Analysis

Green Returns to Education: Does Schooling Contribute to Pro-Environmental Behaviours? Evidence from Thailand

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ABSTRACT

We investigate whether there are green returns to education, where formal education encourages pro-environmental behaviours using nationally representative surveys on environmental issues in Thailand. To establish the causal relationship between education and green behaviours, we exploit the instrumental variables strategy using the supply of state primary schooling i.e. the corresponding number of teachers per 1000 children, which varies over time and across regions as the instrument, while controlling for regional, cohort and income effects. We find that more years of schooling lead to a greater probability of taking knowledge-based environmentally-friendly actions a great deal, but not cost-saving pro-environmental actions. In addition, the paper finds no significant impact of formal education on concern about global warming nor the willingness to pay for environmental tax.

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1. Introduction

This paper aims to investigate whether there are green returns to education, where formal education encourages pro-environmental behaviours after accounting for the potential endogeneity of education. While previous studies have shown a positive association between education and environmental actions, whether general formal education can have a causal impact on promoting attitudes and behaviours that help reduce negative externalities relating to the environment is not firmly established. The exception is a cross-national study of 14 European countries by Meyer (2015) using compulsory school reforms as an exogenous source of variation explaining educational attainment. As noted by Meyer (2015), the relationships between education and pro-environmental behaviours observed can suffer from endogeneity problems. Omitted variables such as ability, values, risk perception, social desirability and social responsibility could confound the effect of education. For example, individuals who exhibit temporal discounting (individuals who prefer a smaller, more immediate reward than a later, larger one) may be less likely to invest in education and pro-environmental behaviours since both the rewards from education and climate-friendly behaviours are not always tangible and immediate. If this is the case, then the observed effect of education is inconsistent and biased upwards.

Building upon Meyer (2015) who analyses such causality using evidence from the European experience, our study offers the first causal analysis in the context of developing economies based on nationally representative data on environmental attitudes and behaviour in Thailand. This study thus complements existing studies which mainly focus on developed countries. It is crucial to consider emerging economies in the climate mitigation discourse since through the process of economic development, the corresponding CO_2 emissions in these countries are increasingly not negligible. Indeed, Thailand is the second largest CO_2 emitter in Southeast Asia (Shrestha and Pradhan 2010). Despite the economic slump in 2008, its electricity demand from the household sector still rises steadily (APEC 2010), and it is estimated that in 2050 its greenhouse gas emission will amount to 1398.7 Mt of carbon dioxide equivalent (Chotichanathawewong and Thongplew 2012), which is comparable to the total emissions in India in the year 2008 (IEA 2010).

To investigate a causal relationship between formal education and various aspects of pro-environmental behaviours, the paper exploits the exogenous time and regional variations from the number of state primary school teachers per 1000 children as the instrumental variable for years of education whilst also controlling for regional, cohort and income effects. Our data are based on two nationally representative surveys of adults aged ≥15 years on perception towards global warming, natural disaster experience and pro-environmental behaviours collected in 2010 and 2013 in Thailand ($n = 3900$). Employing the instrumental variables strategy, indeed we find that there exist green returns to education but only in some types of pro-environmental actions,

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particularly those that involve technical changes (e.g. using energy-efficient appliances) and behavioural changes (e.g. reducing the use of plastic bags). We however do not find a statistically significant relationship between schooling and the likelihood of adopting pro-environmental actions related to cost-saving (e.g. turning off unused lights) and willingness to pay for environmental tax.

The rest of the paper is organised as follows. Section 2 discusses the mechanisms through which education influences environmental behaviour and presents previous empirical evidence. Section 3 covers a brief account of primary schooling in Thailand, which is highly relevant to the validity of our instrumental variable. Section 4 explains the data and the main variables. Section 5 covers our empirical strategies – both the baseline and the instrumental variables strategies – as well as provides validity justification of our instrument. Section 6 illustrates the empirical results and discusses the findings. Section 7 concludes.

2. Education and Environmental Behaviour

Regarding why education influences environmental behaviours, this can be explained via direct and indirect channels. First, directly formal schooling is a primary way individuals acquire knowledge, skills and competencies that can influence their environmental attitudes and behaviours. Given that climate science involves complicated topics associated with largely unfamiliar scientific terms (e.g. solar vs. terrestrial radiation), achieving climate literacy requires skills and ability to acquire, accommodate and interpret complex issues — such skills commonly obtained through schooling. Furthermore, education enhances the acquisition of knowledge, values and priorities as well as the capacity to plan for the future and efficiency in allocation of resources (Cutler and Lleras-Muney 2010; Kenkel 1991). Indeed, not only does education increase access to sources and types of information, it can also lead to a better understanding of complex environmental messages such as climate change (Haron et al. 2005; McCright 2010). Accordingly, it is found that education has positive consequences on awareness of environmental issues and a deeper sense of responsibility (Bybee 2008).

Apart from the direct impacts, education may indirectly promote mitigation actions through many other means. Firstly, education improves socio-economic status as evident that education generally increases earnings. This allows individuals to have command over resources such as installing renewable energy sources at home or willingness to pay carbon taxes. Secondly, many empirical studies have shown that people with more years of formal education have access to more sources and types of information (Cotten and Gupta 2004; Neuenschwander et al. 2012; Wen et al. 2011). Knowing where to get information on how to reduce emissions or what adaptations to take allow individuals to change behaviour appropriately.

Indeed, there is considerable evidence at the individual level regarding the relationship between educational attainment and a wide range of pro-environmental behaviour including consumption, conservation and lifestyle. In terms of consumption, education is found to be associated with food choices that are less damaging to the environment. Consumers with a higher level of education are more likely to be willing to pay for eco-labelled seafood in China (Xu et al. 2012), purchase eco-labelled and organic food products (Blend and van Ravenswaay 1999; Lockie et al. 2004; Ngobo 2011) and eat less meat (De Backer and Hudders 2015; Graça et al. 2015). Likewise, highly educated individuals are also more likely to purchase eco-labelled, higher efficiency electrical appliances (Flamm 2009; Ma et al. 2013; Wijaya and Tezuka 2013) and adoption of fuel-efficient or alternative fuel vehicles (Mannberg et al. 2014; Potoglou and Kanaroglou 2007). Extant studies show that irrespective of income, individuals with more schooling are more likely to opt for energy-efficient behaviours as shown in the United States

(Sharygin 2013), Italy (Pronello and Camusso 2011) and in developing countries like India (Farsi et al. 2007).

With respect to conservation and lifestyle, empirical studies based on self-reported environment related behaviour commonly found the positive relationship between education and pro-environmental behaviour. This includes recycling (Callan and Thomas 2006; Ferrara and Missios 2005; Fiorillo 2013; Hage et al. 2009; López-Mosquera et al. 2015; Zen et al. 2014), energy conserving practices (Mills and Schleich 2012), water saving behaviours (Clark and Finley 2007) and a wide range of carbon emission reduction actions e.g. reducing the use of cars, avoiding taking short-haul flights, reducing the consumption of disposable items and buying seasonal and local products (Ortega-Egea et al. 2014). Furthermore, similar to income, many studies reported a positive association between education and willingness to pay higher taxes or prices for environmental protection, emissions reduction policy and renewable energy (Bigerna and Polinori 2014; Franzen and Vogl 2013; Ivanova and Tranter 2008; Kotchen et al. 2013; Zhang and Wu 2012; Zorić and Hrovatin 2012).

As mentioned above, despite a relatively large literature on the association between education and pro-environmental behaviour, hardly any studies deal with the potential endogeneity of education. In the literature on returns to education, the method of instrumental variables (IV) has been used as a standard solution to the problem of causal inference. It has become common to employ various sources of exogenous variations such as compulsory schooling legislation, tuition costs and accessibility of schools to draw a causal impact of schooling on labour market earnings (Card 2001), health and health behaviour (Brunello et al. 2015; Spasojević 2010), mortality (Clark and Royer 2013; Lleras-Muney 2005), fertility (McCrary and Royer 2011) and crime (Lochner and Moretti 2004; Machin et al. 2011). Policy interventions and reforms of the educational system serve as natural experiments since they exogenously impact the educational attainment of the treated population. This allows the causal effect of education on the outcomes of interest to be identified. In this paper, we employ the normalised number of teachers in state primary school as our identification strategy.

3. Primary Education in Thailand: The Supply Side

Prior to the introduction of formal primary education in 1871, education was mainly supplied within the precinct of individual households. Occupational and life skills were passed on from generation to generation at home. In addition, some boys were sent to Buddhist monasteries to be taught reading, writing, and Buddhist preaching (Pachrapimon and Gamage 2010). Although, initially, formal education was aimed at training particular groups of children in public civil service, gradually schools for commoners had been established throughout the country — mostly within the temples. Three, four and seven years of compulsory education were implemented in 1921, 1936, and 1960, respectively. However, in practice, due to both low demand and low supply of schooling, sending children to schools was still unpopular among general households residing in rural areas (Sangnapaboworn 2007).

Several attempts to improve the institutional features of education on the supply side have been undertaken by the government. The examples of reforms include compulsory schooling laws, school lunch programme and school construction in rural areas. While mandatory education reform can potentially be used as an instrument variable, its nationwide implementation left us with little variation. However, as shown later in Fig. 1, compulsory schooling reform is closely associated with the increase in the number of primary schools and the corresponding increase in the number of teachers per 1000 children. The latter is used as an instrumental variable in this paper.

Despite several education reforms in Thailand, the major and most relevant reform to the supply of education and to the respondents of
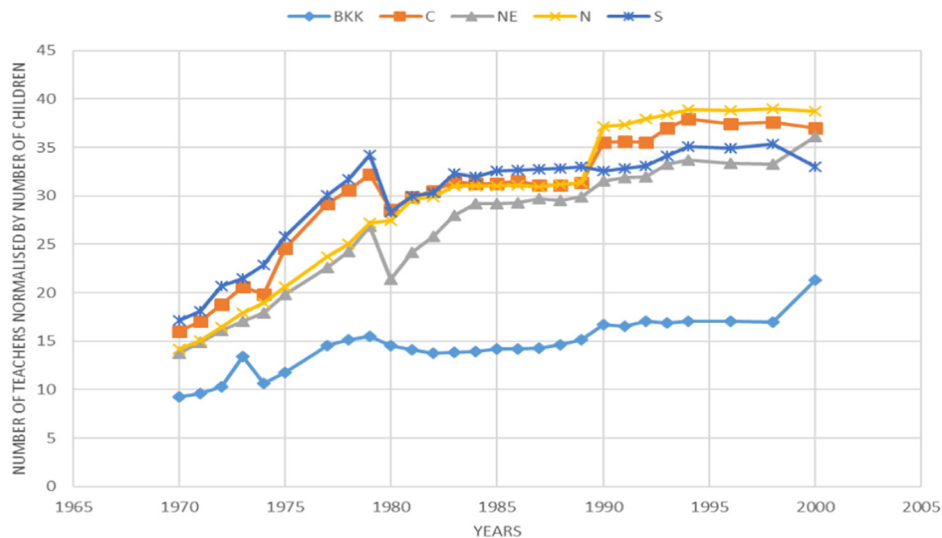
Fig. 1. Number of teachers in state primary schools per 1000 children, by region.
Source: own depiction based on the data from the *Annual Statistical Reports of the Ministry of Education.*

the surveys used in this paper (based on their birth cohorts),[1] is the compulsory primary schooling reform in 1977/1978. Since 1977/1978, compulsory education in Thailand had extended to six years, covering complete primary education, and had been strictly implemented throughout the whole country including rural areas (Thongthew 1999). Primary schools were transferred back from the Ministry of Interior Affairs to the Ministry of Education, and the most major movement within the reform was the establishment of primary schools in every single village for the first time. Although there is no reliable number of schools and classrooms data, based on the Ministry of Education's formula for calculating the number of teachers for a given size of schools and classrooms, the normalised number of teachers in state primary schools can be obtained. This should also reflect the state supply of primary education. A sharp increase of the supply of primary schooling by the state in 1977/78 is evidently reflected by a sharp rise in the number of teachers per 1000 children during the period 1970 to 2000, shown in Fig. 1.

From Fig. 1, even though there is a general upward trend of the number of teachers per 1000 children in each region over time, there exists an evidently sharper increase from 1975 to 1977 in all regions,[2] compared to other periods. The growth rates of normalised number of teachers from 1975 to 1977 are 23.55% in Bangkok, 18.63% in the central region, 13.8% in the northeast, 15.44% in the north and 16.47% in the south. This is in contrast to the average growth rates in each region over the period 1970 to 2000 shown in the figure, which are 3.72% in Bangkok, 3.5% in the central region, 4.01% in the northeast, 4.05% in the north and 2.77% in the south. Such a distinctly sharp rise in the normalised number of teachers corresponds with the implementation of the six-year compulsory primary education reform, which is a major institutional change in the supply side of education. This implies that the normalised teacher variable is likely to represent the supply of state primary schools, rather than the demand. As a result, the use of the number of teachers per 1000 children as an instrument representing the state's supply of primary education in the subsequent empirical section is warranted.

In addition, in order to illustrate that the compulsory primary schooling reform in 1977/1978 and the sharp rise in the number of teachers per 1000 children during this period correspond to an increase in years of education, Fig. 2 summarises trends in the number of students in primary schools before and after the compulsory education reform during the period 1973–1985. Although the average number of lower primary school students (grades 1 to 4), averaged from each grade, remained roughly stable, it can be clearly seen that the 1977/1978 reform had a major impact on student participation in upper primary schools (grades 5 and 6). In particular, from 1977 to 1978, the number of students in grade 5 grew by 37% and so did the number of students in grade 6, from 1978 to 1979, indicating a rise in school participation for a longer period for the cohort directly affected by the reform. Such trends also match the increase in the supply of state primary school teachers after the reform period illustrated in Fig. 1.

4. Data

The data used are mainly based on two nationally representative surveys: (i) Opinions about the Environment and Global Warming (OEGW) 2010 and (ii) Opinions about Natural Disasters and the Environment (ONDE) 2013. Both surveys were computer-assisted personal interviewing carried out by the National Statistical Office of Thailand (NSO) comprising a representative sample of adults aged 15 years and
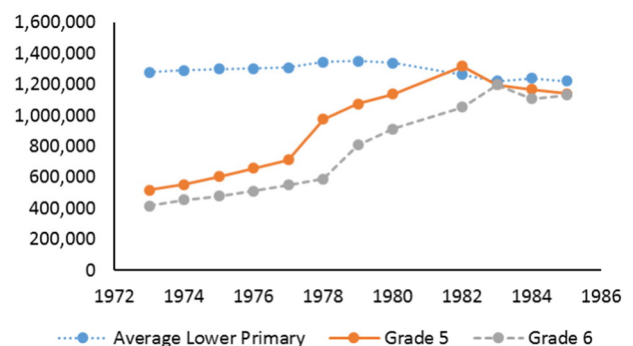
Fig. 2. Number of primary school students (average lower primary, grade 5 and grade 6, 1973–1985). Average lower primary refers to an average number of students from grades 1, 2, 3, and 4.
Source: Statistical Yearbooks of Thailand (1973–1985).

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[1] Although in later periods there have also been other top-down changes in the supply of education in Thailand, such as the reform in 2000 that extends compulsory education to nine years, they are not applicable to the respondents in the two surveys collected in 2010 and 2012 used in this study, which cover the sample of adult population aged 15 years and over.

[2] Note that the data for 1976 are not available from the source.

Table 1
Summary statistics.

Panel A: Environmental attitudes and behaviours	Scale	% of respondents		
		A great deal	A fair amount	Little/not at all
Cocern about global warming (2010)	ordinal	52.4	40.0	7.6
Pro-environmental behaviours (2010)				
Technical/behavioural change				
Use cloth bag instead of plastic bag	ordinal	13.1	55.4	31.5
Reduce the use of styrofoam container	ordinal	20.5	57.9	21.6
Use energy-efficient appliances	ordinal	54.5	36.3	9.2
Use energy saving light bulbs	ordinal	38.7	38.5	22.8
Saving behaviour				
Unplug electrical devices when not in use	ordinal	70.1	28.2	1.8
Turn off unused lights	ordinal	81.1	18.0	0.9
Turn off the tap while brushing teeth/taking shower	ordinal	65.4	27.5	7.1
Fill in a container when washing rather than running tap water	ordinal	57.1	33.7	9.2
		Willing	Not willing	
Willingness to pay for environmental tax (2013)	binary	80.3	20.0	
Panel B: Individual characteristics (% of respondents)	Scale	2010	2013	
Female	binary	23.1	52.4	
Age groups				
aged 15-19 years		7.6	5.4	
aged 20-29 years		15.8	14.5	
aged 30-39 years		23.1	20.6	
aged 40-49 years		22.3	24.5	
aged 50-59 years		19.7	21.1	
aged 60 years and over		11.6	13.9	
Schooling (years)	continuous	9.41	9.37	
		[3.98]	[4.1]	
Average monthly wage by level of education (Baht)	continuous	8531.58	1087.72	
		[5882.05]	[6070.05]	

Note: For both 2010 and 2013 data, the number of observations (respondents) are 3,900 persons.
Standard deviations are in parentheses. Average montly wage by level of education is calculated from average wage by level of education provided by the National Statistical Office and the Bank of Thailand.

above from 3900 households in all regions in Thailand.[3] The OEGW survey was conducted in April 2010 while the ONDE was conducted in November 2012. The former was designed to cover a wide range of environmentally-related information including environmental problems experience, concern about the environment and activities/actions undertaken to reduce global warming while the latter focuses on experience and impacts of natural disasters, disaster preparedness, and opinions towards measures to reduce environmental problems. Since the questions contain in both surveys are not identical, it is not possible to combine the two data sources for the analysis. Table 1 presents the descriptive statistics of the variables of interest and other main variables.

4.1. Dependent Variables

Three levels of pro-environmental attitudes and behaviours are considered in this paper: (i) concern about global warming, (ii) private actions taken and (iii) willingness to support further public action in the future. The first two outcome variables are derived from the OEGW survey. Regarding concern, the respondents were asked "How much do you worry about the problem of global warming?" given four ordinal responses: (i) "a great deal", (ii) "a fair amount", (iii) "a little" and (iv) "not at all". As only 4.4% and 3.2% chose "a little" and "not at all", respectively, the two categories are combined in the subsequent analysis. Regarding private actions taken, the respondents were asked whether they had taken any actions to minimise the problem of global warming, and they had to indicate how often they carried out such actions given three ordinal options: (i) "regularly", (ii) "sometimes" and (iii) "not at all". Eight actions, as listed in Table 1, are used in the empirical analysis.

We also categorise the actions into two distinct broad groups according to their characteristics. The first group covers pro-environmental actions that involve more technical and behavioural change, which may require better environmentally-related technical knowledge, need effort to give up comfort or convenience, and acquires new appliances. The second group covers pro-environmental actions that have a higher degree of cost-saving characteristics and are likely to be taken regardless of whether the respondents are pro-environmental or not. From Table 1, whilst the frequency of actions taken under group one is more equally distributed among regularly, sometimes, and never, it is clear that the majority of respondents carry out most saving actions in group two on a regular basis.

Regarding the willingness to support further public pro-environmental action in the future, we use the information from the ONDE survey. We utilise a binary variable based on the question asking whether the respondents agree if there is going to be an environmental tax in the future. In particular, the question asks whether the respondents agree with the polluter pay principle where polluters bear the full cost of pollution through taxation. For example, the consumers have to pay for packaging waste and the factories have to pay for discharging wastes and pollutants into water bodies. Table 1 shows that there is not much variation in how people support the environmental tax. Most respondents agree that tax should be levied on the polluters.

4.2. Variable of Interest

With respect to education, we construct a continuous variable, capturing years of formal education. The construction is based on the information on the highest level of education each respondent reports. For example, for those reporting their highest level of education as primary school, lower secondary school, upper secondary school, and university, their corresponding years of formal education are six, nine, twelve, and

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[3] A three-stage stratified sample was adopted. The primary sampling units were blocks in municipal areas or villages in non-municipal areas. Households were the secondary sampling unit and household members were the ultimate units. There was no missing information in the variables of interest.

Table 2
Normalised number of teachers by cohort and region, for 2010 and 2013 samples.
Source: Annual Statistics Report, Misnistry of Education.

Cohort	Bangkok	Centre	Northeast	North	South
2010					
15–19	19.160	37.281	34.707	38.835	34.167
20–29	16.692	35.183	32.202	36.321	33.598
30–39	14.739	31.404	27.545	30.332	31.878
40–49	11.298	25.039	19.278	20.935	24.595
50–59	7.070	23.843	15.798	16.918	19.398
60+	7.070	23.843	15.798	16.918	19.398
2013					
15–19	21.314	36.982	36.156	38.717	33.033
20–29	17.451	36.685	33.135	38.267	33.873
30–39	15.124	32.635	29.228	32.946	32.299
40–49	12.883	25.747	21.549	23.438	26.788
50–59	8.380	22.612	16.162	17.174	20.086
60+	8.380	22.612	16.162	17.174	20.086

Notes: the normalised number of teachers for each region is only available from 1962, we cannot compute the variable for the age group 60+, and we thus make an assumption that the variable takes the same values as those of age group 50–59 for all regions.

sixteen years respectively. Some measurement error may be of concern if the individuals have taken fewer or more years to complete the reported highest level of education or their university degrees require more than the usual four years to complete. From Table 1, the mean value of years of formal education is about nine years, which is corresponding to the number of years usually taken to complete lower secondary school.

4.3. Control Variables

To control for cohort effects, we draw the information of the birth cohorts from the respondents' age. Nevertheless, the surveys only report age in age-range categories but not the exact age. Our cohort dummies thus correspond to age groups with a 10-year span. More specifically, there are six cohorts corresponding to six age groups as outlined in Table 1. To control for income, we use average monthly wage. In the OEGW and the ONDE surveys, although there is no direct information on wages, the respondents report their occupation according to the eight following occupational classes: (i) government employee, (ii) private enterprise employee, (iii) non-farm own-account worker, (iv) farm owner/worker, (v) construction worker, (vi) student, (vii) private household worker and (viii) unemployed. Individual income is derived from average wage by occupation, sex, and region, provided by the quarterly Labour Force Survey (LFS) in 2010 and 2013 and the Socioeconomic Survey (SES) in 2011 and 2013. We obtain wage information through matching the seven occupational categories with the available occupational class in the LFS and use the LFS average wage by occupational, sex and region to construct the wage for each respondent. However, the LFS does not cover non-farm own-account workers. We, thus, use the corresponding average monthly income by sex and region of non-farm own-account workers from the SES instead.

5. Empirical Strategies

5.1. Baseline Empirical Strategy

The first two outcomes of interest: (i) concern about global warming and (ii) pro-environmental behaviours are measured in an ordinal scale. The baseline estimation is based on the following ordinal response model:

$$y_i^* = \beta_0 + \beta_1 \text{education}_i + \beta_2' \boldsymbol{X}_i + \varepsilon_i,$$
$$y_i = 1 \text{ if } y_i^* \leq \gamma_1.$$
$$y_i = 2 \text{ if } \gamma_1 < y_i^* \leq \gamma_2$$
$$y_i = 3 \text{ if } y_i^* > \gamma_2,$$

where y_i^* is the latent pro-environmental concern or actions taken. We observe $y_i = 1$ if the individual i is concerned a little/not at all or never takes a particular action, $y_i = 2$ if there is a fair amount of concern or takes a particular action sometimes and $y_i = 3$ if there is a great deal of concern or takes a particular action regularly. The main variable of interest is *education*$_i$ which is measured as years of formal education the individual has taken. $\boldsymbol{X}_i$ is a vector of the control variables including gender (a dummy variable taking the value of one if the individual is female), income (a continuous variable estimated by the log value of average wage by occupational class),[4] sex, region, a series of dummy variables capturing environmentally related experiences (i.e. experienced environmental problems in a community, felt that climate has changed, and heard about climate change), cohort dummies and dummy variables of region of residence.

Income is also added as a control variable in order to mitigate the omitted variable problem that income is highly associated with education and may also drive environmental attitude and behaviour. In particular, higher income can imply the fulfilment of basic material needs and subsequent increase in demand for environmental sustainability and better quality of life (Inglehart 1995).

For the third outcome of interest, y_i^* is the latent willingness to support further public pro-environmental action (i.e. environmental tax for polluters). The observed y_i is a binary variable where it is equal to zero if the individual disagrees and one if he or she supports such policy. The control variables $\boldsymbol{X}_i$ are essentially the same as the ordinal response model except for a series of variables related to environmental experiences including a dummy for having experienced environmental problems in a community and a dummy for having experienced damages from natural disasters.

5.2. Instrumental Variables Estimation

Education is nevertheless potentially endogenous to pro-environmental behaviours. Omitted variables such as ability, values, social desirability, social responsibility, and social participation could confound the effect of education. For example, an individual with higher unobserved ability and social involvement could potentially be more likely to both continue to a higher level of education and have more concern and be more pro-active in response to environmental problems. In addition, social desirability may also drive the reported pro-environmental concern, attitudes, and behaviours of the higher educated groups. It could be possible that similarly to what Karp and Brockington (2005) found in the case of voter turnout, individuals with greater schooling may over-report their environmentally-related concern and actions.

To form credible instrumental variables for individual schooling outcomes that help mitigate the endogeneity of schooling and unobserved ability, institutional features of an education system such as compulsory schooling reforms (Harmon and Walker 1995; Meyer 2015), tuition costs, geographical proximity (Uusitalo and Conneely 1998) and schooling construction (Berlinski and Galiani 2007; Duflo 2001) have been used. The use of supply-side variables can help resolve identification problems on the demand side of the education market (Card 2001). However, all mandatory schooling reforms in Thailand were implemented at the national level and lack cross-sectional variation, which prohibits us from identifying its effect independently from period or cohort effects.

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[4] More specifically, income is measured as $\log(a + b)$, where a is the average wage by occupational class, sex, and region, and b takes a negligible value of 0.001. This is because for two specific occupational groups, i.e. students and the unemployed, that the wages are derived from, the associated wage is zero. To avoid losing data points as $\log(0)$ is undefined, we assume b to take a negligible value of 0.001, which should not lead to any significant change in the original value of the wages.

Table 3

The impact of the supply of schooling on years of education, controlling for cohort.

Years of schooling	2010 Sample		2013 Sample	
	[1]	[2]	[1]	[2]
Normalised teachers	0.104 [0.008]***	0.067 [0.034]**	0.092 [0.008]***	0.094 [0.04]**
Female		−0.333 [0.109]***		−0.099 [0.112]
Had environmental problem in community		0.044 [0.119]		−0.182 [0.120]
Felt that climate has changed compared to last year		0.032 [0.279]		
Heard about climate change		2.337 [0.261]***		
Had been damaged by natural disasters				0.216 [0.188]
Log (wage)		−0.014 [0.013]		0.041 [0.014]***
Cohort dummies	No	Yes	No	Yes
Regional dummies	No	Yes	No	Yes
Observations	3900	3900	3900	3900
F-Statistics on the entire regression	188.45	102.72	120.5	110.31
F-Statistics on the excluded instrument	188.45	3.854	120.5	5.351
Adjusted R-squared	0.046	0.281	0.03	0.282

Note: standard errors are in parentheses. The equivalent first-stage regressions and F-statistics on the excluded instrument in both columns 2 are estimated under the 2SLS estimation.
** Significant at the 5% level.
*** Significant at the 1% level.

In addition, due to the nature of the age variable that comes in the decade-wide age range, we are unable to use the regression discontinuity (RD) in the first stage like in previous papers that utilise nationwide compulsory education reforms (for example, see Meyer 2015). Under the regression discontinuity designs, the identification comes from comparing individuals born just before the effective year of the reform with individuals born just after the effective year of the reform, and robustness checks are based on different estimation bandwidths and polynomial controls (Imbens and Lemieux 2007; Lee and Lemieux 2010). Since the surveys used in our paper only collect the age information in the form of decade-wide ranges, we lack a refined measure of age suitable for applying the RD technique. As a result, in this paper, we exploit the supply of schools which exogenously varies both over time and across region as our instrumental variable.

Several studies provide evidence that in developing countries, the supply of schools, in particular, the number of schools or planned schools associates positively with years of education and school enrolment (Berlinski and Galiani 2007; Duflo 2001). Lacking comprehensive data on the number of schools, we introduce the number of state primary school teachers per 1000 children as a proxy for school supply. This is because, similar to the INPRES programme (a major school construction programme launched in 1973) in Indonesia (Duflo 2001), the Ministry of Education of Thailand had a formula for calculating the number of teachers for a given size of schools and classrooms. In addition, unlike the number of private primary schools and teachers which is likely to be driven by the demand for education, the number of schools and teachers at the basic level of education offered by the state should better reflect the supply side.

The normalised number of teacher variable is estimated from the data provided in the Annual Statistical Reports of the Ministry of Education. For each individual, the variable is the average normalised number of teachers in the region of his or her residence over the years that he or she was in primary school. Table 2 illustrates the values of the number of teachers per 1000 children corresponding to the 2010 and 2013 sample. For the 2013 sample, the numbers are slightly different as they are averaged over different years.

Regarding instrument relevance, the normalised teacher variable should be a valid instrument in this study as it represents the supply of education. The number of teachers in state schools reflects the centrally-planned number of schools by the state. A lack of supply can act as a constraint and a boost of school infrastructure including the resulting number of teachers can significantly encourage formal education enrolment as well as completion. The estimation of the impact of the number of teachers per 1000 children on the individual's years of

education – the first stage of the instrumental variables strategy – can be described as the following.

$$education_{icr} = \gamma_0 + \gamma_1 teacher_{cr} + \gamma_2 cohort_c + \gamma_3 region_r + \gamma_4' \mathbf{X}_{icr} + u_{icr},$$

In other words, years of schooling of an individual i, of cohort c, and in region r, is explained by the average normalised number of teachers in the region of his or her residence (r) over the years that the cohort (c) the individual belongs to was in primary school. In order to separate the effect of the supply of education from the cohort effect, which encompasses the country-wise time effects and cohort-specific characteristics, we control for the cohort dummies corresponding to age-groups ($cohort_c$) in Table 2. Also, to separate the effect of the supply of education from the regional-specific characteristics, regional dummies ($region_r$) are controlled for.

Table 3 reports the impact of the instrument on years of schooling. Although the actual IV ordered probit and IV probit models used in this paper are non-linear models estimated under maximum likelihood and thus direct first stage and F-statistics on the excluded instrument cannot be directly estimated, to provide indicative first-stage diagnostics, we employ linear 2SLS estimation. More specifically, we use the Stata command *ivreg 2sls* (also asking for reporting first stage) and then followed by the post-estimation command, *estat firststage*. As reported in Table 3, for the models with the normalised teacher as a lone explanatory variable (column 1), the F-statistics on the excluded instrument are high at 188.45 and 120.5. Nevertheless, when other control variables are included under the full models (column 2), the F-statistics on the excluded instrument reduce to 3.854 and 5.351. Under the models with no potentially endogenous controls (Appendix B), the F-statistics on the excluded instrument rise to 4.807 (2010 sample) and 5.969 (2013 sample). The relevance of the instrument can be assessed by evaluation using the F-test for the joint significance of the instruments in the first-stage regression. Under the linear instrument estimation, Stock et al. (2002, p. 522) provide selected critical values for weak instrument tests for 2SLS based on the first-stage F-statistics. While our instrument, according to the provided critical values, could be considered slightly weak, definition and additional tests for the linear instrumental model cannot be directly applicable to our models i.e. IV ordered probit and IV probit, which are non-linear. Therefore, the interpretation of the F-statistics shown here is fairly limited.

It is nevertheless plausible that the number of teachers in state primary schools per 1000 children does not satisfy instrument exogeneity. This is because the instrument may also be determined by the demand for education, and the demand for education is likely to increase along

with other conditions that also determine pro-environmental behaviour — all of which are potentially reflected by the possible upward trends of the instrumental variable and pro-environmental behaviour. In what follows, we illustrate that such a concern is, however, less of the case in our context.

First of all, we present explanations as to why this instrumental variable is less likely to be influenced by the demand for education, and is more likely to be determined by the supply of it. The number of teachers in state schools reflects the centrally-planned supply of schooling by the state. At the aggregate regional level, although the number of state schools depends on various factors, it is also by and large influenced by government education policies including the top-down compulsory education reform in 1977/78. Among several changes brought by the 1977/78 reform, primary schools were for the first time to be established in every single village. This implies a sharp increase in the supply of state primary schools, which should be, in turn, reflected by a sharp increase in the normalised number of teachers in state primary schools in each region during the corresponding period — if the normalised number of teacher instrument indeed represents the supply of schooling by the state. This is precisely illustrated in Fig. 1 and elaborated in Section 3 above.

In addition, the identification based on the normalised teacher instrument relies on both time and cross-sectional variations. This should also further mitigate the instrument endogeneity concern. Although it is clear from Fig. 1 that the variable for all regions trends upwards over time, it is also evident that the variations in our instrument are not only from the time dimension but also from the regional variation. Not only are there substantial differences across the five regions, but the upward trends (slopes) for each individual regions are also dissimilar. In particular, even under the compulsory schooling reform period, sharp rises in normalised teachers also varied from region to region. Even though we do not observe the time trend of pro-environmental behaviour variables, in the main regression analyses, point estimates for regional dummies reveal that compared to the central region, residents of Bangkok and the south tend to be more environmentally friendly and residents of the north and northeast are more likely to be less pro-environmental.[5] Nonetheless, such patterns have no correlation with the regional differential in the normalised teacher instrument shown in Fig. 1 and Table 2.

Additionally, as the instrument has both regional and time variations, there is no issue of perfect collinearity between the instrument and the cohort dummies. Indeed, this is distinctive from a simple reform variation that has only time dummy variation but no cross-sectional variation, and, thus, the supply of education cannot be independently identified from the cohort effects. However, regarding the normalised number of teacher instrument, its additional regional variation enables us to properly control for the cohort effects. Although our cohorts are crude with the decade-wide age ranges and not at the yearly interval, together with the regional variation in the supply of teachers, such control can still help identify the effect of the supply of teachers from the cohort effects, which could be related to generational differentials in attitudes and behaviours towards the environment.

Lastly, our IV procedure is based on the instrument that implicitly compares many subgroups of individuals. In the existing studies that exploit particular supply-side intervention, younger (after the reform) versus older (before the reform) cohorts in different regions are normally compared (Card 2001; Duflo 2001). As we can trace back the number of teachers in the regions and during the time of which the cohorts the individuals belong to were in primary school, our instrument compares more subgroups of individuals along the cohort dimension, i.e. six in this case. According to Card (2001), the IV procedure that implicitly compares more subgroups of individuals could be more reliable than the procedure that relies on a single or fewer affected subgroups.

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[5] As the result tables only report whether regional dummies are included, full results on the coefficient estimates for each region are available upon request.

In order to estimate the above mentioned IV ordered probit model, we employ the Stata-based cmp package by Roodman (2011) which estimates IV ordered probit models using maximum likelihood. In what follows, both in the text and tables, IV, otherwise specified, refers to IV ordered probit.

6. Empirical Results

6.1. Concern About Global Warming

Table 4 presents ordered probit and ordered response IV estimation for concern about global warming controlling for income and environmental-related experience and cohort and regional dummies. In the baseline specification, concern about global warming is increasing with years of schooling. In other words, those who have more education tend to express more concern about global warming. Nevertheless, under the IV specification when the endogeneity of education is accounted for, formal education no longer exerts any statistical significant impact on concern about global warming.

In fact, the relationship between education and concern about global warming is not entirely conclusive in the literature. While cross-national studies consistently reported higher concern about climate change among individuals with higher education (Kvaloy et al. 2012; Running 2013; Tjernstrom and Tietenberg 2008), in the United States there is evidence of an inverse relationship between education and perceived climate change risks, both for general education (O'Connor, Bard, & Fisher, 1999) and specific science literacy and numeracy (Kahan et al. 2012). Political orientation coupled with disinformation campaigns and a successful movement by conservative think tanks explain why concern about climate change can be negatively associated with education among the American population (Hamilton 2011; McCright and Dunlap 2003). Nevertheless, none of these studies, with the exception of Meyer (2015) tackled the possible endogeneity of education like ours. Taking the endogeneity of education into account and properly controlling for the cohort effect, we find no statistically significant relationship between years of schooling and concern about global warming in Thailand.

6.2. Private Pro-environmental Actions

In this section, we investigate green behaviours considering two types of pro-environmental actions. The first type involves technical or behavioural change, which requires better environmentally-related technical knowledge, needs more effort to give up comfort or convenience and acquires new appliances. The second type has a higher

Table 4
Ordered probit regression and ordered response IV estimation for concern about global warming.

	Ordered probit	IV
Panel A: Ordered probit and IV estimates		
Schooling	0.033 [0.006]***	0.021 [0.179]
Female	0.086 [0.038]**	0.082 [0.071]
Observations	3900	3900
Log likelihood	−3416	−13,688
LR Chi² (15), LR Chi² (27)	201.19	1452.4

Panel B: Average marginal effects (IV with cohort dummies)	A great deal	A fair amount	Little/not at all
Years of schooling	0.008 [0.069]	−0.005 [0.044]	−0.003 [0.025]

Notes: standard errors are in parentheses. All regressions include cohort dummies, regional dummies, controls for environmental-related experience and income. Full regressions are reported in Table A1 in Appendix A.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 5

Ordered probit regression and ordered response IV estimation for pro-environmental actions involving technical changes.

	Bags	Bulbs	Appliances	Styrofoam
Panel A: Ordered probit				
Schooling	0.059 [0.005]***	0.054 [0.005]***	0.058 [0.006]***	0.035 [0.005]***
Female	0.323 [0.037]***	−0.002 [0.036]	0.106 [0.038]***	0.099 [0.037]***
Observations	3900	3900	3900	3900
Log likelihood	−3548	−4050	−3438	−3701
LR Chi^2 (15)	369.59	260.31	279.83	164.34
Panel B: IV				
Schooling	0.221 [0.092]**	0.056 [0.013]***	0.255 [0.062]***	0.138 [0.141]
Female	0.318 [0.061]***	−0.002 [0.036]	0.142 [0.035]***	0.126 [0.046]***
Observations	3900	3900	3900	3900
Log likelihood	−13,819	−14,322	−13,708	−13,982
LR Chi^2 (30)	1495.18	1430.91	1406.92	1399.41
Average marginal effects: regularly				
Schooling	0.05 [0.025]**	0.021 [0.004]***	0.077 [0.012]***	0.037 [0.038]
Average marginal effects: sometimes				
Schooling	0.018 [0.002]***	−0.004 [0.001]***	−0.014 [0.015]	0.002 [0.004]
Average marginal effects: never				
Schooling	−0.067 [0.024]***	−0.016[0.004]***	−0.063 [0.027]**	−0.039 [0.042]

Notes: standard errors are in parentheses. All regressions include cohort dummies, regional dummies, controls for environmental-related experience and income. Full regressions are reported in Table A2 in Appendix A.

  * Significant at the 10% level.
  ** Significant at the 5% level.
  *** Significant at the 1% level.

degree of cost-saving characteristics and may be likely to be taken regardless of whether the respondents are pro-environmental or not.

6.2.1. Knowledge-based Pro-environmental Actions

Table 5 covers the empirical results regarding four actions: (i) the use of cloth bags instead of plastic bags, (ii) the use of energy-saving light bulbs, (iii) the use of energy efficient appliances, and (iv) the reduction of styrofoam container usage. While Panel A illustrates the results from the baseline specification under the ordered probit model, Panel B shows the results from the ordered-response instrumental

variables specification, which helps mitigate the endogeneity concern of education.

Except for the reduction of styrofoam container usage, the IV results show that there exist statistically significant green returns to education for knowledge-based pro-environmental actions. Based on the average marginal effects, an increase in one year of schooling raises the probability of regular use of (i) cloth bags by 5%, (ii) energy-saving light bulbs by 2.1%, and (iii) energy-efficient appliances by 7.7%. Likewise, a one year increase in education decreases the probability of never using (i) cloth bags by 6.7%, (ii) energy-saving light bulbs by 1.6%, and (iii) energy-efficient appliances by 6.3%.

Table 6

Ordered probit regression and ordered response IV estimation for pro-environmental actions involving saving behaviours.

	Unplug	Light off	Water off	Water saving
Panel A: ordered probit				
Schooling	0.016 [0.006]***	0.013 [0.007]*	0.01 [0.006]*	−0.012 [0.006]**
Female	0.12 [0.042]***	0.092 [0.046]**	0.117 [0.04]***	0.074 [0.038]**
Observations	3900	3900	3900	3900
Log likelihood	−2606	−1989	−3158	−3500
LR Chi^2 (15)	73.17	76.34	78.54	68.62
Panel B: IV				
Schooling	0.081 [0.181]	0.175 [0.135]	0.111 [0.158]	0.204 [0.083]***
Female	0.138 [0.059]**	0.13 [0.045]***	0.143 [0.048]***	0.12 [0.036]***
Observations	3900	3900	3900	3900
Log likelihood	−12,878	−12,260	−13,430	−13,770
LR Chi^2 (30)	1374.11	1379.47	1381.85	1353.65
Average marginal effects: regularly				
Schooling	0.027 [0.059]	0.05 [0.042]	0.039 [0.051]	0.067 [0.02]***
Average marginal effects: sometimes				
Schooling	−0.023 [0.046]	−0.036 [0.012]***	−0.021 [0.017]	−0.016 [0.012]
Average marginal effects: never				
Schooling	−0.004 [0.014]	−0.013 [0.03]	−0.018 [0.034]	−0.051 [0.032]*

Notes: standard errors are in parentheses. All regressions include cohort dummies, regional dummies, controls for environmental-related experience and income. Full regressions are reported in Table A3 in Appendix A.

  * Significant at the 10% level.
  ** Significant at the 5% level.
  *** Significant at the 1% level.

Table 7
Probit regression and IV probit estimation for willingness to pay for environmental tax.

	Willingness to pay for tax	
	Probit	IV probit
Schooling	0.009 [0.007]	−0.132 [0.131]
Female	−0.065 [0.046]	−0.069 [0.044]
Average marginal effect: agree		
Schooling		−0.037 [0.038]
Observations	3900	3900
Log likelihood	−1924	−12,308
LR Chi^2 (14), LR Chi^2 (28)	52.04	1357.81

Notes: standard errors are in parentheses. All regressions include cohort dummies, regional dummies, controls for environmental-related experience and income. Full regressions, which are also based on the probit and the IV probit models, are reported in Table A4 in Appendix A.

Furthermore, except for the energy-saving light bulbs, the results under the IV specification are more than three times as large as the results from the baseline specification. One of the explanations for the downward bias of the baseline results can be founded on the local average treatment effect (LATE) (Imbens and Angrist 1994). There is underlying heterogeneity in the returns to education, and the IV estimates based on the supply side of education, such as compulsory schooling or school construction in rural area, tend to affect the returns to education for a subset of individuals with relatively high returns to education (Card 2001). Such compliers are likely to be individuals who would otherwise have relatively low schooling, from the lower end of the ability and wealth distributions (Meyer 2015). Our instrumental variable strategy is based on the number of teachers per 1000 children in state primary schools which is equivalent to six years of education. Individuals who were induced to stay in schools longer by such supply-side change are likely to constitute those with very low schooling, who might have dropped out before completing primary schools, reflecting their high marginal cost of schooling and leading to larger coefficients under the IV specifications.

This is also in line with the findings of Meyer (2015) which studies the impact of formal education on pro-environmental behaviour in Europe, using European compulsory education reforms under the regression discontinuity design. While the scale of LATE in our paper ranges from 0.021 for the probability of using energy-saving light bulbs a great deal to 0.077 for the probability of using energy-efficient appliances a great deal, the scale of LATE in Meyer (2015) ranges from 0.019 for the probability of reducing care usage to 0.066 for the probability of separating waste for recycling. In other words, although in terms of point estimates, our results are slightly larger, the scales of LATE in Meyer (2015) and in our paper are virtually statistically equivalent.

In addition, according to Table A2 in Appendix A, other factors such as gender and exposure to environmental problems also contribute positively towards this type of environmentally friendly behaviours. Nevertheless, income is found to have no statistically significant effect on these pro-environmental actions.

Indeed, formal education can encourage individuals to perform pro-environmental actions (Diamantopoulos et al. 2003; Ortega-Egea et al. 2014). More specifically, technical behaviour, such as using energy-saving appliances demands capacity and intention to accept new information and knowledge, which can be enhanced by education (Karytsas and Theodoropoulou 2014; Welsch and Kühling 2010). The divergence of the results between climate change concern and pro-environmental actions on the effect of education also helps ensure against the claims of a green hypocrisy by popular media. Green hypocrisy refers to groups with the strongest environmentally friendly attitudes while at the same time having the highest emissions or being more likely to take actions that are most harmful to the environment (Lange et al. 2014). In contrast, according to our results, those who

have spent more years in education but have not shown greater concern towards the environment, are those more likely to express it in terms of actions.

6.2.2. Cost-saving Pro-environmental Actions

Table 6 reports the results on pro-environmental actions that involve a higher degree of cost-saving characteristics. Unlike the above four actions in Section 6.2.1, the following actions can be driven by reasons unrelated to an intrinsic pro-environmental attitude such as the desire to save cost. Despite the respondents' motives, such actions can still benefit the environment. Four actions are considered here: (i) unplugging electrical devices when not in use, (ii) turning off unused lights, (iii) turning off the tap while brushing teeth or taking shower and (iv) filling in a container when washing rather than washing under a running tap.

In contrast to the results in Table 5 Panel B, Table 6 Panel B shows that, with exception of water saving, education appears to have no statistically significant relationship with the probability of taking these actions regularly. This could be because environmentally-friendly actions of this type could be motivated by other incentives such as living arrangement, household conditions, and the desire to be economical which are not related to environmental and climate change concerns (Whitmarsh 2009). What incentives drive people to adopt pro-environmental behaviour matters greatly in promoting positive spillover in behaviours (i.e. when one pro-environmental behaviour increases the likelihood of performing other pro-environmental behaviours such as recycling is correlated with energy conservation) (Evans et al. 2013). Nevertheless, it is argued that a financial saving incentive is less likely to lead to positive spillover since it does not promote concern or engagement in environmental or climate change issues (Thøgersen and Crompton 2009). Although the data used in this study do not permit us to measure motivation for pro-environmental behaviours, our analysis has shown that, females, who generally are more likely to be responsible for household budget in Thailand, are significantly more likely to adopt such pro-environmental cost saving behaviour.

Nevertheless, a closer inspection of the results reveals that the scale of the marginal effects in Table 6 Panel B is almost identical to what we observe in Table 5 Panel B, however with larger standard errors. This implies that although the point estimates for the effect of education on knowledge-based pro-environmental actions and cost-saving pro-environmental actions are similar in magnitudes, the results are noisier in the case of cost-saving pro-environmental actions. Thus, an alternative explanation for the observed insignificant impact of education on cost-saving pro-environmental behaviours in Table 6 Panel B could be based on some suggestive heterogeneity in the treatment effect which results in larger standard errors and noisier results.

6.3. Willingness to Support for Environmental Tax

In this section, we use a binary variable based on the question asking whether the respondents agree that the polluters should bear the full cost of the tax if there is an environmental tax in the future. In line with the limited variation in how people support the environmental tax, i.e. most respondents agree that tax should be levied on the polluters, and the results under the baseline specification and the IV results in Table 7 illustrate no significant impartial effect of education on the willingness to pay for environmental tax.

In fact, there is inconclusive evidence on the relationships between education and willingness to pay to protect the environment. While a series of literature showed that education is an important indicator of willingness to pay higher prices and higher taxes for the protection of the environment (Bigerna and Polinori 2014; Franzen and Vogl 2013; Ivanova and Tranter 2008; Kotchen et al. 2013; Zhang and Wu 2012; Zorić and Hrovatin 2012), some studies reported no significant or negative relationships between education and willingness to pay for the

environment (Dorsch 2011; Gökşen et al., 2002; Ma et al. 2015). Indeed, Adaman et al. (2011) found it rather surprising that in Turkey individuals with a university degree are not significantly more willing to pay for CO_2 emission reductions from power production than those with no qualification. When the question on willingness to pay for e.g. renewable energy is further divided into different payment and provision contexts, it is found that the highly educated are more likely to be willing to pay than other groups only in the case of voluntary payment and private provision (Wiser 2007). The fact that the more educated prefer to contribute to investment in renewable energy through a voluntary scheme rather than mandatory and to have the electricity suppliers invest in privately-owned renewable energy projects rather than the government ones implies the lack of institutional trust.

The insignificant relationship between education and willingness to pay for environmental tax found in our study thus represents ambivalent relations between education level and tax morale (Torgler and Schneider 2007). On the one hand, educated taxpayers are likely to be more informed about tax regulations and fiscal relations and be more aware of civil services provided by the state. Hence, they might be more willing to pay taxes. On the other hand, their knowledge on the benefits derived from government in relation to the amounts they contribute to the state can discourage their willingness to pay. Tax morale is associated with trust in government and there is evidence that the highly educated in Thailand exhibit lower satisfaction with public services and government and trust in public institutions (Punyaratabandhu 2007). Correspondingly, the lower support of environmental tax found might rather be a proxy for attitudes towards government spending in general. Our finding is in line with literature from other developing countries (Dorsch 2011; Gökşen et al., 2002) and could imply that the two opposing effects cancel each other out.

6.4. Robustness Check Excluding Potentially Endogenous Controls

Some of the control variables included in Tables 5, 6 and 7 can be endogenous to pro-environment behaviour and/or potential outcomes of education. It is likely, for example, that our income variable constructed from occupational class is affected by education. Likewise, environmentally related experiences such as the perception that the climate has changed compared to last year or having experienced environmental problems in a community could be endogenous to environmental behaviours. By including such endogenous controls, one can potentially bias the coefficient of interest on education. As a robustness check, we therefore ran ordered probit and IV estimates without these potential endogenous controls. As reported in Tables B1 to B3 in Appendix B, with the exception of the use of energy-saving light bulbs, the results without potential endogenous controls are similar to those with the controls in Tables 5, 6 and 7. This further ensures that our findings on the effects of education on pro-environmental behaviour are robust.

7. Conclusions

Analysing green returns to education measured by concern and actions to mitigate global warming and support of environmental tax in Thailand, our study has two main contributions. First, methodologically we address the endogeneity of education by exploiting the state supply of primary school teachers as the instrumental variable, while controlling for regional, cohort and income effects. This allows us to establish a causal relationship between educational attainment and pro-environmental behaviours. Second, we provide new empirical evidence on green behaviours for Thailand. Conventionally, literature on personal climate change mitigation actions are conducted in advanced industrialised nations while studies on personal adaptation actions are predominantly concentrated in developing countries (Porter et al.

2014). Our study thus adds new insight into public pro-environmental behaviours in the emerging economy context.

Limitations of this study are mainly related to the data employed. First, the surveys used do not collect income data, which is recognised to be one key indicator of pro-environmental behaviours, in particular willingness to pay for the environment (Fairbrother 2013; Franzen and Meyer 2010). We therefore create an income proxy by occupation, sex, and region of residence, which can capture the variation in individual income to a certain extent. Second, this study relies on self-reported pro-environmental actions. Accordingly, engagement in mitigation actions observed may be overstated by the respondents due to social desirability bias i.e. the tendency of the respondents to present themselves in a positive way with regard to socially accepted standards. It is possible that individuals with a higher level of education may over-report their engagement in mitigation actions as found in the case of voter turnout (Karp and Brockington 2005) or reading to children (Hofferth 1999). In our case, the instrumental variable models help correct for unobserved characteristics including such social desirability bias.

Despite these limitations, our findings not only provide understanding of individuals' perceptions and behaviours related to environment and climate change in Thailand but also contribute to identifying positive externalities of public investment in the supply of education. Indeed, it has been widely accepted that education is fundamental to the process of economic growth and development (Klasen 2002; Lutz et al. 2008; Mankiw et al. 1992). Not only does it contribute towards productivity improvement (Schultz, 2001; Orazem and King 2008), it is also fundamental to other factors determining development such as health (Cochrane et al. 1982; Kippersluis et al., 2011), fertility (Osili and Long 2008; Wolpin and Todd 2006) and civic participation (Castelló-Climent 2008; Dee 2004; Glaeser et al. 2007). Recent evidence has pointed that education also contributes to vulnerability reduction in the context of climate change (Lutz et al. 2014; Muttarak and Lutz 2014). In this paper, we have shown that, in addition, formal education significantly encourages pro-environmental behaviours, which are also crucial for the reduction of carbon emissions and the promotion of environmental protection. In particular, by exploiting the state supply of primary school teachers as the instrument to mitigate education endogeneity problems, we find that there exist green returns to education for pro-environmental actions that involve more technical and knowledge-based behavioural changes. This implies that positive externalities from education can possibly contribute to promoting private actions to reduce harm to the environment, as we presented for the case of Thailand.

Appendix A

Table A1
Ordered probit regression and ordered response IV estimation for concern about global warming.

	Ordered Probit	Ordered Probit	IV	IV
	[1]	[2]	[3]	[4]
Panel A: Ordered probit and IV				
Schooling	0.034 [0.005]***	0.033 [0.006]***	0.039 [0.012]***	0.021 [0.179]
Female	0.088 [0.038]**	0.086 [0.038]**	0.089 [0.038]**	0.082 [0.071]
Had environmental problem in community	0.354 [0.041]***	0.355 [0.041]***	0.354 [0.041]***	0.355 [0.041]***
Felt that climate has changed compared to last year	0.558 [0.093]***	0.56 [0.094]***	0.557 [0.094]***	0.56 [0.094]***
Heard about climate change	0.204 [0.089]**	0.204 [0.089]**	0.187 [0.096]**	0.232 [0.423]
Log (wage)	0.003 [0.003]	0.003 [0.004]	0.003 [0.003]	0.003 [0.005]
Cohort dummies	No	Yes	No	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−3418	−3416	−13,772	−13,688
LR Chi² (10), LR Chi² (15), LR Chi² (20), LR Chi² (27)	198.37	201.19	1284.86	1452.4

Panel B: Average marginal effects (IV with cohort dummies)	A great deal	A fair amount	Little/not at all
Schooling	0.008 [0.069]	−0.005 [0.044]	−0.003 [0.025]

Note: standard errors are in parentheses.
** Significant at the 5% level.
*** Significant at the 1% level.

Table A2
Ordered probit regression and ordered response IV estimation for pro-environmental actions involving technical changes.

	Bags	Bulbs	Appliances	Styrofoam
Panel A: Ordered probit				
Schooling	0.059 [0.005]***	0.054 [0.005]***	0.058 [0.006]***	0.035 [0.005]***
Female	0.323 [0.037]***	−0.002 [0.036]	0.106 [0.038]***	0.099 [0.037]***
Had environmental problem in community	0.186 [0.041]***	0.072 [0.04]*	0.08 [0.042]*	0.173 [0.04]***
Felt that climate has changed compared to last year	0.219 [0.096]**	0.151 [0.093]*	0.245 [0.094]***	0.092 [0.094]
Heard about climate change	0.077 [0.091]	0.213 [0.088]**	0.527 [0.088]***	−0.046 [0.088]
Log (wage)	−0.001 [0.004]	0.006 [0.004]	0.001 [0.005]	0.005 [0.004]
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−3548	−4050	−3438	−3701
LR Chi² (15)	369.59	260.31	279.83	164.34
Panel B: IV				
Schooling	0.221 [0.092]**	0.056 [0.013]***	0.255 [0.062]***	0.138 [0.141]
Female	0.318 [0.061]***	−0.002 [0.036]	0.142 [0.035]***	0.126 [0.046]***
Had environmental problem in community	0.144 [0.066]**	0.072 [0.04]*	0.047 [0.046]	0.158 [0.055]***
Felt that climate has changed compared to last year	0.17 [0.11]	0.147 [0.093]	0.159 [0.114]	0.082 [0.095]
Heard about climate change	−0.345 [0.287]	0.206 [0.095]**	−0.144 [0.339]	−0.287 [0.349]
Log (wage)	0.002 [0.004]	0.006 [0.004]	0.004 [0.004]	0.006 [0.004]
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−13,819	−14,322	−13,708	−13,982
LR Chi² (30)	1495.18	1430.91	1406.92	1399.41
Average marginal effects: regularly				
Schooling	0.05 [0.025]**	0.021 [0.004]***	0.077 [0.012]***	0.037 [0.038]
Average marginal effects: sometimes				
Schooling	0.018 [0.002]***	−0.004 [0.001]***	−0.014 [0.015]	0.002 [0.004]
Average marginal effects: never				
Schooling	−0.067 [0.024]***	−0.016 [0.004]***	−0.063 [0.027]**	−0.039 [0.042]

Note: standard errors are in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table A3
Ordered probit regression and ordered response IV estimation for pro-environmental actions involving saving behaviours.

	Unplug	Light off	Water off	Water saving
Panel A: Ordered probit				
Schooling	0.016 [0.006]***	0.013 [0.007]*	0.01 [0.006]*	−0.012 [0.006]**
Female	0.12 [0.042]***	0.092 [0.046]**	0.117 [0.04]***	0.074 [0.038]**
Had environmental problem in community	0.093 [0.045]**	0.083 [0.05]*	0.051 [0.043]	0.09 [0.042]**
Felt that climate has changed compared to last year	0.122 [0.103]	−0.025 [0.119]	0.233 [0.097]**	0.111 [0.096]**
Heard about climate change	0.399 [0.095]***	0.335 [0.102]***	0.145 [0.094]	0.204 [0.091]**
Log (wage)	0.012 [0.005]***	0.007 [0.005]	0.001 [0.005]	0.005 [0.004]
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−2606	−1989	−3158	−3500
LR Chi^2 (15)	73.17	76.34	78.54	68.62
Panel B: IV				
Years of schooling	0.081 [0.181]	0.175 [0.135]	0.111 [0.158]	0.204 [0.083]***
Female	0.138 [0.059]**	0.13 [0.045]***	0.143 [0.048]***	0.12 [0.036]***
Had environmental problem in community	0.088 [0.049]*	0.063 [0.056]	0.044 [0.046]	0.054 [0.047]
Felt that climate has changed compared to last year	0.116 [0.105]	−0.028 [0.109]	0.215 [0.109]**	0.068 [0.096]
Heard about climate change	0.235 [0.495]	−0.016 [0.473]	−0.102 [0.415]	−0.359 [0.257]
Log (wage)	0.013 [0.005]***	0.008 [0.005]*	0.002 [0.005]	0.006 [0.004]
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−12,878	−12,260	−13,430	−13,770
LR Chi^2 (30)	1374.11	1379.47	1381.85	1353.65
Average marginal effects: regularly				
Schooling	0.027 [0.059]	0.05 [0.042]	0.039 [0.051]	0.067 [0.02]***
Average marginal effects: sometimes				
SchoolingYears of schooling	−0.023 [0.046]	−0.036 [0.012]***	−0.021 [0.017]	−0.016 [0.012]
Average marginal effects: never				
Schooling	−0.004 [0.014]	−0.013 [0.03]	−0.018 [0.034]	−0.051 [0.032]*

Note: standard errors are in parentheses.
  * Significant at the 10% level.
 ** Significant at the 5% level.
*** Significant at the 1% level.

Table A4
Probit regression and IV estimation for willingness to pay for environmental tax.

	Willingness to pay for tax	
	Probit	IV
Normalised teachers		
Schooling	0.009 [0.007]	−0.132 [0.131]
Female	−0.065 [0.046]	−0.069 [0.044]
Had environmental problem in community	−0.016 [0.049]	−0.041 [0.05]
Had been damaged by natural/environmental disasters	−0.162 [0.081]**	−0.111 [0.102]
Log (wage)	−0.003 [0.007]	0.003 [0.008]
Cohort dummies	Yes	Yes
Regional dummies	Yes	Yes
Average marginal effect: agree		
Schooling		−0.037 [0.038]
Observations	3900	3900
Log likelihood	−1924	−12,308
LR Chi^2 (14), LR Chi^2 (28)	52.04	1357.81

Note: standard errors are in parentheses.
 ** Significant at the 5% level.

Appendix B

Table B1
Ordered probit regression and ordered response IV estimation for pro-environmental actions involving technical changes with no potentially endogenous controls.

	Bags	Bulbs	Appliances	Styrofoam
Panel A: Ordered probit				
Schooling	0.06 [0.005]***	0.056 [0.005]***	0.063 [0.006]***	0.035 [0.005]***
Female	0.315 [0.037]***	−0.006 [0.036]	0.094 [0.038]***	0.095 [0.036]***
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−3563	−4058	−3463	−3721
LR Chi^2 (11)	341.03	245.43	229.9	143.1
Panel B: IV				
Schooling	0.206 [0.093]**	0.269 [0.037]***	0.254 [0.056]***	0.115 [0.133]
Female	0.323 [0.048]***	0.082 [0.039]**	0.142 [0.035]***	0.121 [0.052]**
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−13,875	−14,367	−13,774	−14,033
LR Chi^2 (22)	1384.73	1341.08	1275.71	1296.27
Average marginal effects: regularly				
Schooling	0.046 [0.025]*	0.077 [0.007]***	0.077 [0.011]***	0.032 [0.036]
Average marginal effects: sometimes				
Schooling	0.018 [0.001]***	0.001 [0.003]	−0.015 [0.013]	0.001 [0.003]
Average marginal effects: never				
Schooling	−0.064 [0.024]***	−0.078 [0.01]***	−0.062 [0.024]***	−0.033 [0.039]

Note: standard errors are in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table B2
Ordered probit regression and ordered response IV estimation for pro-environmental actions involving saving behaviours with no potentially endogenous controls.

	Unplug	Light off	Water off	Water saving
Panel A: Ordered probit				
Schooling	0.019 [0.006]***	0.017 [0.007]***	0.012 [0.006]**	−0.01 [0.006]*
Female	0.113 [0.041]***	0.086 [0.046]*	0.113 [0.04]***	0.069 [0.038]*
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−2621.75	−2000.47	−3163.62	−3507.05
LR Chi^2 (11)	42.08	52.55	68.11	55.41
Panel B: IV				
Schooling	0.091 [0.157]	0.172 [0.121]	0.11 [0.141]	0.194 [0.079]**
Female	0.136 [0.059]**	0.13 [0.048]***	0.142 [0.051]***	0.123 [0.037]***
Cohort dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	3900	3900	3900	3900
Log likelihood	−12,934.38	−12,312.72	−13,476.14	−13,818.19
LR Chi^2 (22)	1261.28	1274	1289.68	1258.78
Average marginal effects: regularly				
Schooling	0.031 [0.051]	0.049 [0.038]	0.038 [0.046]	0.065 [0.018]***
Average marginal effects: sometimes				
Schooling	−0.026 [0.037]	−0.036 [0.011]***	−0.021 [0.016]	−0.017 [0.009]*
Average marginal effects: never				
Schooling	−0.005 [0.014]	−0.013 [0.027]	−0.017 [0.03]	−0.048 [0.029]*

Note: standard errors are in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table B3
Probit regression and IV probit estimation for willingness to pay for environmental tax with no potentially endogenous controls.

	Willingness to pay for tax	
	Probit	IV probit
Schooling	0.008 [0.007]	−0.131 [0.125]
Female	−0.064 [0.046]	−0.07 [0.043][*]
Cohort dummies	Yes	Yes
Regional dummies	Yes	Yes
Average marginal effect: agree		
Schooling		−0.037 [0.036]
Observations	3900	3900
Log likelihood	−1926.37	−12,317.99
LR Chi^2 (11), LR Chi^2 (22)	47.62	1339.14

Note: standard errors are in parentheses.
[*] Significant at the 10% level.

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