Journal for Nature Conservation 55 (2020) 125830

Contents lists available at ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.com/locate/jnc

Women in parliament and deforestation: cross-country evidence

Raufhon Salahodjaev[a,b], Dilyafruz Jarilkapova[b]

[a] ERGO Analytics, Uzbekistan
[b] Westminster International University in Tashkent, Uzbekistan

ARTICLE INFO

Keywords:
Deforestation
Women in parliament
Forest cover
U-shaped

ABSTRACT

The aim of this study is to contribute to the empirical literature on the antecedents of deforestation. Specifically, we investigate the relationship between female parliamentarism and forest cover change. Based on annual data from more than 176 countries between 1990 and 2015, the estimates suggest that the proportion of women in parliament has a significant U-shaped association with per capita forest cover. In particular, the nation-states with a critical mass of female legislators above 38 % should experience increases in per capita forest cover.

1. Introduction

There has been an immense increase in empirical and policy interest in researching deforestation at national and cross-national levels. The body of research has grown rapidly and has studied many aspects of deforestation, including the correlates, antecedents and consequences of clear-cutting. Indeed, research on the determinants of deforestation can be categorised into three distinct groups. The first is the role of economic development in deforestation processes, which has been comprehensively explored (Bhattarai & Hammig, 2004; Culas, 2007; Koop & Tole, 1999, 2001; Mather, Needle, & Fairbairn, 1999; Scrieciu, 2007). These studies have broadly concluded that 'in the early stages of economic growth [deforestation] increases, but beyond some level of [GDP per person] …the trend reverses, so that at high income levels economic growth leads to [reforestation]', the environmental Kuznets curve (EKC) hypothesis (Stern, 2004, p. 1419). Higher national wealth and economic development are projected to decrease pressure on forest cover by creating greater prospects for off-farm employment. Citizens in high-income nations may also claim that ruling elites protect forests rather than clear-cutting them. Conversely, economic growth may also increase deforestation in low-income countries due to greater demand for agricultural and timber products (Cuaresma et al., 2017).

A second avenue of empirical studies explores the relationship between institutions and political regimes and deforestation (Mak Arvin & Lew, 2011; Winslow, 2005; Didia, 1997). Overall, the evidence is mixed. While some studies have reported that democratisation reduces deforestation rates (Rydning Gaarder & Vadlamannati, 2017), others have argued that democracy is positively (Martinez, Crenshaw, & Jenkins, 2002) or non-linearly associated with deforestation (Buitenzorgy & Mol, 2011; Obydenkova, Nazarov, & Salahodjaev, 2016).

The third branch of research on the underlying causes of deforestation focuses on population pressure (Krishnadas, Agarwala, Sridhara, & Eastwood, 2018; Vieilledent et al., 2018). Analytical models of deforestation propose that deforestation rates may increase as growing populations require more land for agriculture, and in more populous countries, there are fewer off-farm employment prospects due to an oversupply of inexpensive labour. By contrast, the empirical literature states that 'the effect of population growth on deforestation rate may be uneven across countries' (Jha & Bawa, 2006, p. 910). While some studies have reported that population growth is positively associated with the deforestation rate (Rock, 1996), other studies have found that population growth is negatively (Inman, 1993) or insignificantly related to deforestation (Palo, 1994; Cropper and Griffiths, 1994).

Concurrently, an independent stream of literature in the field of development has emerged that investigates the cross-country correlates of female parliamentarism. While these papers link female parliamentarians to economic growth (Jayasuriya & Burke, 2013), a decrease in corruption (Dollar, Fisman, & Gatti, 2001), and subjective wellbeing (York & Bell, 2014), no study has explored the relationship between the proportion of women in parliament and deforestation. That is the aim of this research. If female parliamentarism is a strong predictor of sustainable development, we predict a positive impact of female political empowerment on reforestation and a negative impact on deforestation.

Many arguments predict a strong correlation between female political empowerment and decreasing global deforestation. First, a large body of empirical evidence demonstrates that women are more likely to express greater anxiety with respect to the environment than men (Hunter, Hatch, & Johnson, 2004; Schahn & Holzer, 1990). For example, Franzen and Vogl (2013) investigated the antecedents of environmental concern using data from 33 countries. Their study found

E-mail address: salahodjaev25@gmail.com (R. Salahodjaev).

https://doi.org/10.1016/j.jnc.2020.125830
Received 31 December 2018; Received in revised form 26 September 2019; Accepted 8 April 2020

that female respondents were more likely to report greater environmental concerns, and this held true even after controlling for education, income, age and political preferences. Sturgeon (1997) offered an explanation for this relationship by introducing the concept of ecofeminism. In his study, he suggested that 'most simply put, ecofeminism is a movement that makes connections between environmentalisms and feminisms: more precisely, it articulates the theory that the ideologies that authorize injustices based on gender, race and class are related to the ideologies that sanction the exploitation and degradation of the environment' (Sturgeon, 1997, p. 25). Indeed, there is evidence from various global regions that women have historically been an integral part of environmental movements (Rocheleau, Thomas-Slayter, & Wangari, 1996). For example, women have participated in resistance movements against toxic waste dumping (Miller, Hallstein, & Quass, 1996; Bru-Bistuer, 1996) and the clear-cutting of forests (Watls-Walter, 1996). This was documented within the Chipko movement, a non-violent social and ecological movement by rural villagers, particularly women, in India in the 1970s aimed at protecting trees and forests slated for government-backed logging. It is likewise visible in the Kenyan Greenbelt Movement, an environmental organisation that empowers communities, particularly women, to improve livelihoods by conserving the environment. These two cases serve as clear evidence that women possess greater environmental values and are more concerned with environmental problems than men, shaping the ideology of ecofeminism (Shiva, 1989).

Moreover, it is well established in the field of political economy that the proportion of women in parliament is positively associated with the quality of government institutions (Chen, 2013). For example, using data from more than 100 countries, Dollar et al. (2001) investigated the association between female participation in government legislatures and the level of perceived corruption. Their study demonstrates that higher rates of female participation in government are associated with lower levels of corruption. In addition, research has revealed that supportive attitudes (Eagly & Crowley, 1986), electoral support for candidates with social agendas (Goertzel, 1983) and higher levels of honesty (Grosch & Rau, 2017) are observed more frequently among women than men. In turn, rampant corruption, weak rule of law and a lack of government integrity are all among the underlying causes of deforestation in both developed and developing countries (Koyuncu & Yilmaz, 2009, 2013; Mendes, Junior, & Tourrucôo, 2016). Therefore, it is possible that countries with higher rates of female participation in government legislatures are more likely to implement pro-environmental policies and, as a result, have lower rates of deforestation. Indeed, Norgaard and York (2005, p. 508) have argued that 'if women tend to be more environmentally progressive, the inclusion of women as equal members of society—as voters, citizens, policy makers, and social movement participants—should positively influence state behaviour' (Clots-Figueras, 2011). In their study, the authors demonstrated that countries with a greater share of women in national parliaments are more likely to sign and ratify multilateral environmental agreements.

Therefore, the main contribution of this research is to offer first empirical estimates of the link between female participation in government legislatures and forest cover change, using data from both developed and developing countries. The empirical analysis indicates that the share of women in national parliaments has a U-shaped association with forest cover change. In particular, in countries at the early stages of female political empowerment, deforestation rises as society becomes more equal. By contrast, after society attains a certain level of female political empowerment, an increase in the share of women in parliament leads to an increase in per capita forest cover.

The remainder of this study is organised as follows: Section 2 discusses data and methods, Section 3 presents our main results, Section 4 carries out robustness tests and Section 7 concludes the paper.

2. Data and methods

2.1. Period

The body of research on the causes of deforestation has been growing since the beginning of the 1990s, and most such studies have relied on panel data analysis. In accordance with these papers, our study builds on the panel data framework to analyse whether an increase in the share of women in parliamentary seats ensures lower deforestation. Thus, we rely on a fixed effects regression in our analysis. The dependent variable in this study is per capita forest cover from 1990 to 2015. A number of factors determined the selection of this particular time frame. Based on the most current data, it is possible to revisit the findings of earlier studies with respect to conventional antecedents of deforestation. In addition, the quantity and quality of data on forest cover change has significantly improved over the past two decades. For instance, 'as of 2014, 112 countries representing about 83 % of the global forest area reported that they had carried out or had an ongoing national forest assessment, of which most had been done or had been updated during the last five years' (FAO, 2016, p. 4). It is noteworthy that our study also covers former Soviet states that became independent in 1990's and are particularly heterogeneous in their forest cover and female representation in parliament. Finally, this period also takes into account the consequences of the globalisation processes that have exerted a significant influence on cultural values (Berggren & Nilsson, 2015), institutions (Li & Reuveny, 2003) and the environment (Baek, Cho, & Koo, 2009).

2.2. Sample

Our sample covers 177 nations for which data was available. These states were categorised as low-, middle- and high-income economies according to the World Bank.

2.3. Dependent variable: per capita forest cover

The dependent variable in our study is per capita forest cover from 1990 to 2015. We divide forest cover by population levels to compare forest stocks across countries. This variable has been recently used in the empirical literature on the determinants of deforestation (Wang et al., 2007; Murtazashvili, Murtazashvili, & Salahodjaev, 2019; Cai, Murtazashvili, Murtazashvili, & Salahodjaev, 2019). We calculated this data from the World Bank's World Development Indicator (WDI) dataset. FAO (2016) has reported that the average per capita forest area decreased from 0.8 ha to 0.6 ha from 1990 to 2015. In our study, per capita forest cover ranged from 0 ha in San Marino to 0.38 ha in Suriname.

2.4. Independent variable: female representation in policymaking

Our key independent variable is the proportion of seats held by women in national parliaments. This variable captures the political empowerment of women within a nation. The data for our sample was taken from the World Bank. The average percentage of female parliamentarians between 1990 and 2015 ranged from 0% in United Arab Emirates, Qatar and Tonga to 63.8 % in Rwanda. A number of studies have demonstrated the importance of a female presence in parliament because of women's significant support for education spending (Clots-Figueras, 2011), infrastructure investments (Chattopadhyay & Duflo, 2004), lower corruption (Chen, 2013), public health expenditures (Mavisakalyan, 2014) and lower child mortality rates (Miller, 2008). In our study, we also included the squared term of the proportion of women in parliamentary seats for two purposes. The first was to test whether a non-linear relationship exists between female parliamentarism and forest cover change. The second was to test the so-called 'critical mass' hypothesis coined by the United Nations (UN). According

to the UN (2003, p. 2), 'if women are represented in sufficiently large numbers in the decision-making arena (constituting what has been termed a "critical mass", estimated at a level of at least 30–35 % in decision-making bodies), they have a visible impact on the style and content of political decisions'.

In accordance with this statement, our study found a U-shaped association between the proportion of women in parliament and per capita forest cover, with the turning point above 30 %. This implies that attaining a critical mass of female political representatives is instrumental in influencing the passage of environmental policy.

2.5. Control variables

In this study, we included controls for deforestation as well as other underlying institutional and economic factors that, in accordance with extant studies, are most likely to impact the link between women in parliament and deforestation. Economic development is universally associated with lower levels of societal inequality. For example, economic growth is negatively linked with happiness inequality (Clark, Flèche, & Senik, 2016) and gender inequality (Eastin & Prakash, 2013). Similarly, the relationship between economic development and deforestation has been widely examined through the EKC hypothesis (Choumert, Motel, & Dakpo, 2013; Cuaresma et al., 2017; Culas, 2007), which was initially posed by Kuznets (1955). To account for the role of the EKC in deforestation, we controlled for **gross domestic product (GDP) per capita** and its squared term from the World Bank in our study. To account for the effect of political institutions on deforestation and female parliamentarism, we also included a **democracy index** and its squared term in our analysis (Buitenzorgy & Mol, 2011; Obydenkova et al., 2016). The democracy index is measured as an average of civil rights and political liberties and ranges from 1 (autocratic) to 7 (democratic); the data was taken from Freedom House.

Trade openness has been linked to deforestation in cross-national studies (López & Galinato, 2005; Tsurumi & Managi, 2014). In our study, **trade openness** was measured as a sum of exports and imports and expressed as a percentage of GDP (with data from the World Bank). Studies have revealed that the forest cover of a particular region can only be retained when the population density of that region is low. In such a case, it is possible to keep forest cover intact as the population can be sustained on non-timber forest products rather than by resorting to agriculture. We constructed the **population density** by dividing the total population by the total area expressed in thousands of square kilometres. The data for total population and total area came from the World Bank. Table 1 presents descriptive statistics for our main variables.

2.6. Model

The main aim of this study is to assess the relationship between the proportion of women in parliament and deforestation. To reach this goal, the following econometric model was estimated:

$$FOREST_{i,t} = \alpha_0 + \alpha_1 WOMEN_{i,t} + X_{i,t}\lambda + e_{i,t} \quad (1)$$

where *FOREST* is per capita forest cover, *i* and *t* represent the country and year, *WOMEN* is the share of women in parliament, *X* is a set of control variables and *e* is an error term.

Table 2
Bivariate regressions: forest cover per capita.

	(1)	(2)	(3)	(4)
Women in parliament	−0.021***	−0.018***	−0.044***	−0.016***
	(0.001)	(0.001)	(0.003)	(0.001)
Women in parliament squared	0.000***	0.000***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	−5.595***	−6.020***	−5.263***	−5.470***
	(0.009)	(0.014)	(0.031)	(0.010)
N	3461	1013	527	1921
adj. R^2	0.171	0.152	0.343	0.148

Standard errors in parentheses.
*p < 0.1, ** p < 0.05, *** p < 0.01.

3. Main results

Table 2 presents the preliminary empirical results of our estimation of the bivariate model for the full sample of 189 countries and for the sub-samples. Column 1 displays the coefficients for all countries. We found that the estimates for the share of women in parliament were negative and significant while the estimates for the squared term of the share of women in parliament were positive and significant. This implies that there is a U-shaped association between female parliamentarism and forest cover change. In countries at the early stages of female political empowerment, deforestation rises as society ascends the equality ladder. By contrast, after a society attains a certain level of female political empowerment, an increase in the share of women in parliament leads to an increase in per capita forest cover. We next split our sample into three sets of country clusters: low income (column 2), middle income (column 3) and high income (column 4). Here as well, the U-shaped association between female parliamentarism and per capita forest cover was highly significant.

However, the bivariate correlations that are presented in Table 2 should be interpreted with caution as the proportion of seats occupied by women in parliament and forest cover change may be correlated with other socio-economic variables. The bivariate regressions reported above may thus reflect spurious correlations. Consequently, the major research inquiry of this study was to determine whether the effect of female political empowerment on forest cover change persists even after accounting for the other determinants of deforestation. We therefore report the main results of this empirical exercise in Table 3.

Column 1 presents the parameters for estimating Eq. (1), where only the proportion of women in parliament and GDP per capita are added as independent variables. As anticipated, both female parliamentarism and economic development significantly predicted forest cover change. As estimates for women in parliament and women in parliament squared were significantly negative and positive, respectively, the U-shaped association between female parliamentarism and forest cover change was observed across developed and developing countries. Moreover, we did find strong support for the existence of the Kuznets curve. Indeed, according to our estimates, the turning point of the Kuznets curve occurs at a GDP per capita approximately equal to

Table 1
Descriptive statistics.

Variable	Description	Mean	SD	Min	Max
Forest per capita	Sq. km forest cover per person	0.01	0.03	0.00	0.38
Women in parliament	Proportion of seats held by women in national parliaments (%)	15.51	10.77	0.00	63.80
GDP per capita	GDP per capita, PPP (constant 2011 international $)	15.11	18.49	0.25	137.16
Democracy	Democracy index, average of political rights and civil liberties	4.55	2.00	1.00	7.00
Trade	Trade as % of GDP	87.13	52.82	0.02	531.74
Population density	Population density ('000 people per sq. km of land area)	0.37	1.81	0.00	21.40

Table 3
Main results.

	(1)	(2)	(3)	(4)
Women in parliament	−0.018***	−0.019***	−0.019***	−0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
Women in parliament squared	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	−1.488***	−1.449***	−1.380***	−1.553***
	(0.101)	(0.101)	(0.107)	(0.108)
GDP per capita squared	0.078***	0.075***	0.071***	0.082***
	(0.006)	(0.006)	(0.006)	(0.006)
Democracy		−0.066***	−0.059***	−0.054***
		(0.016)	(0.017)	(0.017)
Democracy squared		0.008***	0.007***	0.007***
		(0.002)	(0.002)	(0.002)
Trade openness			−0.019	−0.016
			(0.011)	(0.011)
Population density				−0.287***
				(0.033)
Constant	1.384***	1.326***	1.145**	1.870***
	(0.448)	(0.450)	(0.475)	(0.477)
N	3335	3319	3174	3161
adj. R^2	0.234	0.237	0.225	0.246

Standard errors in parentheses.
** p < 0.05, *** p < 0.01.

Table 5
Robustness test: alternative time periods.

	(1)	(2)
Women in parliament	−0.015***	−0.012***
	(0.001)	(0.001)
Women in parliament squared	0.000***	0.000***
	(0.000)	(0.000)
GDP per capita	−0.738***	−2.307***
	(0.117)	(0.120)
GDP per capita squared	0.038***	0.122***
	(0.007)	(0.007)
Democracy	−0.103***	0.016
	(0.016)	(0.017)
Democracy squared	0.010***	−0.000
	(0.002)	(0.002)
Trade openness	−0.051***	−0.000
	(0.013)	(0.010)
Population density	−0.295***	−0.344***
	(0.044)	(0.034)
Constant	−1.565***	5.056***
	(0.513)	(0.537)
N	2169	2474
adj. R^2	0.168	0.267
Time	1990 − 2010	2000 − 2015

Standard errors in parentheses.
* p < 0.1, ** p < 0.05, *** p < 0.01.

38,000 international PPP USD, which is approximately equal to the level of France in our sample. This implies that 'in the early stages of economic growth [deforestation] increases, but beyond some level of income per capita, the trend reverses, so that at high income levels economic growth leads to environmental improvement' (Stern, 2004, p. 1419).

In column 2, the democracy index and its squared term are further added to our empirical model. We found that estimates for democracy and democracy squared were significantly negative and positive, respectively, suggesting an EKC association between clear-cutting and democracy. As suggested by Buitenzorgy and Mol (2011, p. 68), 'the EKC relationship between deforestation and democracy suggests that in earlier stages of democracy, deforestation rates increase as countries move toward higher levels of democracy. However, after reaching a certain level of democracy, more democracy leads to a lower rate of deforestation'. The relationship between female parliamentarism and forest cover change was unaffected even after we took into account the role of democracy.

In column 3, trade openness is included in the model. The estimate for trade openness was negative and significant. A 10 % increase in trade would lead to a nearly 0.3 % decrease in annual forest cover change. This may suggest that in developing countries where property rights with respect to forests are poorly defined, greater trade integration would foster an overexploitation of commonly owned resources

Table 4
Robustness test: alternative controls.

	(1)	(2)	(3)	(4)	(5)
Women in parliament	−0.018***	−0.017***	−0.016***	−0.015***	−0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Women in parliament squared	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Life expectancy	−0.091***	−0.094***	−0.090***	−0.092***	−0.054***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)
Life expectancy squared	0.001***	0.001***	0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Polit IV	−0.038***	−0.035***	−0.041***	−0.045***	−0.015***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)
Polit IV squared	0.003***	0.003***	0.004***	0.004***	0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Population density	−0.170***	−0.173***	−0.166***	−0.163***	−0.035
	(0.029)	(0.029)	(0.028)	(0.029)	(0.018)
Exports		0.000	0.001	0.001**	−0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Rents		−0.002***	−0.002***	−0.003***	−0.001***
		(0.000)	(0.001)	(0.001)	(0.000)
KOF			−0.002***	−0.002***	−0.000
			(0.000)	(0.000)	(0.000)
Agriculture				−0.001	−0.001**
				(0.001)	(0.001)
cons	−1.698***	−1.647***	−1.828***	−1.752***	0.087
	(0.172)	(0.177)	(0.179)	(0.185)	(0.119)
N	2850	2740	2579	2438	2438
adj. R^2	0.461	0.450	0.448	0.432	0.067

Standard errors in parentheses.
** p < 0.05, *** p < 0.01.

Table 6
Robustness test: per sq. km forest cover.

	(1)	(2)	(3)	(4)
Women in parliament	−0.004***	−0.005***	−0.005***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Women in parliament squared	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	−0.380***	−0.350***	−0.408***	−0.417***
	(0.055)	(0.056)	(0.059)	(0.060)
GDP per capita squared	0.023***	0.022***	0.025***	0.026***
	(0.003)	(0.003)	(0.003)	(0.003)
Democracy		−0.034***	−0.033***	−0.033***
		(0.009)	(0.009)	(0.009)
Democracy squared		0.005***	0.004***	0.004***
		(0.001)	(0.001)	(0.001)
Trade openness			0.010	0.010
			(0.006)	(0.006)
Population density				−0.021
				(0.018)
Constant	−0.109	−0.192	0.014	0.052
	(0.246)	(0.247)	(0.262)	(0.264)
N	3322	3306	3161	3161
adj. R^2	0.01	0.01	0.01	0.01

Standard errors in parentheses.
** p < 0.05, *** p < 0.01.

Table 7
Robustness test: Controlling for other gender empowerment measures.

	(1)	(2)
Women in parliament	−0.013***	−0.006***
	(0.001)	(0.001)
Women in parliament squared	0.000***	0.000***
	(0.000)	(0.000)
GDP per capita	−1.757***	−0.727***
	(0.111)	(0.065)
GDP per capita squared	0.098***	0.044***
	(0.006)	(0.004)
Democracy	−0.067***	−0.023**
	(0.016)	(0.009)
Democracy squared	0.008***	0.003***
	(0.002)	(0.001)
Trade openness	−0.016	−0.000
	(0.010)	(0.006)
Population density	−0.951***	0.343***
	(0.093)	(0.055)
Female enrolment	−0.003***	−0.000
	(0.000)	(0.000)
Female in labour force	−0.010***	−0.003***
	(0.001)	(0.001)
Constant	3.076***	1.433***
	(0.505)	(0.297)
N	2627	2627
adj. R^2	0.353	0.050
Dependent variable	Forest cover per capita	Forest cover per sq. km

Standard errors in parentheses.
* p < 0.1, ** p < 0.05, *** p < 0.01.

such as forests (Ferreira, 2004).

Finally, column 5 accounts for the role of population density in environmental processes. This variable was intended to capture the effects of population pressure on forest cover and was negative and significant. Coefficients for both women in parliament and women in parliament squared remained significant. According to our estimates, the turning point of the female parliamentarian curve occurs when the proportion of women in parliament reaches approximately 38 % of total seats, which is near the level of Denmark in our sample. That turning point exceeds that which has been suggested by the UN (i.e., 30 % of legislative seats occupied by women). This indicates that the nation-states with a critical mass of female legislators above 38 % will

Table 8
Robustness test: controlling for the effect of institutions.

	(1)	(2)	(3)
Women in parliament	−0.008***	−0.013***	−0.007***
	(0.001)	(0.001)	(0.001)
Women in parliament squared	0.000**	0.000***	0.000**
	(0.000)	(0.000)	(0.000)
GDP per capita	−2.218***	−2.050***	−2.367***
	(0.121)	(0.115)	(0.126)
GDP per capita squared	0.123***	0.107***	0.129***
	(0.007)	(0.006)	(0.007)
CPI	−0.004***		−0.004***
	(0.000)		(0.000)
CPI squared	0.000***		0.000***
	(0.000)		(0.000)
Rule of law		0.093***	0.038***
		(0.013)	(0.014)
cons	4.030***	4.044***	4.802***
	(0.544)	(0.516)	(0.570)
N	2381	2609	2217
adj. R^2	0.326	0.275	0.334

Notes: Standard errors in parentheses; Democracy, democracy squared, trade openness and population density are included but not reported to converse space; ** p < 0.05, *** p < 0.01.

experience increases in per capita forest cover. The UN's critical mass hypothesis appears to be confirmed by our econometric results.

The results in Table 3 suggest that the non-linear relationship between the share of women in parliament and forest cover is robust to the inclusion of different control variables to the forest cover equation.

4. Robustness tests

This section of our analysis evaluates the robustness of the main results. We present several robustness tests: firstly, we incorporate a series of alternative deforestation drivers; secondly, we test the link between the proportion of women in parliament and forest cover using alternative time periods.

As seen in Table 4, to check the robustness of our main findings, we used an alternative vector of control variables. In column 1, we replace GDP per capita with life expectancy (with data from the World Bank). Gross domestic product per capita is estimated based on monetary values and prices; thus, it fails to adequately capture quality of life. For example, it does not take into account environmental degradation and the economic role of women in society, such as unpaid work in the home and volunteering. In addition, we replaced the democracy index from Freedom House with the democracy index from the POLIT IV project.[1] This index captures three instrumental aspects of democracy: political participation, political competition and executive constraints. Again, we found that social development and democracy have a U-shaped association with the forest cover change.

In column 2, we include exports and natural resource rents as percentages of GDP (all data from the World Bank) to capture the dependence of the economy on natural resource extraction. Once more, exports were insignificant, while dependence on natural resources had a significant negative effect on forest cover. In columns 3 and 4, we add a KOF index of globalisation[2] and agriculture as a share of GDP (from the World Bank). Of these two variables, only globalisation had a significant negative association with forest cover change.

Finally, in column 5, we re-estimate Eq. (1) now for for forest cover per square kilometre, as our alternative dependent variable. Throughout all regressions, the proportion of seats occupied by women in parliament again had a U-shaped association with forest cover

[1] See for details http://www.systemicpeace.org/inscr/p4manualv2013.pdf
[2] The data for KOF index is from https://www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html

change.

In order to test whether our main results were driven by some particular period in our sample, we re-estimated our main model by changing the observation periods, as displayed in Table 5. The results for female parliamentarism and the main controls were similar to those displayed in Tables 3.

As another robustness check, we estimated Eq. (1) by introducing forest cover per square kilometre as our alternative dependent variable (see Table 6). A comparison of these results with the coefficients in Table 3 suggests that there is little difference in the association between female parliamentarism and forest cover when we normalise forest cover per capita versus per square kilometre. The non-linear (U-shaped) relationship between the proportion of women in parliament and forest cover per square kilometre is significant across all regressions in Table 6. The turning point for the proportion of women in parliament with respect to forest cover per square kilometre is now approximately 27 %. With respect to control variables, one exception for this is population density, which is significantly related only to per capita forest cover.

One can argue that the share of women in parliament may simply capture the overall effect of female empowerment on forest cover change. Therefore, to resolve this issue we re-estimated our baseline results by including the female labour force participation rate and female school secondary enrolment to capture the effects of female participation in the labour force and female representation in society. The results are reported in Table 7. Once more, we found that the share of women in parliament was significantly and non-linearly related to forest cover change with respect to both per capita forest cover (column 1) and forest cover per square kilometre (column 2).

It is possible that female participation in government influences other institutional dimensions, which then have an impact on deforestation. For example, the proportion of women in parliamentary seats has been proven to be correlated with anti-corruption policies (Chen, 2013) and government effectiveness (Dollar et al., 2001). Thus, as displayed in Table 8, we additionally controlled for the Corruption Perceptions Index from Transparency International (column 1) and the Rule of Law Index from the World Bank (column 2). After we controlled for both these variables, we still observed that the proportion of women in parliamentary seats was significantly and non-linearly related to per capita forest cover (see column 3).

5. Conclusion

Earlier research on deforestation has highlighted economic development, population pressure and institutions as deep roots of deforestation across developing and developed countries. This research moves beyond the existing literature by investigating the association between female equality in legislature on the reduction of deforestation rates.

Our paper contributes to the literature on the consequences of female parliamentarism for important socio-economic outcomes by considering how representation of women in parliaments relates to deforestation. We find that increased female political empowerment is crucial to the reduction of deforestation levels in both developing and developed nations with different income levels. These results support what the UN calls the “critical mass hypothesis” relating female representation to forward-looking social outcomes.

Our study also provides evidence of a nonlinear effect of parliamentarian representation on different economic groups. We showed that economic development is non-linearly linked to deforestation rates, following Environmental Kuznets Curve-type pattern. The U-shaped relationship whereby deforestation declines with increasing representation, increases, and then begins to decline at higher levels of female participation in national parliaments is also robust to additional theoretically relevant control variables. Our evidence thus shows that female participation in national parliaments reduces deforestation through its effect on advocacy and implementation of pro-forest policies, but also that the effects depend in important ways on the overall level of economic development.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jnc.2020.125830.

References

Baek, J., Cho, Y., & Koo, W. W. (2009). The environmental consequences of globalization: A country-specific time-series analysis. *Ecological Economics, 68*(8–9), 2255–2264.

Berggren, N., & Nilsson, T. (2015). Globalization and the transmission of social values: The case of tolerance. *Journal of Comparative Economics, 43*(2), 371–389.

Bhattarai, M., & Hammig, M. (2004). Governance, economic policy, and the environmental Kuznets curve for natural tropical forests. *Environment and Development Economics, 9*(3), 367–382.

Bru-Bistuer, J. (1996). Spanish women against industrial waste. A gender perspective on environmental grassroots movements. In Dianne Teoksessa Rocheleau, Barbara Thomas Slayter, & Esther Wangari (Eds.). *Feminist political ecology. Global issues and local experiences* (pp. 105–124). London: Routledge.

Buitenzorgy, M., & Mol, A. P. (2011). Does democracy lead to a better environment? Deforestation and the democratic transition peak. *Environmental & Resource Economics, 48*(1), 59–70.

Cai, M., Murtazashvili, I., Murtazashvili, J., & Salahodjaev, R. (2019). Individualism and governance of the commons. *Public Choice,* 1–21.

Chattopadhyay, R., & Duflo, E. (2004). Women as policy makers: Evidence from a randomized policy experiment in India. *Econometrica, 72*(5), 1409–1443.

Chen, L. J. (2013). Do female politicians influence public spending? *Evidence from Taiwan. International Journal of Applied Economics, 10*(2), 32–51.

Choumert, J., Motel, P. C., & Dakpo, H. K. (2013). Is the Environmental Kuznets Curve for deforestation a threatened theory? A meta-analysis of the literature. *Ecological Economics, 90*, 19–28.

Clark, A. E., Flèche, S., & Senik, C. (2016). Economic growth evens out happiness: Evidence from six surveys. *The Review of Income and Wealth, 62*(3), 405–419.

Clots-Figueras, I. (2011). Women in politics: Evidence from the indian states. *Journal of Public Economics, 95*(7–8), 664–690.

Cropper, M., & Griffiths, C. (1994). The interaction of population growth and environmental quality. *The American Economic Review, 84*(2), 250–254.

Cuaresma, J. C., Danylo, O., Fritz, S., McCallum, I., Obersteiner, M., See, L., et al. (2017). Economic development and forest cover: Evidence from satellite data. *Scientific Reports, 7*, 40678.

Culas, R. J. (2007). Deforestation and the environmental Kuznets curve: An institutional perspective. *Ecological Economics, 61*(2-3), 429–437.

Didia, D. O. (1997). Democracy, political instability and tropical deforestation. *Global Environmental Change Part A, 7*(1), 63–76.

Dollar, D., Fisman, R., & Gatti, R. (2001). Are women really the “fairer” sex? Corruption and women in government. *Journal of Economic Behavior & Organization, 46*(4), 423–429.

Eagly, A. H., & Crowley, M. (1986). Gender and helping behavior: A meta-analytic review of the social psychological literature. *Psychological Bulletin, 100*(3), 283.

Eastin, J., & Prakash, A. (2013). Economic development and gender equality: Is there a gender Kuznets curve? *World Politics, 65*(1), 156–186.

FAO (2016). *Global Forest Resources Assessment 2015: How are the world’s forests changing?* (second edition). .

Ferreira, S. (2004). Deforestation, property rights, and international trade. *Land Economics, 80*(2), 174–193.

Franzen, A., & Vogl, D. (2013). Two decades of measuring environmental attitudes: A comparative analysis of 33 countries. *Global Environmental Change Part A, 23*(5), 1001–1008.

Goertzel, T. D. (1983). The gender gap: Sex, family income, and political opinions in the1980s. *Journal of Political and Military Sociology, 11*, 209–222.

Grosch, K., & Rau, H. A. (2017). Gender differences in honesty: The role of social value orientation. *Journal of Economic Psychology, 62*, 258–267.

Hunter, L. M., Hatch, A., & Johnson, A. (2004). Cross-national gender variation in environmental behaviors. *Social Science Quarterly, 85*, 677–694.

Inman, K. (1993). Fueling expansion in the third world: Population, development, debt, and the global decline of forests. *Society & Natural Resources, 6*(1), 17–39.

Jayasuriya, D. S., & Burke, P. J. (2013). Female parliamentarians and economic growth: Evidence from a large panel. *Applied Economics Letters, 20*(3), 304–307.

Jha, S., & Bawa, K. S. (2006). Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology, 20*(3), 906–912.

Koop, G., & Tole, L. (2001). Deforestation, distribution and development. *Global Environmental Change Part A, 11*(3), 193–202.

Koop, G., & Tole, L. (1999). Is there an environmental Kuznets curve for deforestation? *Journal of Development Economics, 58*(1), 231–244.

Koyuncu, C., & Yilmaz, R. (2009). The impact of corruption on deforestation: A cross-country evidence. *Journal of Developing Areas, 42*(2), 213–222.

Koyuncu, C., & Yilmaz, R. (2013). Deforestation, corruption, and private ownership in the forest sector. *Quality & Quantity, 47*(1), 227–236.

Krishnadas, M., Agarwala, M., Sridhara, S., & Eastwood, E. (2018). Parks protect forest

cover in a tropical biodiversity hotspot, but high human population densities can limit success. *Biological Conservation, 223*, 147–155.
Kuznets, S. (1955). Economic growth and income inequality. *The American Economic Review, 45*(1), 1–28.
Li, Q., & Reuveny, R. (2003). Economic globalization and democracy: An empirical analysis. *British Journal of Political Science, 33*(1), 29–54.
López, R., & Galinato, G. I. (2005). Trade policies, economic growth, and the direct causes of deforestation. *Land Economics, 81*(2), 145–169.
Mak Arvin, B., & Lew, B. (2011). Does democracy affect environmental quality in developing countries? *Applied Economics, 43*(9), 1151–1160.
Martinez, K., Crenshaw, E. M., & Jenkins, J. C. (2002). Deforestation and the environmental Kuznets curve: A cross-national investigation of intervening mechanisms. *Social Science Quarterly, 83*(1), 226–243.
Mather, A. S., Needle, C. L., & Fairbairn, J. (1999). Environmental Kuznets curves and forest trends. *Geography,* 55–65.
Mavisakalyan, A. (2014). Women in cabinet and public health spending: Evidence across countries. *Economics of Governance, 15*(3), 281–304.
Mendes, C., Junior, S., & Tourrucôo, F. (2016). Corruption and Deforestation: A differential game model. *Business and Economic Research, 6*(1), 481–491.
Miller, G. (2008). Women's suffrage, political responsiveness, and child survival in American history. *The Quarterly Journal of Economics, 123*(3), 1287–1327.
Miller, V., Hallstein, M., & Quass, S. (1996). Feminist politics and environmental justice. Women's community activism in West Harlem, New York. In Dianne Teoksessa Rocheleau, Barbara Thomas Slayter, & Esther Wangari (Eds.). *Feminist political ecology. Global issues and local experiences* (pp. 62–85). London: Routledge.
Murtazashvili, I., Murtazashvili, J., & Salahodjaev, R. (2019). Trust and deforestation: A cross-country comparison. *Forest Policy and Economics, 101*, 111–119.
Norgaard, K., & York, R. (2005). Gender equality and state environmentalism. *Gender & Society, 19*(4), 506–522.
Obydenkova, A., Nazarov, Z., & Salahodjaev, R. (2016). The process of deforestation in weak democracies and the role of Intelligence. *Environmental Research, 148*, 484–490.
Palo, M. (1994). Population and deforestation. In K. BROWN, & D. W. PEARCE (Eds.). *The causes of tropical deforestation. The economic and statistical analysis of factors giving rise to the loss of the tropical forests* (pp. 42–56). London: University College London Press Ltd.
Rocheleau, D., Thomas-Slayter, B., & Wangari, E. (1996). *Feminist political ecology. Global issues and local experiences*. London: Routledge.
Rock, M. T. (1996). The stork, the plow, rural social structure and tropical deforestation in poor countries? *Ecological Economics, 18*(2), 113–131.
Rydning Gaarder, A., & Vadlamannati, K. C. (2017). Does democracy guarantee (de) forestation? An empirical analysis. *International Area Studies Review, 20*(2), 97–121.
Schahn, J., & Holzer, E. (1990). Studies of individual environmental concern: The role of knowledge, gender and background variables. *Environment and Behavior, 22*, 767–786.
Scrieciu, S. S. (2007). Can economic causes of tropical deforestation be identified at a global level? *Ecological Economics, 62*(3-4), 603–612.
Shiva, V. (1989). *Staying alive: Women, ecology and development.* London: Zed Press.
Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World Development, 32*(8), 1419–1439.
Sturgeon, N. (1997). *Ecofeminist natures: Race, gender, feminist theory and political action.* New York: Routledge.
Tsurumi, T., & Managi, S. (2014). The effect of trade openness on deforestation: Empirical analysis for 142 countries. *Environmental Economics and Policy Studies, 16*(4), 305–324.
UN (2013). *United Nations targets for proportion of women in leadership and decision-making positions. INFORMATION PAPER LC Paper No. CB(2)1636/02-03(01).* Retrieved on April, 22. 2020 from https://www.legco.gov.hk/yr02-03/english/panels/ha/papers/ha0314cb2-1636-1e.pdf.
Vieilledent, G., Grinand, C., Rakotomalala, F. A., Ranaivosoa, R., Rakotoarijaona, J. R., Allnutt, T. F., et al. (2018). Combining global tree cover loss data with historical national forest-cover maps to look at six decades of deforestation and forest fragmentation in Madagascar. *Biological Conservation, 222*, 189–197.
Wang, S., DesRoches, C. T., Sun, L., Stennes, B., Wilson, B., & Cornelis van Kooten, G. (2007). Linking forests and economic well-being: A four-quadrant approach. *Canadian Journal of Forest Research, 37*(10), 1821–1831.
Watls-Walter, D. (1996). Protecting the environment against state policy in Austria. From women's participation in protest to new voices in Parliament. In Dianne Teoksessa Rocheleau, Barbara Thomas Slayter, & Esther Wangari (Eds.). *Feminist Political Ecology: Global Issues and Local Experiences* (pp. 86–104). Routledge.
Winslow, M. (2005). Is democracy good for the environment? *Journal of Environmental Planning and Management, 48*(5), 771–783.
York, R., & Bell, S. E. (2014). Life satisfaction across nations: The effects of women's political status and public priorities. *Social Science Research, 48*, 48–61.