Property rights, tenure security, and forest investment incentives:
evidence from China's Collective Forest Tenure Reform

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Online Appendix

China's Forest Tenure Reforms

In 1954, China's forestland tenure system began to collectivize private forests, followed by returning "ownership" or control of the trees around homesteads to individual households in the early 1960s. Another long, profoundly influential change was the "Three-Fix" policy announced by the State Council in 1981 (in the official document of "Resolution on Issues Concerning Forest Protection and Development"). By 1986, nearly 70 per cent of collectively owned forestland had been transferred to farmer household management (Xu and Jiang, 2009).

This round of reform in the forest property rights regime featured three forms of management (or tenure types): 1) family or private plots, 2) responsibility plots or hills, and 3) collective management. While all forestland is declared collective property, the former two types reflect individual households' use rights and ownership of trees planted on the plots. The responsibility plots/hills differ from the family plots in that the collective owns both the land and the trees, but decision-making needs to be shared by the collective and the households. In collective management, both management and ownership of the land and trees belong to the collective, and decision-making is by village leaders (Liu and Edmunds, 2003).

Although the "Three-Fix" permitted some privatization, this was not specifically stated in the resolution nor required of the villagers. At the same time, due to emerging problems – such as fire incidents, disputes over borders and ownership, lack of management skills, illegal logging, poor or no cooperation among farmers, etc. – some villages decided to take forestland back under the collective control. For example, in Jiangxi province, two out of five surveyed counties reported that their forestland had been reclaimed by the village in the 1990s, and then reallocated equally according to the number of household members in 2005.

In early 2003, initiated in Fujian, a new round of reform in forestland tenure regime was formally approved by the central government, which spread rapidly to 10 other provinces,

predominantly in southern China. This recent round of reform is characterized by the reallocation of the collective forest use rights to individual households, mainly through formal documentation of farmers' tenure rights to forestland, i.e., the issuance of forestland certificates with clearly specified contract lengths. For instance, family plots were given a clear duration, ranging from 30 to 70 years, and family or private plots certificates bear "Long-term" as the contracted duration.

The use rights granted to households include harvesting and production decisions, such as converting forestland to cropland, selecting tree or plant species, interchanging different forest types, using non-timber forest products, and even abandoning plots. Rights related to gains-from-trade include forestland transfers, inheritance, mortgaging, and so on. Legal contracts in the form of forestland certificates also ensure farmers' use rights.

Both policymakers and economists expected that individual management would produce stronger incentives to plant trees and invest in forestland. In general, the reform is expected to give individual households lower costs and a stronger propensity to invest in forestry, which would lead to more frequent harvesting and reforestation, and a higher income and improved social welfare. More specifically, Chinese forest farmer households are expected to invest for the following reasons. First, forestland is seen as a long-term asset by farmers, so that they are willing to take care of their land when they feel more secure in maintaining their right to keep their forestland over a long period. Second, they have a greater incentive to undertake investment such as tree planting and land-related improvements or conservation if a higher return is expected. Third, consistent with Besley (1995: 910-12), farmers expect or realize greater return on investments in their forestland if the land can be easily converted to liquid assets through sale or transfer.

However, during the "Three-Fix" reforms, the period of use rights given to the family or private plots was ambiguous, while the responsibility plots/hills specified 5-15 years as the

contracted period – too short for most timber species (Holden *et al.*, 2009). The outcome was that most forestland allocated as family plots became deforested. Many believe that this situation undermined farmers' incentives to invest because they were obliged to replant and they felt uncertain about the expected return. In other cases, when such lands were reclaimed by the collectives, reallocated to other households, or leased out, high tenure insecurity was the result, which discouraged any initiative to replant after existing trees were harvested (Holden et al., 2009; Liu and Edmunds, 2003).

In light of such experiences, the new reform has extended contracts and given them clearly specified durations. It has also strengthened the contracted property rights to individual households. The reform therefore provides an interesting case for the study of how the change in tenure rights affects the perceived tenure security and investment. A more detailed discussion of the reform and contracted rights is given along with a descriptive analysis of the data in section 3 of the article.

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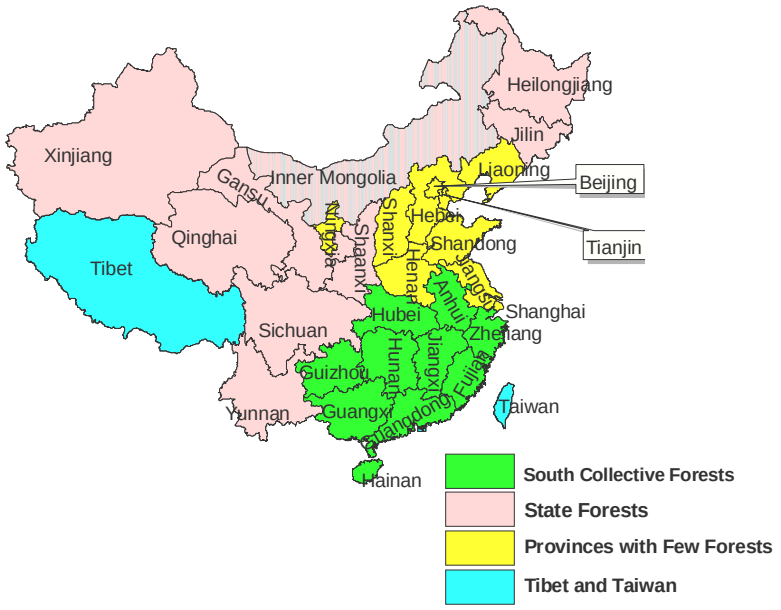

Figure A1. *Distribution of the eight surveyed provinces on the map of China*

Note: EEPC surveyed provinces of Fujian, Jiangxi, Zhejiang, Anhui, Hunan, Liaoning, Shandong, and Yunnan.

Table A1. *Sample distribution of the 2006-2007 survey of collective forest reform, China*

Time	Province	County	Township	Village	Household
March-April 2006	Fujian	12	36	72	720
May 2006	Jiangxi	5	15	30	300
Oct-Nov 2006	Zhejiang	6	18	36	360
April 2007	Anhui	5	15	30	300
April 2007	Hunan	5	15	30	300
May-June 2007	Liaoning	5	15	30	300
May-June 2007	Shandong	5	15	30	300
August 2007	Yunnan	6	12	30	600
Total:	8	49	141	288	3180

Source: Survey conducted by EEPC, Peking University in 2006 and 2007 (data collected for information about 2005 and 2006 respectively.

Table A2. *Share of forest tenure type, China, 2006/2007 (%)*

Province	Year	Individual	Partnership	Villager cluster	Outsider contract	Collective	Eco-reserve	Total
Fujian	2005	50.63	7.81	5.62	4.72	13.78	17.44	100
Jiangxi	2005	62.97	2.77	4.16	9.95	12.47	7.67	100
Zhejiang	2005	82.66	1.37	7.48	0.25	7.37	0.87	100
Anhui	2006	85.07	0.4	3.06	1.28	2.07	8.12	100
Hunan	2006	92.43	0.27	4.46	0.74	0.98	1.11	100
Liaoning	2006	55.21	7.04	3.08	11.9	22.09	0.68	100
Shandong	2006	54.3	0	0	7.05	3.08	35.56	100
Yunnan	2006	69.87	3.68	16.63	0.45	5.03	4.35	100
Total	2006	69.14	2.92	5.56	4.54	8.36	9.48	100

Sources: Survey conducted by EEPC, Peking University in 2006 and 2007.

Table A3. *Disaggregated forestland rights at household forest plot level, China*

Type of Forestland Right	Fujian Mean	Fujian Std. Dev.	Jiangxi Mean	Jiangxi Std. Dev.	Zhejiang Mean	Zhejiang Std. Dev.	Ahhui Mean	Ahhui Std. Dev.
Right to convert forestland to cropland	0.443	0.48	0.512	0.486	0.535	0.489	0.462	0.497
Right to change forest type	0.709	0.439	0.804	0.386	0.739	0.421	0.533	0.493
Right to select tree species	0.744	0.424	0.821	0.372	0.768	0.412	0.553	0.492
Right to use non-timber products	0.836	0.367	0.869	0.332	0.798	0.399	0.599	0.489
Right to abandon forestland	0.598	0.367	0.772	0.317	0.71	0.398	0.584	0.452
Right transfer plot to other villagers	0.622	0.464	0.652	0.465	0.648	0.455	0.512	0.483
Right to transfer plot to outsiders	0.51	0.481	0.627	0.473	0.579	0.47	0.478	0.482
Right to mortgage forestland as collateral with certificate	0.139	0.337	0.057	0.229	0.192	0.386	0.115	0.317
Right to mortgage forestland as collateral without certificate	0.391	0.469	0.337	0.467	0.26	0.429	0.207	0.402
Property Rights Index (Sum of Scores)	4.986	2.612	5.452	2.383	5.229	2.883	4.044	3.344

	Hunan Mean	Hunan Std. Dev.	Liaoning Mean	Liaoning Std. Dev.	Shandong Mean	Shandong Std. Dev.	Yunnan Mean	Yunnan Std. Dev.	Full Sample Mean	Full Sample Std. Dev.
Right to convert forestland to cropland	0.013	0.115	0.079	0.259	0.782	0.41	0.423	0.49	0.412	0.484
Right to change forest type	0.016	0.124	0.418	0.437	0.821	0.38	0.642	0.474	0.614	0.471
Right to select tree species	0.016	0.124	0.547	0.459	0.824	0.378	0.667	0.465	0.65	0.465
Right to use non-timber products	0.016	0.124	0.77	0.402	0.861	0.345	0.771	0.418	0.728	0.441
Right to abandon forestland	0.019	0.136	0.66	0.363	0.806	0.351	0.687	0.387	0.619	0.414
Right transfer plot to other villagers	0.016	0.124	0.584	0.453	0.745	0.421	0.518	0.488	0.566	0.478
Right to transfer plot to outsiders	0.013	0.111	0.532	0.458	0.618	0.467	0.466	0.487	0.596	0.481
Right to mortgage forestland as collateral with certificate	0.007	0.072	0.227	0.402	0.023	0.149	0.091	0.284	0.117	0.314
Right to mortgage forestland as collateral without certificate	0.027	0.157	0.209	0.38	0.651	0.469	0.325	0.459	0.323	0.456
Property Rights Index (Sum of Scores)	0.142	0.848	4.026	2.289	6.13	2.671	4.59	2.919	4.527	3.005

Notes: 1=if have use rights, 0.5=if use rights requires approval, 0=if no use rights. Property Rights Index=sum of scores of each right.

Table A4. ***Descriptive statistics of basic characteristics***

Variable	National Mean (Std.D.)	Fujian Mean (Std.D.)	Jiangxi Mean (Std.D.)	Zhejiang Mean (Std.D.)	Anhui Mean (Std.D.)	Hunan Mean (Std.D.)	Liaoning Mean (Std.D.)	Shandong Mean (Std.D.)	Yunnan Mean (Std.D.)
Household Characteristics									
Household size, (number of people)	4.31 (1.64)	4.65 (1.67)	4.69 (1.61)	4.06 (1.68)	4.71 (1.71)	4.31 (1.71)	3.65 (1.25)	3.9 (1.33)	5.04 (1.76)
Age of household head, (years)	50.5 (10.97)	49.33 (10.78)	50.14 (10.91)	51.63 (10.46)	51.66 (11.82)	51.92 (10.82)	52.42 (10.05)	50.94 (11.62)	46.01 (11.43)
Years of education of household head	5.89 (3.16)	5.01 (3.21)	5.93 (2.64)	5.33 (3.11)	6.04 (3.52)	6.97 (2.94)	7.19 (2.56)	6.16 (3.37)	5.71 (3.32)
Gender of household head. 1=male, 0=female	0.96 (0.19)	0.97 (0.16)	0.96 (0.2)	0.97 (0.18)	0.97 (0.16)	0.96 (0.21)	0.98 (0.15)	0.94 (0.24)	0.92 (0.27)
Household head is member of the Communist Party [a]	0.18 (0.39)	0.17 (0.37)	0.17 (0.38)	0.19 (0.39)	0.24 (0.43)	0.18 (0.39)	0.24 (0.43)	0.16 (0.36)	0.13 (0.33)
Household head is village leader [a]	0.06 (0.24)	0.07 (0.25)	0.05 (0.22)	0.09 (0.29)	0.12 (0.32)	0.03 (0.18)	0.03 (0.16)	0.06 (0.24)	0.06 (0.24)
Household head once had job in forestry sector [a]	0.01 (0.11)	0.02 (0.15)	0.003 (0.06)	0 (0)	0.01 (0.09)	0 (0)	0.04 (0.19)	0.01 (0.1)	0.01 (0.1)
Total household income, (yuan)	38637 (143799)	34129 (38110)	27373 (27399)	54402 (122215)	48795 (135735)	16937 (14169)	17937 (23394)	13277 (19247)	56033 (372920)
Log of total household income in yuan	9.97 (1.01)	9.997 (0.99)	9.86 (0.9)	10.12 (1.14)	10.16 (1.01)	9.45 (0.79)	9.45 (0.8)	8.99 (1.02)	9.85 (1.06)
House value in 2005, (10,000 yuan)	5.08 (9.01)	4.52 (7.57)	3.09 (4.04)	8.57 (12.35)	5.56 (9.42)	5.6 (10.74)	4.58 (8.07)	3.77 (4.23)	4.43 (12.29)
Borrowed money or not [a]	0.39 (0.49)	0.45 (0.5)	0.4 (0.49)	0.35 (0.48)	0.32 (0.47)	0.32 (0.47)	0.45 (0.49)	0.33 (0.47)	0.49 (0.5)
Can successfully borrow 500 yuan within one week [b]	1.79 (0.57)	1.72 (0.53)	1.75 (0.66)	1.86 (0.51)	1.88 (0.48)	1.89 (0.46)	1.82 (0.58)	1.87 (0.5)	1.62 (0.78)
Forestry income share	0.04 (0.13)	0.06 (0.14)	0.04 (0.11)	0.04 (0.14)	0.02 (0.08)	0.013 (0.06)	0.012 (0.06)	0.005 (0.03)	0.02 (0.07)
Forest Plot Characteristics									
Forest plot area (mu)	38.1 (302.5)	48 (349.5)	12.13 (37.3)	5.4 (8.76)	4.2 (14.51)	6.6 (13.39)	156.5 (642.3)	0.83 (1.18)	13.85 (54.68)
Household's total plot number in 2005	2.69 (2.33)	2.89 (2.33)	2.99 (2.12)	3.64 (3.23)	3.93 (3.02)	2.38 (1.55)	2.09 (1.67)	1.61 (1.08)	2.53 (2.14)
Irrigation dummy [a]	0.19 (0.39)	0.13 (0.34)	0.16 (0.37)	0.21 (0.41)	0.07 (0.26)	0.14 (0.35)	0.02 (0.15)	0.58 (0.49)	0.11 (0.32)
Slope (1 = >25, 0=<25)	0.56 (0.5)	0.67 (0.47)	0.64 (0.48)	0.71 (0.45)	0.39 (0.49)	0.4 (0.49)	0.75 (0.43)	0.05 (0.22)	0.68 (0.46)
Distance to home (km)	1.59 (1.9)	1.97 (1.75)	1.82 (1.72)	1.84 (1.95)	1.3 (1.28)	1.09 (1.8)	1.67 (1.83)	0.32 (0.48)	2.56 (3.05)
Distance to road (km)	1.34 (1.87)	1.28 (1.47)	1.4 (1.57)	1.64 (1.99)	1.49 (1.88)	0.99 (1.83)	1.89 (2.34)	0.36 (0.58)	1.96 (2.71)
Forest type when managing [c]	1.24 (1.05)	1.68 (0.97)	1.77 (0.97)	1.71 (0.97)	0.96 (1.15)	.	1.16 (0.63)	0.14 (0.56)	0.79 (0.84)
Length of one rotation period (years)	19.47 (8.66)	19.16 (3.36)	12 (0.38)	12.2 (3.46)	18.09 (3.49)	30 (0)	34.99 (2.03)	14 (0.33)	12.99 (1.08)
Start year of managing forest plot	1993.2 (11.9)	1993.2 (15.3)	1992.8 (9.2)	1991.6 (11.2)	1989.6 (10.9)	1990.4 (9.4)	1993.1 (10.5)	1995.2 (9)	1995.3 (11)
Has certificate or not for forest plot [a]	0.23 (0.42)	0.16 (0.36)	0.13 (0.33)	0.41 (0.49)	0.26 (0.44)	0.4 (0.49)	0.47 (0.5)	0.01 (0.12)	0.15 (0.36)
Length of contract for forest plot (years)	69.67 (46.15)	63.3 (45.15)	81.89 (46.9)	74.17 (42.02)	64.41 (44.53)	27.75 (37.53)	.	68.94 (49.72)	66.04 (46.43)
Other Control Variables									
Household's total cropland area (mu)	12.19 (27.17)	10.79 (10.53)	10.3 (9.04)	7.8 (53.27)	12.84 (10.47)	19.09 (14.99)	13.71 (10.65)	16.73 (12.81)	19.47 (16.9)
Household's total working days in off-farm jobs	534.5 (530)	540.5 (517.6)	614.1 (554.4)	666.2 (615.3)	557.1 (428.5)	546.7 (539.4)	431.3 (477.4)	444.1 (410.2)	398.1 (534.4)
Number of times of small land adjustment in the village	1.54 (2.21)	1.26 (1.94)	1.98 (2.2)	1.36 (2.31)	1.16 (1.25)	2.36 (2.54)	2.62 (2.26)	1.07 (2.27)	0.38 (0.77)
Expectation of small land adjustment in the future [b]	1.1 (0.89)	0.81 (0.86)	1.23 (0.83)	1.15 (0.9)	0.81 (0.83)	1.21 (0.83)	1.08 (0.93)	1.5 (0.78)	0.95 (0.88)

Notes: 1 mu= 1/15 hectare.

[a] Dummy variables (1 = yes, 0 = no)

[b] Ordinal variables (0 = no, 1 = unsure, and 2 = yes)

[c] Forest type, based on availability of forest harvesting (0 = no forest, 1 =land with few woods, 2 =timber forests, 3 =bamboo and economic forests)

Table A5. *Summary statistics of perceived tenure security (full sample)*

Province	Mean	Std. Dev.	Min	Max	Observations
Fujian	1.887	0.347	0	2	10088
Jiangxi	1.918	0.332	0	2	5409
Zhejiang	1.919	0.318	0	2	6955
Anhui	1.86	0.434	0	2	1700
Hunan	1.699	0.524	0	2	4400
Liaoning	1.89	0.348	0	2	6499
Shandong	1.847	0.427	0	2	6235
Yunnan	1.867	0.446	0	2	3171
Total	1.869	0.39	0 (1.9%)	2 (89%)	44457

Notes: Variable specification: If owners perceive they will hold the plot after five years. (0=no, 1=uncertain, 2=yes)

Table A6. *Distribution of forest investment in China under individual management (2000 and 2005/2006, respectively)*

Province	2000 (*In Chinese Yuan*)			2005/2006 (*In Chinese Yuan*)		
	Mean (Std. Dev.)	**Min**	**Max**	**Mean (Std. Dev.)**	**Min**	**Max**
Fujian	280.69 (945.72)	0	7740	559.52 (1821.04)	0	20550
Jiangxi	4.41 (33.39)	0	397.5	8.79 (60.12)	0	800
Zhejiang	79.63 (660.5)	0	11050	73.71 (311.09)	0	3540
Anhui	130.42 (464.25)	0	5340	682.13 (6571.97)	0	100499
Hunan *	.	.	.	.	.	.
Liaoning	50.61 (452.97)	0	6400	182.09 (770.71)	0	16300
Shandong	95.64 (431.76)	0	4410	224.2 (678.03)	0	7440
Yunnan	32.54 (147.22)	0	1500	151.3 (413.39)	0	4125
Total	116.24 (619.69)	0	11050	258.82 (1734.8)	0	100499

Source: Survey conducted by EEPC, Peking University in 2006 and 2007.

*Unfortunately, none of the sample forest plots in Hunan is under individual management in the sample.