**Impacts of Policy Measures on the Development of State-Owned Forests in Northeast China: Theoretical Results and Empirical Evidence**

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## ONLINE APPENDIX

**Appendix A.** Additional information about the forest resource, timber harvest, forest management investment, and the number of retired workers and social service staff of the SOFEs in Heilongjiang, Jilin, and Inner Mongolia during 1980-2004

Table A1. *Shares of different types of forests in Heilongjiang and Jilin provinces and Inner Mongolia autonomous region (%)*

| Year | Timber forest | Shelterbelt | Fuelwood forest | Special purpose forest |
|---|---|---|---|---|
| 1980 | 92.00 | 4.57 | 0.13 | 6.15 |
| 1985 | 93.08 | 5.12 | 0.05 | 2.25 |
| 1990 | 91.81 | 5.57 | 0.32 | 2.59 |
| 1995 | 92.23 | 5.46 | 0.42 | 2.28 |
| 1997 | 92.62 | 5.27 | 0.24 | 2.11 |
| 2000 | 87.65 | 9.72 | 0.00 | 2.63 |
| 2004 | 56.55 | 34.84 | 0.00 | 8.62 |
| 2008 | 33.44 | 56.07 | 0.00 | 0.00 |

Table A2. *Proportion of mature timber stock in timber forests (%)*

| Year | Heilongjiang | Jilin | Inner Mongolia |
|---|---|---|---|
| 1980 | 65.64 | 75.27 | 71.75 |
| 1985 | 47.88 | 53.63 | 52.83 |
| 1990 | 16.74 | 37.43 | 38.66 |
| 1995 | 10.23 | 37.39 | 33.91 |
| 1997 | 8.12 | 28.21 | 32.60 |
| 2000 | 3.66 | 32.40 | 28.97 |
| 2004 | 3.15 | 32.60 | 24.89 |
| 2008 | 3.24 | 32.60 | 24.89 |

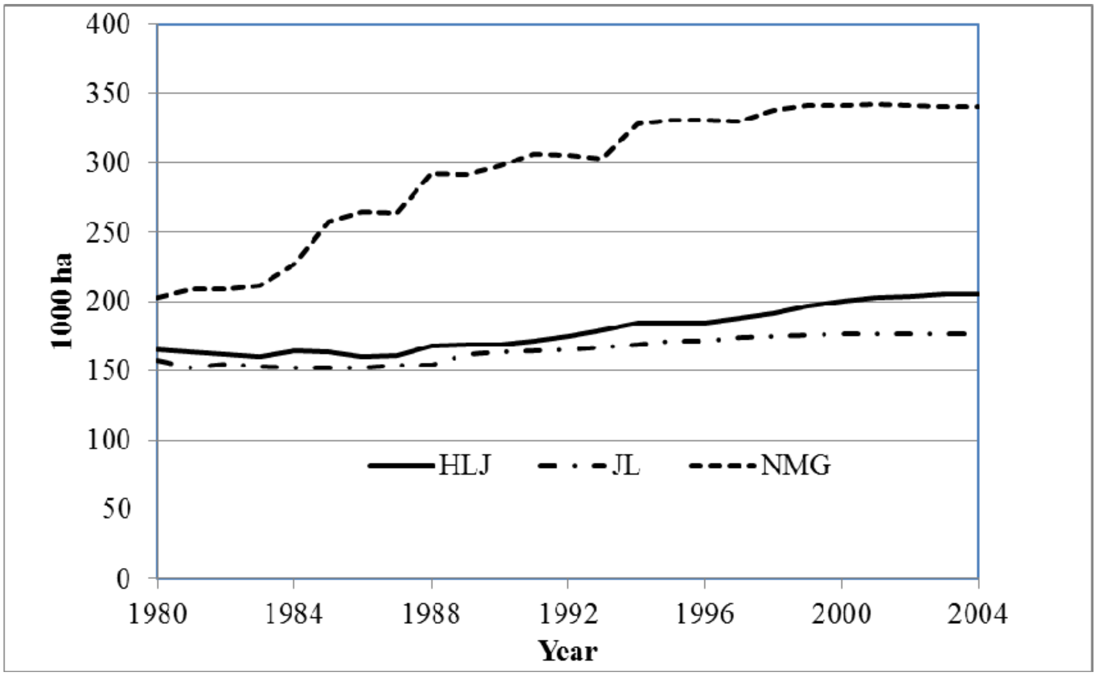


Figure A1. *Average area of forest land managed by each SOFE in Heilongjiang, Jilin, and Inner Mongolia*

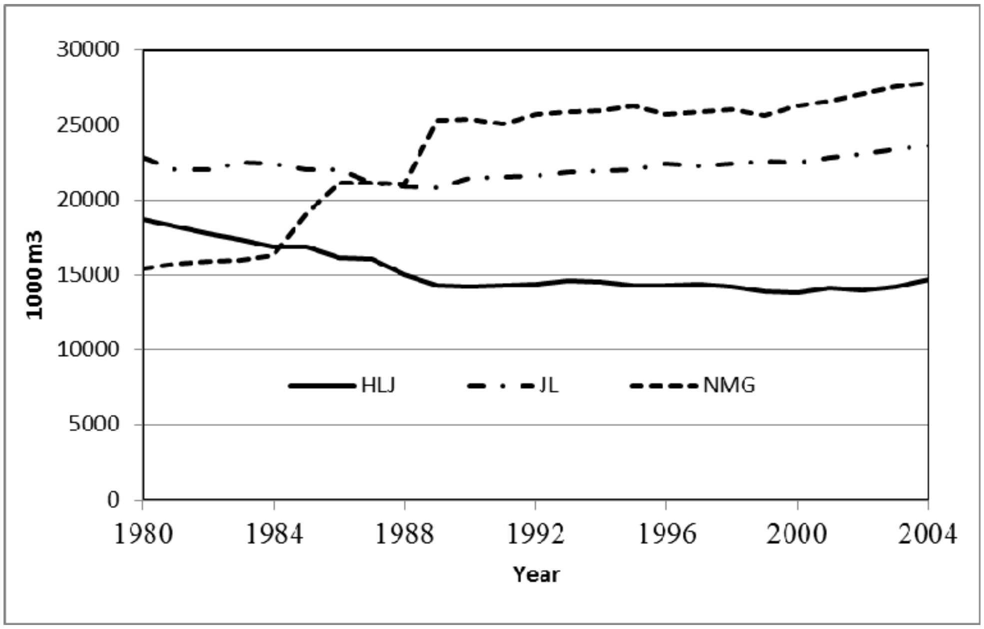


Figure A2. *Average growing stock of timber managed by each SOFE in Heilongjiang, Jilin, and Inner Mongolia*

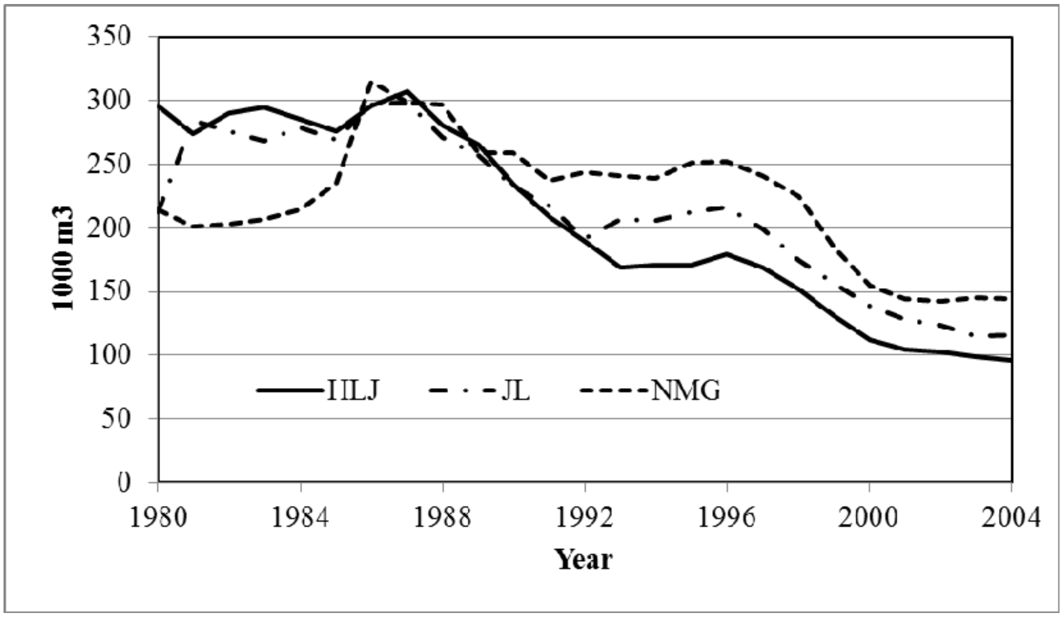


Figure A3. *Average volume of timber harvest of each SOFE in Heilongjiang, Jilin, and Inner Mongolia*

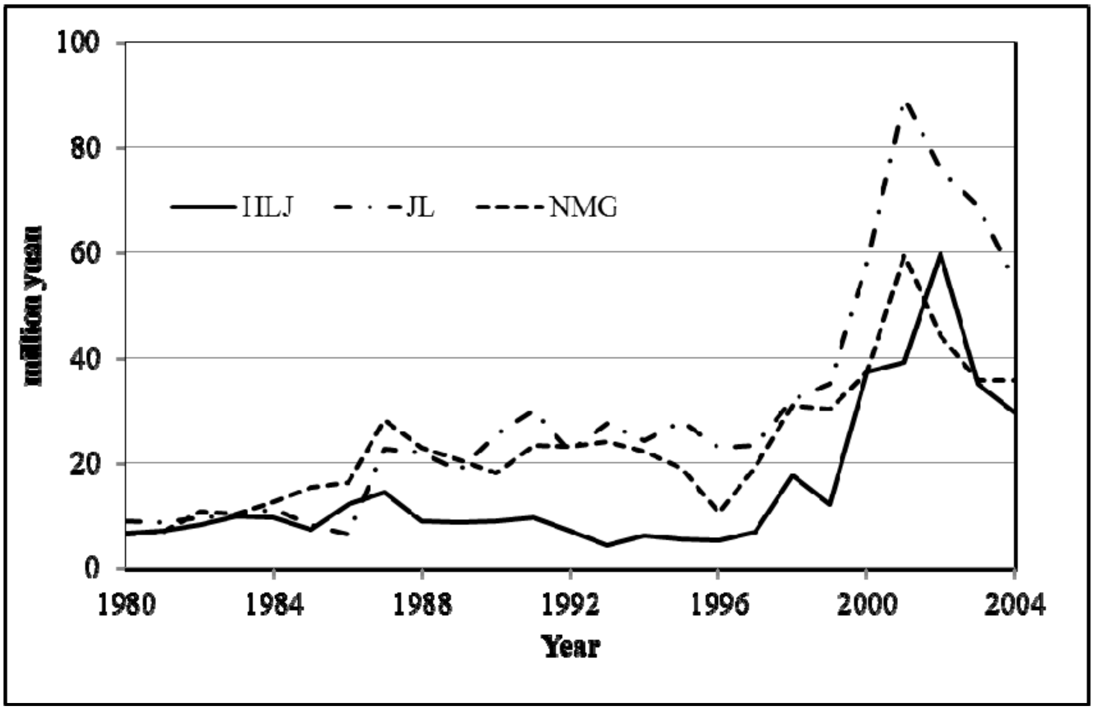


Figure A4. *Average fixed assets investment of the SOFEs in Heilongjiang, Jilin, and Inner Mongolia*

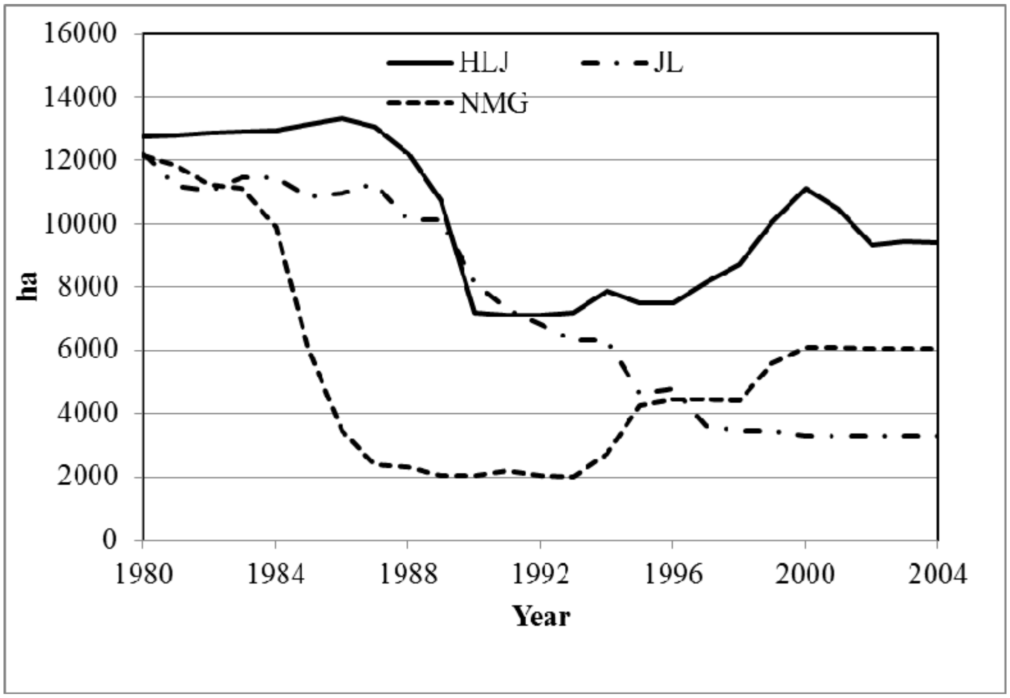


Figure A5. *Average area of non-forest land managed by the SOFEs in Heilongjiang, Jilin, and Inner Mongolia*

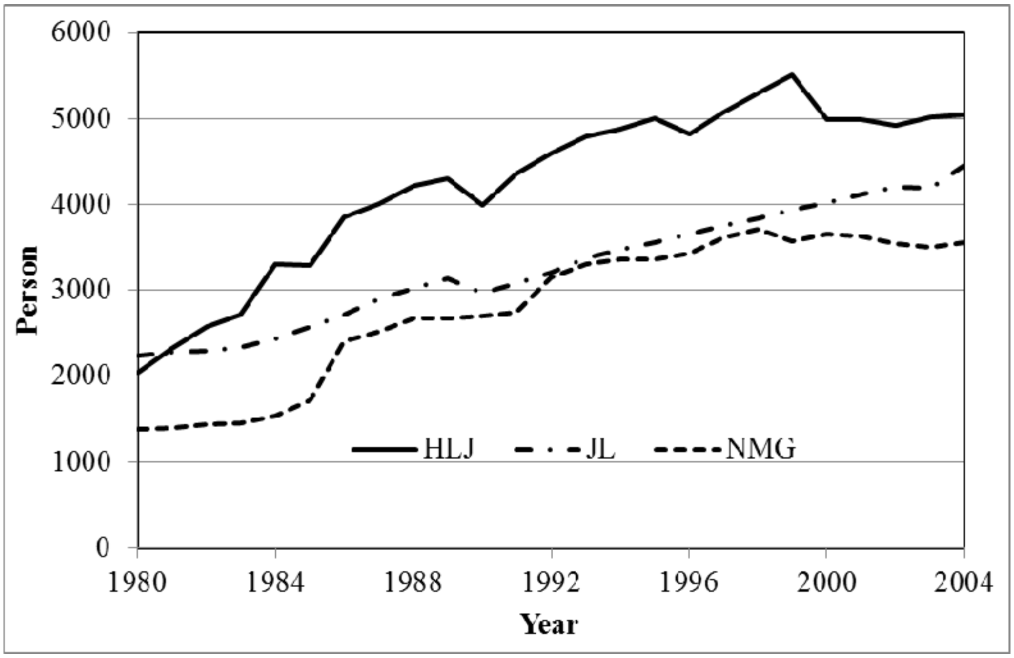


Figure A6. *Average number of retired workers and social service staff of the SOFEs in Heilongjiang, Jilin, and Inner Mongolia*

**Appendix B**

This appendix presents additional comparative statics of the theoretical model of the State-owned Forest Enterprise (SOFE) on logging and investment.

From the analysis presented in the main text [equations (3a) and (3b)] we know that changes in optimal decisions on timber harvest (*dh*) and forest management investment (*dI*) and changes in the influencing factors satisfy the following equalities:

$$\begin{aligned} Adh + BdI &= \{g''()S() - g'()S_I()[p - C_h()]\}dQ_0 + g()S_I()C_{hr_h}()dr_h \\ &+ S_{Ir_m}()\{g'() - g()[p - C_h()]\}dr_m - g()S_I()dp \end{aligned} \quad \text{(A1)}$$

and

$$\begin{aligned} Cdh + DdI &= -S()d\alpha_1 + (\pi_f + \pi_n - \overline{c})S_I()d\alpha_2 + \alpha_2 S_I()hdp \\ &+ \alpha_2 S_I()d\pi_n - \alpha_2 S_I()d\overline{c} - \alpha_2 S_I()C_{r_h}()dr_h \\ &+ \{\alpha_2(\pi_f + \pi_n - \overline{c})S_{Ir_m}() - \alpha_1 S_{r_m}()\}dr_m \end{aligned} \quad \text{(A2)}$$

where:

$$A = g''()S() - g'()S_I()[p - C_h()] - g()C_{hh}() < 0$$

$$B = g()S_{II}()[p - C_h()] - g'()S_I() < 0$$

$$C = -\alpha_2 S_I()[p - C_h()] < 0$$

$$D = (\alpha_1 + \alpha_2)S_I() - \alpha_2(\pi_f + \pi_n - \overline{c})S_{II}() > 0$$

Set the changes in all influencing factors except $\alpha_2$ to 0 and solve equations (A1) and (A2), we obtain the effects of an increase in the relative importance of an increase in the forest resource for the SOFE:

$$\frac{\partial h}{\partial \alpha_2} = \frac{B(\pi + \pi_0)S_I(r_m, I)}{BC - DA} < 0$$

$$\frac{\partial I}{\partial \alpha_2} = \frac{-A(\pi + \pi_0)S_I(r_m, I)}{CB - AD} > 0$$

The effects of an increase in the profit in the beginning of the year:

$$\frac{\partial h}{\partial \pi_0} = \frac{B\alpha_2 S_I(r_m, I)}{BC - DA} < 0$$

$$\frac{\partial I}{\partial \pi_0} = \frac{-A\alpha_2 S_I(r_m, I)}{BC - DA} > 0$$

The effects of an increase in timber price:

$$\frac{\partial h}{\partial p} = \frac{B\alpha_2 S_I(r_m, I)h + Dg(Q_0 - h)S_I(r_m, I)}{BC - DA} <=> 0$$

$$\frac{\partial I}{\partial p} = \frac{-A\alpha_2 S_I(r_m, I)h - Cg(Q_0 - h)S_I(r_m, I)}{BC - DA} > 0$$

The effects of an increase in the growing stock of timber at the beginning of the year:

$$\frac{\partial h}{\partial Q_0} = \frac{-D\{g''(Q_0 - h)S(r_m, I) - g'(Q_0 - h)S_I(r_m, I)[p - C_h(r_h, h)]\}}{BC - DA} > 0$$

$$\frac{\partial I}{\partial Q_0} = \frac{C\{g''(Q_0 - h)S(r_m, I) - g'(Q_0 - h)S_I(r_m, I)[p - C_h(r_h, h)]\}}{BC - DA} > 0$$

The effects of an increase in the productivity of timber harvest and regeneration efforts:

$$\frac{\partial h}{\partial r_h} = \frac{-S_I(r_m, I)}{BC - DA}\{\alpha_2 BC_{r_h}(r_h, h) - Dg(Q_0 - h)C_{hr_h}(r_h, h)\} <=> 0$$

$$\frac{\partial I}{\partial r_h} = \frac{S_I(r_m, I)}{BC - DA}\{\alpha_2 AC_{r_h}(r_h, h) + Cg(Q_0 - h)C_{hr_h}(r_h, h)\} > 0$$

The effects of an increase in the productivity of forest management efforts:

$$\frac{\partial h}{\partial r_m} = \frac{\alpha_2 B(\pi + \pi_0)S_{Ir_m}(r_m, I) - \alpha_1 BS_{r_m}(r_m, I) - DS_{Ir_m}(r_m, I)\{g'(Q_0 - h) - g(Q_0 - h)[p - C_h(r_h, h)]\}}{BC - DA} <=> 0$$

$$\frac{\partial I}{\partial r_m} = \frac{-\alpha_2 A(\pi + \pi_0)S_{Ir_m}(r_m, I) + \alpha_1 AS_{r_m}(r_m, I) + CS_{Ir_m}(r_m, I)\{g'(Q_0 - h) - g(Q_0 - h)[p - C_h(r_h, h)]\}}{BC - DA} <=> 0$$

Based on the above analysis of the logging and investment, $Q_1$, the growing stock of timber at the end of year *t*, can be analyzed as follows:

$$\frac{\partial Q_1}{\partial Q_0} = g'_{Q_0}(1 - \frac{\partial h}{\partial Q_0}) + g \cdot S'_I \frac{\partial I}{\partial Q_0} > 0$$

$$\frac{\partial Q_1}{\partial \alpha_1} = g'_h(-\frac{\partial h}{\partial \alpha_1})S + g \cdot S'_I \frac{\partial I}{\partial \alpha_1} < 0$$

$$\frac{\partial Q_1}{\partial \alpha_2} = g'_h(-\frac{\partial h}{\partial \alpha_2})S + g \cdot S'_I \frac{\partial I}{\partial \alpha_2} > 0$$

$$\frac{\partial Q_1}{\partial \pi_0} = g'_h(-\frac{\partial h}{\partial \pi_0})S + g \cdot S'_I \frac{\partial I}{\partial \pi_0} > 0$$

$$\frac{\partial Q_1}{\partial p} = g'_h(-\frac{\partial h}{\partial p})S + g \cdot S'_I \frac{\partial I}{\partial p} <=> 0$$

$$\frac{\partial Q_1}{\partial r_h} = g'_h(-\frac{\partial h}{\partial r_h})S + g \cdot S'_I \frac{\partial I}{\partial r_h} <=> 0$$

$$\frac{\partial Q_1}{\partial r_m} = g'_h(-\frac{\partial h}{\partial r_m})S + g \cdot S'_I \frac{\partial I}{\partial r_m} <=> 0$$