs (1998), Natural Forest Conservation Program (1998)	Yes
India	1961–1970	762 (1966)	1939 (1966)	19.1 (1970)	Regulated Import	Public	none	No
	1971–2010	1963 (2001)	2331 (2001)	20.3 (2000)	Liberalized import (1996)	Private Individual	Forest Conservation Act (1980), National Forest Policy (1988), Joint Forest Management Circular (1990), National Working Plan Code (2004)	Yes
Japan	1936–1945	2874 (1940)	2525 (1961)	51.9 (1945)	Regulated import	Private individual	Forest Law (1897), Expansive afforestation policy (1940s)	No
	1946–1980	10,040 (1971)	2729 (1971)	66.8 (1971)	The General Rules on Trade and Exchange Liberalization Plan (1960)	Private individual	Forestry Basic Law (1964)	Yes
Philippines	1991–2000	2296 (1996)	2364 (1996)	22.3 (1990)	No restriction	Public	None	No
	2001–2010	2741 (2006)	2516 (2006)	25.7 (2010)	No restriction	Public	Community Based Forest Management (1995)	Yes
Republic of Korea	1946–1955	854 (1950)	2141 (1961)	34.3 (1955)	Regulated import	Private individual	None	No
	1956–1987	2332 (1971)	2899 (1971)	60.3 (1970)	Liberalized import	Private individual	Limitation of timber use and harvest (1968, 1987), National Forest Development Plans (1973–1987)	Yes
Vietnam	1981–1990	929 (1986)	2065 (1986)	27.8 (1990)	No restriction	Public	None	No
	1991–2010	1911 (2001)	2402 (2001)	33.2 (2000)	No restriction	Private individual	National Five Million Hectare Reforestation Banning of log and sawn timber export (1992), Land law (1993), Limitation of logging (1997), Promotion of community forestry	Yes
Indonesia	1991–2010	3445 (2001)	2424 (2001)	52.0 (2001)	No restriction	Public	Re-greening and reforestation program (1968), National Movement (2003–2009) but limited result	No
Laos	1991–2010	1241 (2001)	2092 (2001)	41.5 (2001)	No restriction	Public	None	No
Malaysia	1991–2010	8031 (2001)	2822 (2001)	64.8 (2001)	No restriction	Public	Compensatory Forest Plantation Program (1981), Special Purpose Vehicle in Reforestation (2005)	No

4.1.2. GDP per capita

The values of GDP per capita for the different countries were gathered from a study conducted by the Maddison Project (Bolt and van Zanden, 2013). Estimated GDP per capita was based on the 1990 Geary–Khamis dollar, an indicator of the purchasing power of a country. This data source is also able to provide estimates of GDP per capita before 1960, which other statistical sources rarely provide. For some cases, the values of GDP per capita before 1960 were used in this study. GDP per capita is an indicator of the economic development status and plays a significant role in forest transition (Rudel et al., 2005; Lambin and Meyfroidt, 2010). Greater GDP per capita is usually accompanied by the transformation of the industrial structure from agriculture to manufacturing, which makes the conversion of forests to agriculture less profitable and leaves marginal agricultural lands uncultivated or abandoned. Moreover, as income increases, the demand for ecosystem services, which could support the rehabilitation or conservation of forest areas, increases. Therefore, the level of GDP per capita is hypothesized to be important for a country to experience forest transition.

4.1.3. Food provision

The more food provision a country secures, the less pressure people feel to convert forest area to agricultural land, and vice versa (Rudel et al., 2005; Barbier et al., 2010). So the level of food provision is hypothesized to be important for a country to experience forest transition. A country's food provision is reported in terms of food balance. The FAO food balance sheets describe the food supplies that are available for human consumption in terms of energy units, kcals (FAO, 2014). The FAO food database contains food supplies in terms of production per region, food imports and stock changes, food export, manufacturing for food and non-food uses, losses during storage and transportation, and human consumption. Food provision can be improved through agricultural policy, mainly by domestic food production, while trade is important for countries which rely on foreign sources of food. This variable is considered to represent the impact of agricultural policy, which is an important factor in the explanation of forest transitions.

4.1.4. Forest cover

The logic behind including forest cover as an explanatory variable is that the scarcity of forest resources may trigger reforestation efforts (Rudel et al., 2005). Forest coverage is hypothesized to be important for a country to experience forest transition. Estimating the exact forest cover across nine countries posed challenges because definitions of forests may differ between countries and organizations. For example, according to the FAO (2010), forest is "land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ."

in the case of China, the State Forestry Administration prior to 1998, defined forest as "land that is occupied by tree crown cover of more than 20 percent (Hyde et al., 2003)." We used various data sources to estimate forest cover in this study (see Table 2).

4.1.5. Timber trade

Timber trade is considered an important factor influencing forest transitions. When a country's demand for timber increases, the pressure to utilize forest resources from domestic forests intensifies if timber cannot be easily supplied from abroad (Meyfroidt and Lambin, 2009; Meyfroidt et al., 2010). On the other hand, if there is no restriction on timber imports, than the pressure on domestic forests is lessened. Therefore, the status of timber import liberalization is hypothesized to be important for a country to experience forest transition. This paper did not consider timber export restrictions because there was no country among those studied with a total restriction on timber export (APAFRI, 2013). Timber-rich countries, such as Indonesia, Laos and Malaysia, do not promote timber import but rather restrict exports of timber, especially un-processed timber. The timber trade variable was categorized as liberalized or regulated import based on the country reports by authors (APAFRI, 2013).

4.1.6. Forest ownership

According to the definition suggested by the FAO (2010), forest ownership falls into two categories: public ownership and private ownership. Private ownership is divided into four sub-categories: individuals, private business entities and institutions, local communities, and indigenous/tribal communities. The type of forest ownership reflects the extent to which forest owners will respond to external conditions, such as the market, forest policies, and institutions. The causal effect of forest ownership on land use decisions seems to be ambivalent. Private ownership appears to be more responsive to market changes than public ownership. Economic theory predicts that if the marginal benefits of converting forest land to other land uses are larger than the benefits of maintaining forest land, then forests will be converted to other land uses. This conversion can lead to deforestation under stable market conditions, but as agricultural technologies advance, intensive cultivation of more productive and accessible agricultural lands will become more profitable, and thus, marginal lands will be abandoned. The abandoned land can then be rehabilitated with trees naturally or artificially (Mather and Needle, 1998; Lambin and Meyfroidt, 2010). The rehabilitation on marginal lands can be organized more efficiently under private ownership than public ownership if the market conditions are favorable. Public ownership can lead to extensive reforestation driven by government resources, but can also cause massive destruction due to aggressive land development programs or lack of effective protection for public lands (Mather, 2007). In this study we hypothesize private forest ownership to be necessary for a country to experience forest transition, considering that many developing countries still have limited capacity to implement forest policies.

4.1.7. Forest policy

Previous research has shown that the effective implementation of forest policy is a key condition for forest transitions according to the state intervention pathway (Lambin and Meyfroidt, 2010; Bae et al., 2012; Liu et al., 2016; Singh et al. 2017). The analysis of forest policy in each case was based on the case studies conducted by co-authors of this paper, reported in the APAFRI (2013). The policy includes significant changes in administrative actions related to the forest sector. As previously mentioned, timber trade and forest ownership play distinctive roles in the change of forest cover. Therefore, these two conditions were excluded from consideration in analyzing the factor of forest policy. The key elements of the forest policy variable in this study were: whether the government promotes forest rehabilitation, regulates excessive use of forest resources, conserves ecologically important forest areas, bans illegal logging, and compensates the local communities when prohibiting forest use following the analysis of Mather (2007). Each element of the forest policy in each of the nine countries was chronologically described. As long as a forest policy was not abolished in a subsequent period, it was assumed to still be in effect. We hypothesized the existence of these elements of forest policy in a country to be important for the country to experience forest transition.

4.2. Forest conditions and policies in nine Asian countries

4.2.1. China

A forest transition has already occurred in China. More than half of Chinese territory was covered by forests 5000 years ago. By 1850, 44% of Chinese forests had been cleared, leaving China with approximately 17% of remaining forest cover. This decline continued to 12.5% in 1949, when the People's Republic of China (PRC) was established (Fig. 1) (Houghton, 2002; He et al., 2007). In the last three decades, however, forest cover has increased rapidly in China, up to 21.63% in 2015 (Liu et al., 2017) This increase was possible due to paradigm shift of forest management to participatory forestry (Liu and Innes, 2015), economic development (Liu et al., 2017), or interventions by the Chinese government through a series of policy programs, including, regulations, forestland tenure reform, reforestation and afforestation programs, timber-saving technology in timber-use sectors, and payment for ecosystem services (PES).

4.2.2. India

India witnessed a turning point in forest cover in the 1980s (Fig. 1). The first forest policy in independent India during 1952 envisaged one third of its geographical area as forested. As a result, more and more wilderness areas were identified as government forests and brought under scientific management, while at the same time forests were being cleared for agricultural use under the legal provisions of land settlement acts in different states, in order to meet the food requirements of a growing population. With the onset of the green revolution, the pressure to convert forests to agriculture eased gradually in 1970s. In 1976, the subject "Forest" was transferred from the state list to the concurrent list, where both the Union and State have jurisdiction of legislation with primacy given to Union Law, of the Constitution of India. Furthermore, the "Forest Conservation Act" was enacted in 1980 to control the diversion of forestland to non-forestry purposes. In January 1985, forestry and wildlife affairs were transferred from the Ministry of Agriculture to the Ministry of Environment and Forests, a new ministry of the Central Government meant to prioritize the emerging issues in forestry and wildlife. A new National Forest Policy was established in 1988. This marked a major departure from the 1952 policy by putting emphasis on environmental stability and forest conservation, while meeting the domestic requirements for wood fuel, fodder, minor forest produce and construction timber for rural and tribal populations, including their participation in the protection and management of forests. Wood-based industries were encouraged to develop direct links with the rural people for their raw material requirements, shifting demands away from government forests. Forests were no longer a source of revenue to the government. The forest policy changed substantially from command and control systems to coordinating with communities in afforestation and forest rehabilitation. India issued a circular from the Ministry of Environment and Forests in June 1990, which provided the state governments with a framework for the involvement of village communities in the protection, regeneration and development of degraded forests in the vicinity of the villages. Joint Forest Management has since been adopted by all states. The total numbers of JFM Committees in the country are now 112,896, and the forest area under their domain is 24.6 million hectares, as of March 2010 (FSR—India 2010) (Bhojvaid et al., 2013). Clearly, the forest policies facilitating the participation of local people in forestry activities was effective in reverting the previously degraded or converted forest land back to forests.

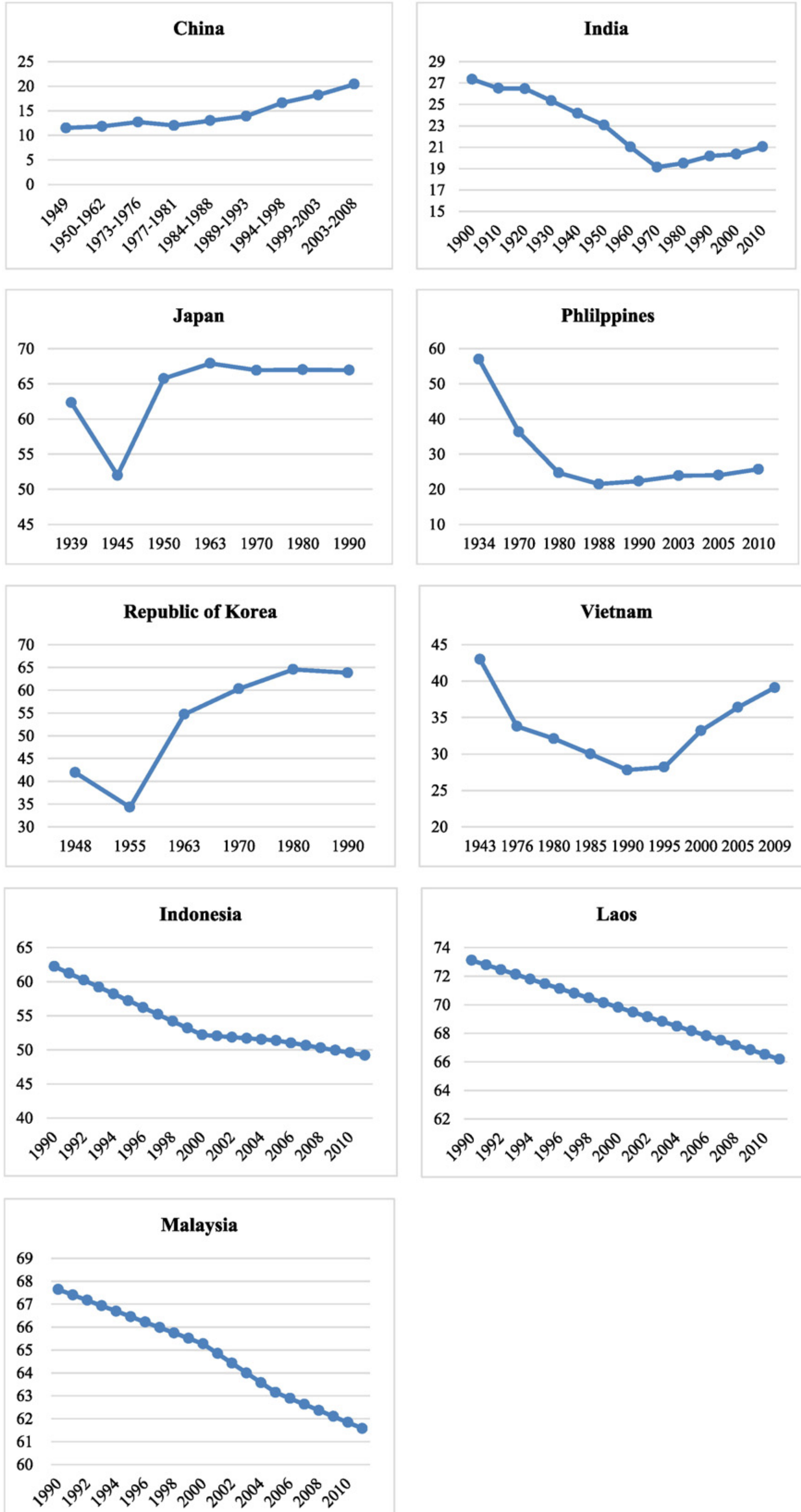

Fig. 1. Changes of ratio of total forest areas to total land areas by year.
Sources: China - the Institute of Geographic Science and Natural Resources Research (1949, 1950-1962), First to Seventh China National Forest Inventories (1973-2008) cited in Country Report of China (Liu et al., 2013); India - Food and Agriculture Organization and Forest Survey of India cited in Country Report of India (Bhojvaid et al., 2013); Japan - Forest Agency of Japan; Philippines - Department of Environment and Natural Resources, Philippines and FAO; Republic of Korea - Bae et. al. (2012); Vietnam – VNFOREST (VNFOREST, 2013); Indonesia, Laos, Malaysia – FAO;

4.2.3. Japan

Japan has seen increased forest cover since the early 1950s (Yorimitsu, 1984), which represents a second cycle of forest transition in the country (Tachibana et al., 2013). The Forestry Planning System and Forest Owners' Cooperatives System, which was introduced under the revised Forest Law in 1951, had a significant influence on the promotion of forest management and the expansion of forested areas. The Forest Owners' Cooperative has played an important role in forestry practices since that time.

This expansive reforestation measure, which aimed to replace broad-leaved forests with coniferous tree plantations, was implemented by the Forestry Agency during the 1950s–1970s. This measure deserves special mention in regards to forest expansion: annually, 40–90,000 ha of coniferous trees were planted for future use as industrial wood. The Forestry Agency recommended Japanese cedar, Japanese cypress, Japanese larch, Sakhalin fir and Japanese red pine as species for the plan because they are fast-growing and straight. This agency even introduced subsidies for planting these species. Forest planting activities, especially the reforestation policies for securing industrial timber, played a significant role in the increase of Japanese forest area from the 1950s through the first half of the 1980s.

4.2.4. Philippines

While many government initiatives meant to control deforestation and promote the sustainable use of forests failed prior to the 1980s, the Philippines did see an increase in forest areas after the 1990s (Fig. 1). Forest policy has since shifted from central government programs to collaborative partnerships between forest-dependent peoples and local governments. There are three distinct periods in the history of community-based forestry management in the country. First is the pioneering period (1971–1980), when the government adopted three major people-oriented forestry programs: Forest Occupancy Management (FOM), Family Approach to Reforestation (FAR), and Communal Tree Farming (CTF). The second period (1981–1989) represents integration and consolidation of these programs, including the implementation of the Integrated Social Forest Program (ISFP) and Community Forestry Program (CFP). The Integrated Social Forestry Program provided forest land occupants secure access to land through Certificate of Stewardship Contracts (CSC), giving them twenty-five year occupancy rights to public forest lands which could be renewed for an additional twenty-five years. After CSC, the National Forestation Program (NFP) and Community Forest Program (CFP) were implemented. The third period (1990 to present) saw expansion and institutionalization of these practices, during which the Philippine government adopted CBFM in 1995 as its national strategy for sustainable forestry and social justice. The effect of the policy change started to appear on the ground as forest cover increased with a time lag. This strategy integrated all the forestry programs in the country (Gascon et al., 2006). The Philippine CBFM Strategic Plan (2008–2017) also gave CSCs to migrant communities and indigenous people who lived within areas that were covered by the community-based forest management agreements (Carandang et al., 2013).

In pursuit of conserving and protecting the country's forests, thus, increase its forest cover, the government issued Executive Order No. 23 in February 2011, declaring a moratorium on the cutting and harvesting of timber in the natural and residual forests and in February 2011, Executive Order No. 26 implementing the National Greening Program (NGP). Under the NGP, 1.5 billion trees shall be planted in about 1.5 million hectares for a period of six (6) years from 2011 to 2016.

4.2.5. Republic of Korea

After the Korean War (1950 to 1953), the ROK experienced severe deforestation and forest degradation. The decline of forest cover in the ROK ended in 1955, when forest area was 35% of the national land area, excluding non-stock forestland. After 1955, forest cover increased, peaking at 65% in 1980 (Bae et al., 2012). As of 2010, the ROK forest area is approximately 6.4 million ha and almost 64% of the total land area, consisting of national forests (24.2%), local governmental owned forests (7.7%) and private forests (68.1%) (Korea Forest Service, 2014).

The ROK government adopted the first Forest Act that began reforestation programs in 1961, and implemented the First (1973–1978) and Second National Reforestation Plans (1979–1987), which focused on the rehabilitation of denuded forestlands. Under these plans, 2.1 million ha of forestlands were reforested. Timber and logging were regulated by the Ministry of Agriculture and Forestry notification No. 1795 (25 April 1968) and notification No. 5 (20 April 1987). The amount of imported timber increased almost fifteen times, from 590 thousand m^3 in 1962 to 8770 thousand m^3 in 1977 (Park and Youn, 2017). Numerous projects were implemented to substitute firewood with fossil fuels, to eliminate slash-and-burn (SAB) fields and to establish firewood plantations (Bae et al., 2012; Park and Youn, 2017). Saemaul Undong, which began in 1970 as a new village movement, facilitated public participation in reforestation activities and the remodeling of fire stoves to use coal briquettes. As a result, by 1970 only 7% of urban areas still used firewood for heating and cooking in homes (Bae et al., 2012: 204). The policies for reforestation, control of timber demand and the abolishment of SAB fields contributed to a successful forest restoration in the ROK.(Park, 2013)

4.2.6. Vietnam

The policies that aided forest recovery in Vietnam included: reforestation programs, legal arrangement for forestland tenure and protection, logging and log export bans, and the promotion of community forestry. Since 1990, reforestation was one of the highest priorities in Vietnamese forestry policy. The government of Vietnam set a target of increasing forest cover from 28% to 43% by 2010. Many countrywide reforestation programs were carried out, specifically the Program 327 and the Five-million-ha Reforestation Project (Huu-dung, 2013).

In addition to ambitious forest plantation programs, forest protection laws and regulations have been introduced. A forest protection and development law was issued in 1991, which set the policy guidelines for forest management, protection, development, and exploitation and utilization. The government started banning log and sawn timber export in 1992 to prevent over-logging and illegal cutting, especially for endangered timber species. To compensate for the timber deficiency resulting from this policy, the government allowed processing industries to import timber (Huu-dung, 2013).

To mobilize people to participate in forest protection and reforestation, the Vietnamese government adopted a series of policies to promote community forestry, such as the policy of forest land allocation, which provided land use rights for up to 50 years (renewable), land use tax reduction and exemption, low interest rate loans and credits for investment in plantation establishments, and technical support. Forests are also contracted to people for their protection and management. In general, the forestry sector of Vietnam has moved over time from centralized forest management with the core objective of a maximum extraction of natural resources, to a social forestry model that emphasizes environmental protection and social development for those living in and around forests (Huu-dung, 2013). Some have argued that the achievement of this transition is limited. For instance, while the nominal forest area, including man-made forest plantations, increased over the last decades, there is still severe degradation of the country's rich and diverse natural forests (McElwee, 2009).

4.2.7. Indonesia

Indonesia has abundant forest resources but has experienced severe deforestation, reducing its forest cover from 62% in 1990 to 49% in 2010 (Fig. 1). This decline was caused by logging, conversion for cash crop production and smallholder agriculture, and forest fires. Underlying causes that supported these direct forest conversions include transmigration, investment policies, economic crises, population pressure, and a transition to regional autonomy (Damayanti et al., 2013).

The government of Indonesia has strived to sustain their declining forests, but has been ineffective overall. This has been due to a lack of law enforcement and partnership from local communities that makes sustainable forest management difficult. In 1945, the Constitution declared that natural resources, including forests, should be controlled and managed by the State for the greatest benefit of the people. In 1967, the administration enacted the Basic Forestry Law, which was replaced by the Forestry Act in 1999. Massive reforestation programs have been implemented, including the re-greening and reforestation program in 1968 and a national effort to address forest decline from 2003 to 2009 (Damayanti et al., 2013).

4.2.8. Laos

The forest cover in Laos did not reach transition until 2010. Forest cover in Laos decreased dramatically from 73% in 1990 to 66% in 2010 (Fig. 1). Deforestation was driven by four main factors, including shifting cultivation, unsustainable logging, conversion for industrial tree plantation, and mining and infrastructural development (Moore et al., 2011). While the government has recognized the importance of forest rehabilitation after witnessing the rapidly decreasing forest area, and has recently started to promote sustainable forest management, through revision of the Forest Law of 1996 in 2007 (Wanneng, 2013), there is still a lack of institutional arrangements for sustainable forest management. In particular, there is limited capacity for enforcing the forest law. As a result, Laos has not yet effectively implemented a forest rehabilitation policy or program.

4.2.9. Malaysia

Forest policy in Malaysia differs for each of the country's states: Peninsular Malaysia, Sabah and Sarawak. Industrialization and a growing economy both significantly influence land use in the country, favoring agriculture, commercial logging, and resettlement; all contributing to deforestation. From 1970 to 2000, natural forest area was reduced approximately 20% in Malaysia, mainly due to conversion to the cash crops oil palm and rubber and intensive logging. A large area of the over-logged forests has been designated to undergo treatment to achieve sustainable forest management. By the end of 1988, there were approximately 2.29 million ha of over-logged forests in Peninsular Malaysia, 1.92 million ha in Sarawak and approximately 2.25 million ha in Sabah (Wan Razali, 1990).

In 1992, the National Forestry Policy of 1978 (NFP) was revised to increase the conservation of biological diversity, sustainable utilization of forest genetic resources, and the role of local communities in forest development. To ensure effective forest management and implementation of the National Forestry Policy in Malaysia, state authorities have been formulating and enforcing various acts and ordinances. Forest management planning and operations were further streamlined and strengthened with the adoption of the National Forestry Act and wood-based industries. Similar to the NFP, the National Forestry Act of 1984 was amended in 1993 to incorporate additional provisions related to sustainable forest management, including more stringent penalties for violations such as the illegal felling of trees, and to provide for mandatory imprisonment of convicted offenders. The police and armed forces were given new powers of surveillance in the forestry sector with the aim of curbing illegal logging, encroachment, and timber theft.

4.3. Dichotomizing data in the model

The data were entered into the QCA software program, which performed the Boolean algebra. While the program can interpret various data, including continuous, ordinal or categorical values, the variables were transformed into binary data based on specific thresholds. To transform the data into a dichotomized form, a median value or a threshold value dividing the two groups is recommended. In this study, however, the decision point for grouping the conditions of six variables needed careful consideration based on other data and knowledge related to forest transitions (see Table 2). The variables with continuous values included: GDP per capita, food provision, and forest cover. The distribution of the values of these variables needed to be understood in order to set the thresholds for dichotomization. For the variable GDP per capita, the world average GDP per capita was used as a threshold for dichotomization. This threshold may not fully indicate structural shifts in a country from agriculture to manufacturing, but it was assumed that if a country's GDP per capita was higher than the world average, it would be more likely for the economic structure to be industrialized compared to those with a GDP per capita less than the world average. The period when GDP per capita is greater than the threshold level was coded as 1, while the period when it is below the threshold level was coded as 0. For the variable of forest cover, the ratio of forest area to total land areas was used to dichotomize, with a threshold set at the world's forest area compared to the total land cover (currently 31%). Subsequently, a forest cover ratio higher than 31% was coded as 1, while a forest cover ratio equal to or less than 31% was coded as 0. The thresholds set for dividing the range of GDP per capita and forest cover variables into 1 or 0 does not mean that the level of value for each variable represents the condition for transition to occur. Instead, they are the dividing points at which the variables are grouped into lower level and higher level in a relative term. We assumed that the country's GDP per capita is related to its economic structure and the relative forest coverage of a country can represent the scarcity of forest goods and services. Nevertheless there is no empirical evidence about the threshold of GDP per capita for forest transition. Liu et al. (2017) confirms that there is no uniform economic threshold that signals when forest transition occurs for developing countries. This is also the case for forest coverage threshold. So we consider the threshold level as the first best guess, set for dichotomization need in QCA. For food provision, the dividing value was set at 2300 kcal, which is the median value of food intake in one day (2000 kcal and 2600 kcal for women and men, respectively) recommended by the WHO. Consequently, a value of 1 was assigned to periods with food provision of more than 2300 kcal, and 0 to periods with food provision below 2300 kcal. We hypothesized that a country under food provision below 2300 kcal per person per day can hardly experience forest transition.

For the timber trade, a state of no timber import restrictions, liberalized import and regulated import were grouped into two categories, liberalized import and non-liberalized import, and assigned a value of 1 and 0, respectively. A state of no timber import restrictions means that there were no regulations on the timber imports in a country, while a state of liberalized import implied initial restrictions on timber imports that had been withdrawn. This division was based on the assumption that an influx of wood resources into a country reduces pressure on the forest exploitation in that country. Forest ownership was coded in a similar manner, with 1 for the private, individual ownership of forests and 0 for non-private, individual ownership. A case of private ownership with some public ownership was also coded as 1. Japan and the Republic of Korea both belong to this category. After their forest transitions, China, India, Philippines and Vietnam were coded as 1 considering that the forest tenure was given to the local people even though officially forest lands are owned by the state.

Forest policy has the most features that need to be captured by the contextual situations. Forest policy is influenced by being under the broad domain of governmental interventions and social institutions. Because there are only a few qualitative studies on the impact of forest policies on forest transitions, the characteristics of each policy have not yet been fully articulated. In the model, forest policy was categorized in two distinct situations: the effective implementation of forest policy to avoid deforestation and to support forest rehabilitation, and the non-existence of such a forest policy or failure of the forest policy, with codes 1 (presence) and 0 (absence), respectively. Here, key elements of forest policy included nation-wide programs,

Table 3
Truth table for the nine Asian countries in this study.

Country	Period	Explanatory conditions						Outcome
		GDP per capita	Food provision	Forest cover	Timber trade	Forest ownership	Forest policy	Forest transition
China	1971–1981	0	0	0	0	0	0	0
	1984–2008	0	1	0	1	1	1	1
India	1961–1970	0	0	0	0	0	0	0
	1971–2010	0	1	0	1	1	1	1
Japan	1936–1945	1	1	1	0	1	1	0
	1946–1980	1	1	1	1	1	1	1
Philippines	1991–2000	0	1	0	1	0	0	0
	2001–2010	0	1	0	1	1	1	1
Republic of Korea	1946–1955	0	0	1	0	1	0	0
	1956–1980	0	1	1	1	1	1	1
Vietnam	1981–1990	0	0	0	1	0	0	0
	1991–2000	0	1	1	1	1	1	1
Indonesia	1991–2010	0	1	1	1	0	0	0
Laos	1991–2010	0	0	1	1	0	0	0
Malaysia	1991–2010	1	1	1	1	0	1	0

action plans and regulations for avoiding deforestation and planting trees. The success or failure of forest policy implementation was judged by the author of the case study report for the country, as described in Section 4.1.1 of this paper. Finally, the forest transition variable was assigned the value 0 (absence) and 1 (presence) based on whether it was before or after the forest transition, respectively (Table 3).

5. Results and discussion

The subsequent QCA analysis showed multiple paths to both the occurrence and hindrance of forest transitions in nine Asian counties. When the analysis took into account only existing cases, occurrence of forest transition stems from two distinct combinations of conditions shown in Eq. (1) and Table 4: 1) low GDP per capita, sufficient food provision, liberalized timber import, private forest ownership or forest tenure given to individuals and the existence of effective forest policy (forest transition periods of China, India, ROK, Philippines and Vietnam); 2) sufficient food provision, large forest cover, liberalized timber import, private individual forest ownership, and the existence of effective forest policy (forest transition periods of Japan, ROK and Vietnam). These combinations are stated in the following equation, where a variable coded with upper-case letters refers to the existence of a particular condition and forest transition outcome, those with lower-case letters to the non-existence of a particular condition and forest transition outcome, and plus signs indicate logical 'or' and multiplication signs indicate logical 'and' in Boolean algebra:

$$\mathrm{OUTCOME} = \mathrm{gd} * \mathrm{PR} * \mathrm{IM} * \mathrm{OW} * \mathrm{PO} + \mathrm{PR} * \mathrm{CO} * \mathrm{IM} * \mathrm{OW} * \mathrm{PO}; \quad (1)$$

where gd is low GDP per capita, PR is high food provision, CO is high forest coverage, IM is liberalized timber import, OW is private forest ownership or forest tenure given to individuals, PO is the existence of effective forest policy, and OUTCOME or outcome is the occurrence or absence of forest transition.

Based on this model, two interesting features were derived from Eq. (1). First, the liberalization of timber import and private forest ownership or tenure was necessary for forest transitions to occur in the 6 countries which experienced a forest transition. Additionally, an above minimum level of food provision and the existence of effective forest policy were also necessary for forest transition to occur in a country. Under such conditions, five Asian countries, including China, India, Philippines, ROK and Vietnam, experienced a forest transition when their economic development was still below the world average. This suggests that the forest tenure situation and forest policy of a country are important conditions for forest transition to occur. The level of forest cover was not a necessary condition for forest transition in the nine Asian countries studied in this paper. This reduces the long solution into one formula, which indicates that either liberalized timber import or privatized forest ownership is essential for forest transition in these Asian countries. The equation is as follows:

$$\mathrm{OUTCOME} = \mathrm{IM} * \mathrm{OW} \quad (2)$$

Table 4
Combinations leading to a forest transition.

Combinations	Countries
gd * PR * IM * OW * PO	Forest transition periods of China, India, Philippines, Republic of Korea and Vietnam
PR * CO * IM * OW * PO	Forest transition periods of Vietnam, Japan and Republic of Korea

Based on this result, two intriguing implications emerged. First, the results suggest that liberalized timber import must be combined with private forest ownership, while the combination implies that the conditions of economic development, food supply, scarcity of forest resources and policy procedures do not result in forest transition on their own. This combination agrees well with Mather's argument for forest policy to be an important condition for forest transition (Mather, 2007). The results imply that when there are limited resources, the state is induced into devising a forest policy in order to conserve degraded forests and promote forest recovery. Second, forest transitions can occur in Asian countries when there is liberalized timber import and forest tenure is arranged for the private sector to play an active role in the forestry business. This finding differs from previous results by Rudel (2002) and Meyfroidt et al. (2010) in which there was no mention of the relationship between these two factors. The literature indicates an expected relationship in which forest transition could only occur when high demand is decreased by timber imports. As individual forest private

Table 5
Combinations inhibiting a forest transition.

Combinations	Countries
gd * IM * ow * po	Indonesia, Laos, deforestation period of Vietnam and Philippines
gd * pr * co * ow * po	Deforestation period of China, India and Republic of Korea
gd * pr * CO * im * OW * po	Deforestation period of Vietnam and Republic of Korea
GD * PR * CO * im * OW * PO	Deforestation period of Japan
GD * PR * CO * IM * ow * PO	Malaysia

owners become sensitive to market changes, under private forest ownership, timber harvests from domestic private forests decrease due to the lack of profitability from reduced timber prices after the liberation of timber markets.

The conditions that deter forest transition, or create continuous deforestation, arise from many diverse combinations of conditions. In these case studies, five combinations appear to prevent the occurrence of a forest transition (Table 5): 1) low GDP per capita, liberalized timber import, non-private forest ownership, and absence of effective forest policy (seen in Indonesia, Laos, the deforestation period of Vietnam and the Philippines); 2) low GDP per capita, insufficient food provision, low forest cover, non-private forest ownership, and absence of effective forest policy (seen in the deforestation period of China and India); 3) low GDP per capita, insufficient food provision, high forest cover, no liberalization of timber imports, private forest ownership, and the absence of effective forest policy (seen in the deforestation period of Vietnam and the ROK); 4) high GDP per capita, sufficient food provision, large forest cover, no liberalization of timber imports, private individual forest ownership, and the existence of effective forest policy (seen in the deforestation period of Japan); and 5) high GDP per capita, sufficient food provision, large forest cover, liberalized timber import, non-private forest ownership, and the existence of effective forest policy (seen in Malaysia). The deforestation in Vietnam can be explained through two different combinations of conditions. These combinations appear to lead to deforestation in various countries, presented in a logical equation below:

$$\text{outcome} = \text{gd} * \text{IM} * \text{ow} * \text{po} + \text{gd} * \text{pr} * \text{co} * \text{ow} * \text{po} + \text{gd} * \text{pr} * \text{CO} * \text{im} * \text{OW} * \text{po} + \text{GD} * \text{PR} * \text{CO} * \text{im} * \text{OW} * \text{PO} + \text{GD} * \text{PR} * \text{CO} * \text{IM} * \text{ow} * \text{PO} \quad (3)$$

The above equation shows that all the conditions can take either value, yet still yield deforestation. This indicates that deforestation was caused by diverse combinations of conditions which are difficult to generalize. By incorporating the logical remainders in the equation, the prevention of forest transitions or continuous deforestation can be explained with a simple set of conditions. This result indicates that deforestation resulted from an insufficient supply of timber due to import constraints in the ROK and Japan, and non-private forest ownership in the deforestation period of China, India, Philippines, and Vietnam, Indonesia, Laos, and Malaysia). The logical equation below summarizes the conditions that prevented forest transitions:

$$\text{outcome(L)} = \text{im} + \text{ow} \quad (4)$$

The equation yields two distinctive results. First, two of the five conditions, non-liberalized timber import and the absence of private forest ownership or tenure allowing entrepreneurship, were sufficient on their own to prevent a forest transition. This implies that countries with restrictions on forest product imports have difficulties alleviating the demand for forest products. Second, even when there is a high GDP per capita, high food provision, and high forest coverage, if private forest ownership or entrepreneurship is absent, then there will be deforestation. This combination was observed only in Malaysia, therefore it may be hard to generalize this particular case. We can argue, however, that high GDP per capita and high food provision can be attained by the exploitation of rich forest resources through forest conversion to agricultural or industrial land and timber production. The decision regarding converting forest to non-forestry use is possible with more ease if forests are owned by the state. Thus, under the conditions in Eq. (4), deforestation is likely to take place and forest transition prevented.

The levels of threshold for GDP per capita and forest cover were set to the world average. To test the robustness of these particular thresholds we conducted a sensitivity analysis. The thresholds of three conditions were examined, including GDP per capita, food provision, and forest cover. Shifting the values of thresholds by 10%, 20%, or 30%, more or less independently, parsimonious solutions only for forest transition were obtained and compared with the results above. Even when GDP per capita, food provision, and forest cover thresholds were shifted by ±30%, the parsimonious solutions for forest transition occurrence were unchanged (Table 6). The result of the sensitivity analysis indicates that the conditions for forest transitions are quite robust to the conditions of economic development status, food supply condition and forest coverage of the country.

Table 6
Parsimonious solutions from the sensitivity analysis.

	GDP per capita	Food provision	Forest cover
+30%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
+20%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
+10%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
0	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
−10%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
−20%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW
−30%	OUTCOME = IM * OW	OUTCOME = IM * OW	OUTCOME = IM * OW

There could be more factors which were not included in our model, but may have influence on the trajectory of forest cover in a country. So the result of our analysis covering nine countries in Asia may be sensitive to introduction of additional factors. In this study, the variable of timber export policy was not addressed in our analysis. The conditions for or occurrence or non-occurrence of forest transition that we found in our study and that apply for the nine countries included in this study not necessarily apply for other regions of the world.

We contrast our results with those by Li et al. (2017) and Liu et al. (2017). Li et al. (2017) identified conditions that trigger forest transition based on qualitative assessment of six variables of the same nine countries as in this paper, but using time series data that were subjected to regression analysis. Liu et al. (2017) employed regression and pattern analysis. The result of this study in which we used QCA and Boolean algebra revealed the necessary conditions for forest transition to occur and sufficient conditions for forest transition not to occur while the other two studies explained the drivers for forest transitions in Asia more broadly. Even though the three studies employed similar data, but very different methods of data analysis to explain forest transition in Asia, they arrived at a few common findings. For example the role of the state was found to be important in recovering denuded forest lands and thus leading to forest transition in the nine countries. Also the agricultural productivity and import of timber were found to be significant factors for some countries that experienced forest transition. On the other hand, the relevance of forest ownership to forest transition was only observed to be of significance in this study.

6. Conclusions and recommendations

In this study, we have identified the important conditions under which forest transitions can or cannot occur based on case studies of nine Asian countries, including China, India, Indonesia, Japan, Laos, Malaysia, ROK, Philippines and Vietnam. A qualitative comparative analysis (QCA) method was used to identify the conditions under which forest transitions occur or not. The results of this analysis suggested that in order for forest transition to occur, the country should be able to meet demands for timber and allow private entrepreneurship in forest management by arranging private forest ownership. Under the conditions of public forest ownership and trade policies regulating timber imports, forest transition is unlikely to occur in the country. The conditions for forest transitions to occur or not mainly concerned the regulation of timber imports and forest ownership or forest tenure. This finding may be too simple to account for all of the possible causes of forest transition, however, because this result was based on case studies of nine Asian countries it will be interesting to see whether these conditions may be meaningful for other countries.

The results presented here rely on data obtained from nine countries only, as this was the data available to us. Thus, the results may be sensitive to changes in the judgement of qualitative data for the explanatory variables, such as the existence of effective forest policy. The findings here should be further tested in future research, with different methods or introducing other factors not covered in this study. This study suggests that in order to facilitate a forest transition, or for REDD+ to be effective, forest policies facilitating the rehabilitation of deforested lands should be aligned with land tenure and trade policy. Therefore, we believe that for REDD+ to be effectively implemented, private entrepreneurship in forest management or private land ownership should be institutionalized, making the forestry business, including timber production, more competitive with other land uses, such as agriculture.

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