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Optimizing rotation periods of forest plantations: the effects of carbon accounting regimes

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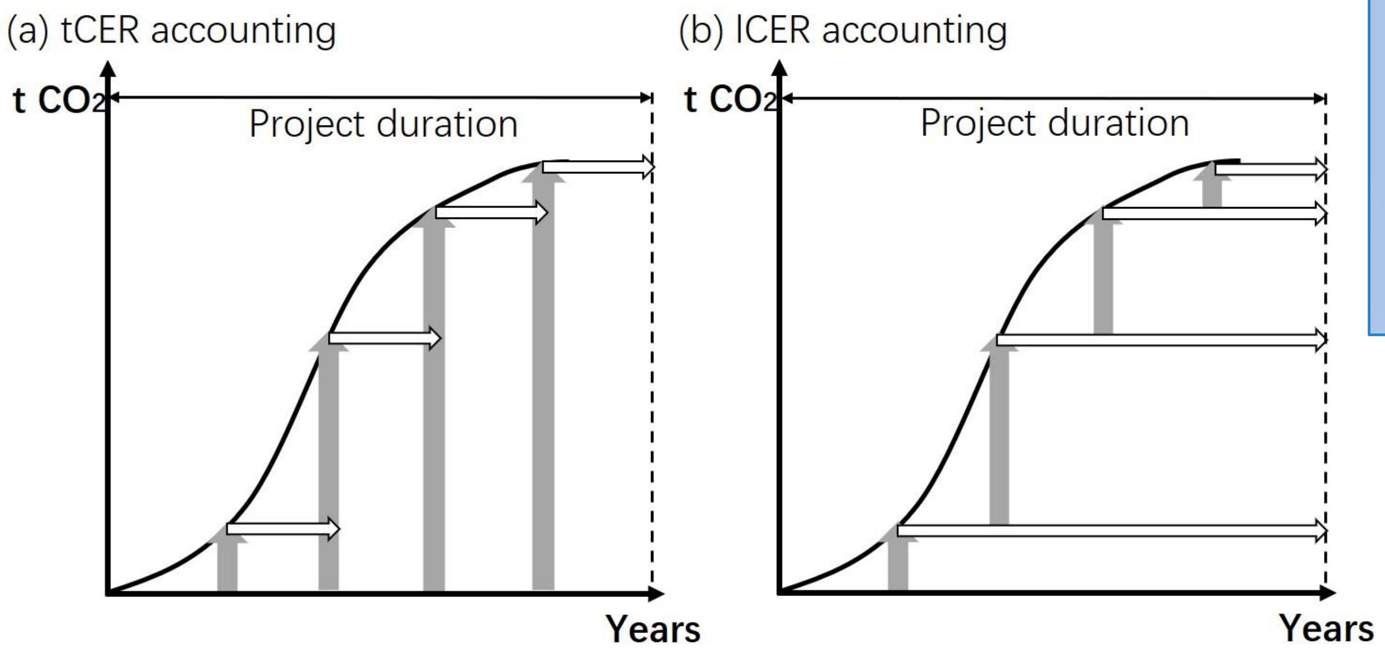
1. Introduction

- *Carbon accounting regimes*



Two big differences
i. Expiring time
tCER: expire every 5 years
lCER: expire at the end of a project crediting period.
ii. Amount of CERs
tCER: total amount of CO_2e sequestered.
lCER: the additional amount of CO_2e sequestered since the last verification.

Fig. 1. Carbon offset accounting systems for afforestation projects. Grey arrows represent the number of offsets (in t CO_2) issued through time; blank arrows represent the lifetime of these CERs.

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2. Research questions

➢ *Research questions:*

(i) How does the value of the carbon sequestered by forests affect the optimal rotation period?

(ii) How do different carbon accounting methods (tCER and lCER) affect the optimal rotation period across different tree species and regions?

(iii) How do changes in carbon prices and discount rates influence the optimal rotation period of different plant species?

3. Methods

3.1. Estimation of timber production and Carbon Sequestration

- *Stand growth models*
  -forest biomass carbon
- *Meta-analysis*
  -soil organic carbon
- *Regression analyses*
  -temporal patterns of carbon sequestration

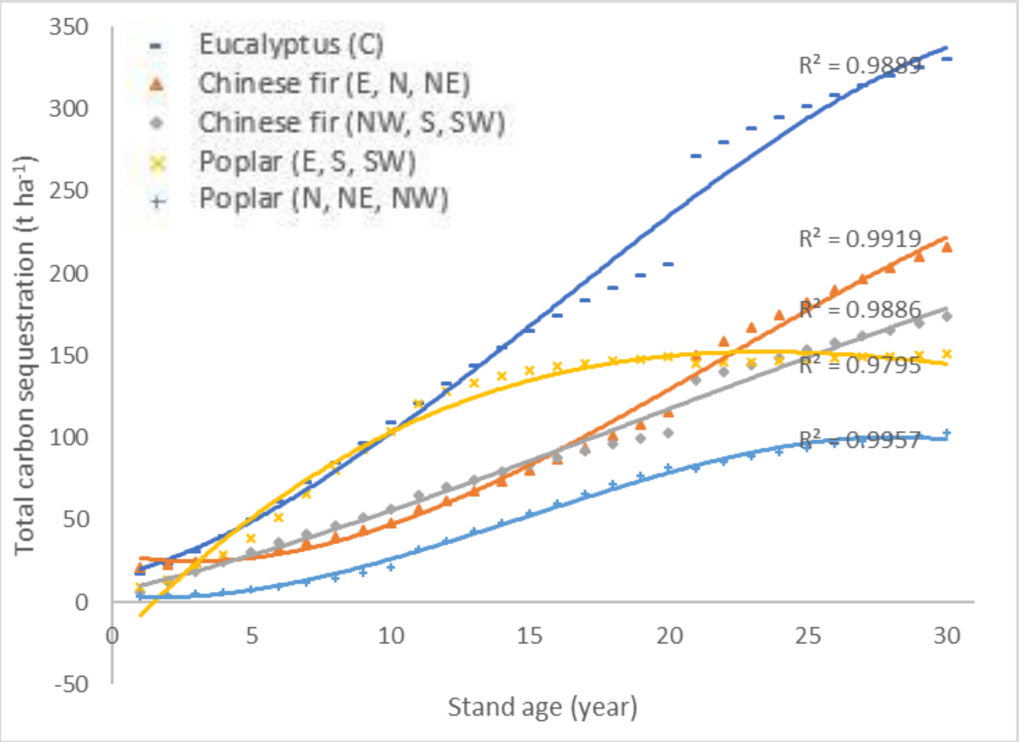

Fig. 2. Total carbon sequestered by tree biomass and soil carbon after afforestation of cropland.

Notes: C, E, N, NE, NW, S, and SW stand for China, and the eastern, northern, northeastern, northwestern, southern, and southwestern region, respectively.

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3. Methods

3.2. Calculation of the optimal rotation periods

3.2.1. Collection of Economic Data

3.2.2. Modified Hartman rotation model

Costs of reforestation

- Site preparation (e.g. Seedling or sapling; Insecticide; Herbicide; Fertilizer; Manual cleaning)
- Forest management (e.g. Replanting; Weeding and climber cutting; Pruning)
- Harvesting (Tools and machinery)

Incomes from reforestation

- Revenues from timber/wood use

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4. Results

4.1. Differences between tCER and lCER accounting

- *Carbon prices*
- *CER generation*

Table 4. Carbon price and CER generated (tree biomass and soils) of different afforestation alternatives under two carbon accounting systems.

		Duration (years)					Total
		5.0	10.0	15.0	20.0	25.0	
Carbon price	ptCER (USD $tCER^{-1}$)	15.0	15.0	15.0	15.0	15.0	
	plCER (USD $lCER^{-1}$)	52.6	45.8	37.5	27.3	15.0	
Eucalyptus (C)	tCER (t ha^{-1})	179.9	377.0	614.7	859.2	1076.6	3107.3
	lCER (t ha^{-1})	179.9	197.1	237.7	244.5	217.4	1076.6
Chinese fir (E, N, NE)	tCER (t ha^{-1})	98.4	172.5	305.7	473.5	651.0	1701.0
	lCER (t ha^{-1})	98.4	74.1	133.2	167.8	177.6	651.0
Chinese fir (NW, S, SW)	tCER (t ha^{-1})	104.6	204.1	314.6	430.2	545.3	1598.7
	lCER (t ha^{-1})	104.6	99.6	110.4	115.6	115.1	545.3
Poplar (E, S, SW)	tCER (t ha^{-1})	187.3	378.4	494.0	548.5	556.2	2164.4
	lCER (t ha^{-1})	187.3	191.1	115.6	54.5	7.7	556.2
Poplar (N, NE, NW)	tCER (t ha^{-1})	26.7	95.8	192.8	288.9	355.5	959.7
	lCER (t ha^{-1})	26.7	69.1	96.9	96.1	66.7	355.5

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4. Results

4.1. Differences between tCER and lCER accounting

- *Present value of CERs*

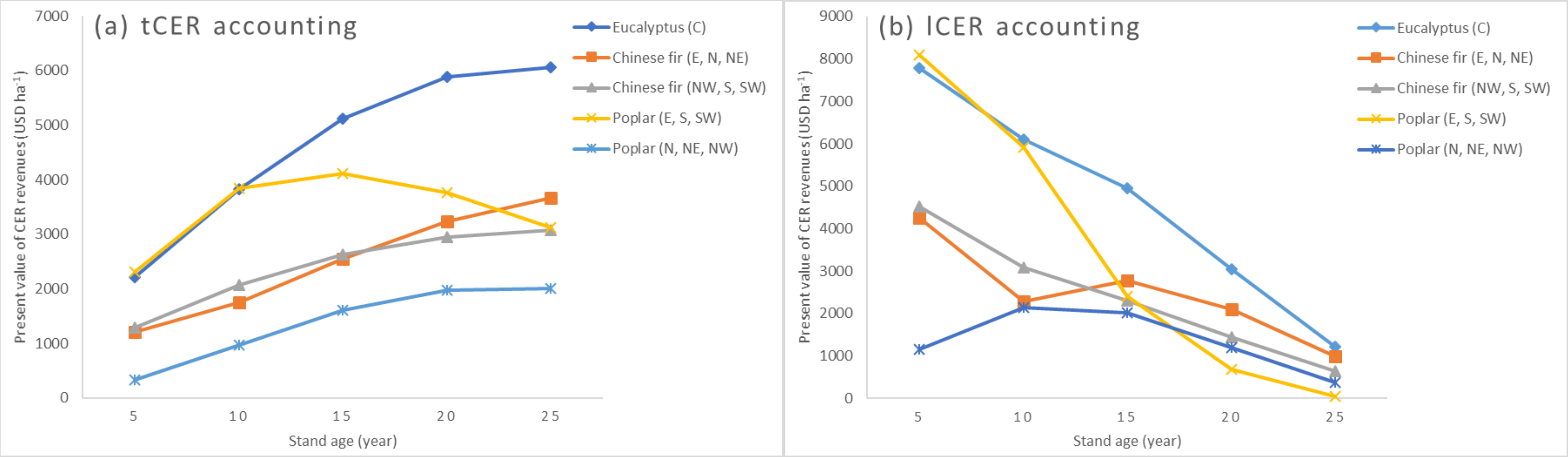

Fig. 3. Present value of CER revenues for different afforestation alternatives under two carbon accounting regimes.

Note: C, E, N, NE, NW, S, and SW stand for China, and the eastern, northern, northeastern, northwestern, southern, and southwestern regions, respectively. (Basic price = 15 USD per ton of CO_2. Discount rate = 4%)

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4. Results

4.2. Optimal rotation periods under different carbon accounting regimes

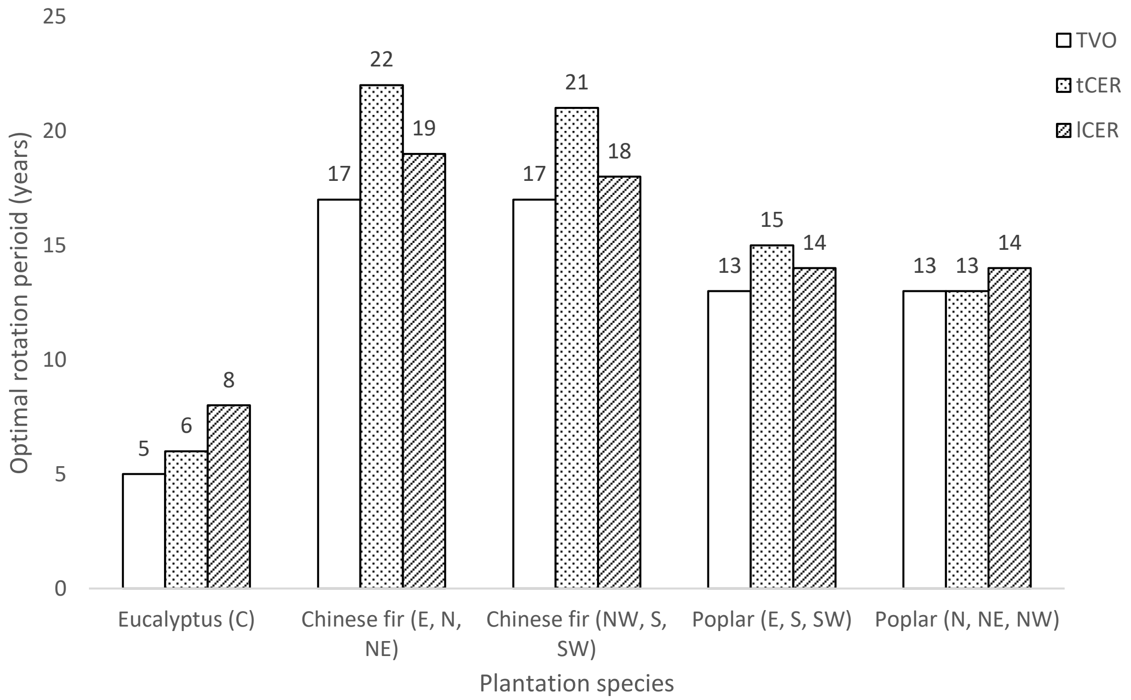

Fig. 4. Optimal rotation period for different plantation species with varying carbon accounting methods.

Note: TVO = timber value only, tCER = temporary carbon credits, lCER = long-term carbon credits. C, E, N, NE, NW, S, and SW stand for China, and the eastern, northern, northeastern, northwestern, southern, and southwestern region, respectively. (Basic price = 15 USD per ton of CO_2. Discount rate = 4%).

4. Results

4.3. Impact of changes in carbon prices on rotation period

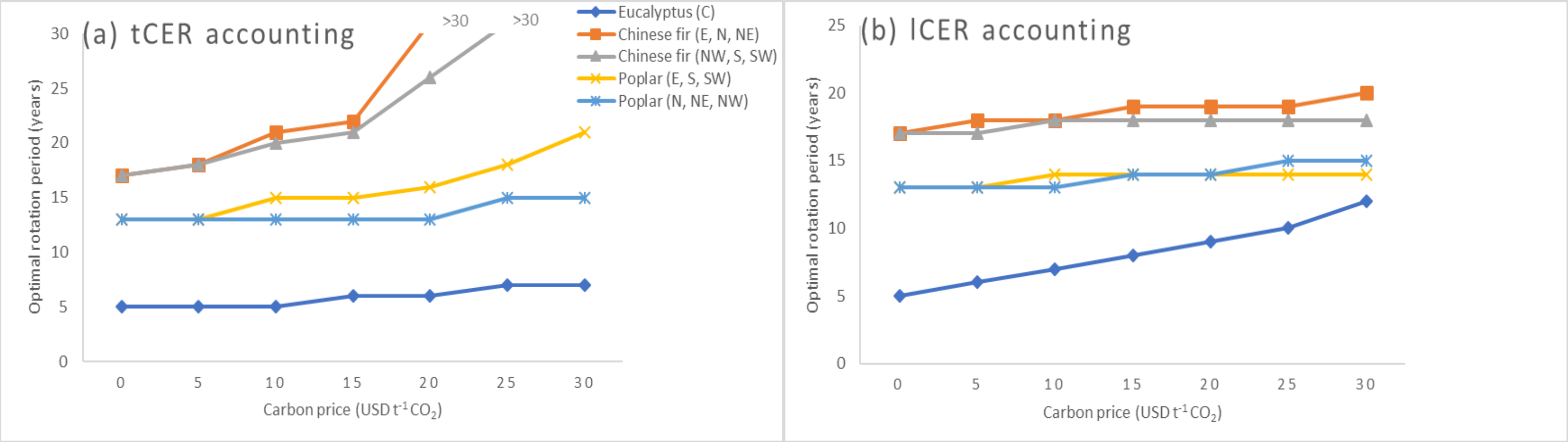

Fig. 5. Optimal rotation period varying with the increase of carbon prices under two carbon accounting method.

Note: C, E, N, NE, NW, S, and SW stand for China, and the eastern, northern, northeastern, northwestern, southern, and southwestern region, respectively.

4. Results

4.3. Impact of changes in discount rate on rotation period

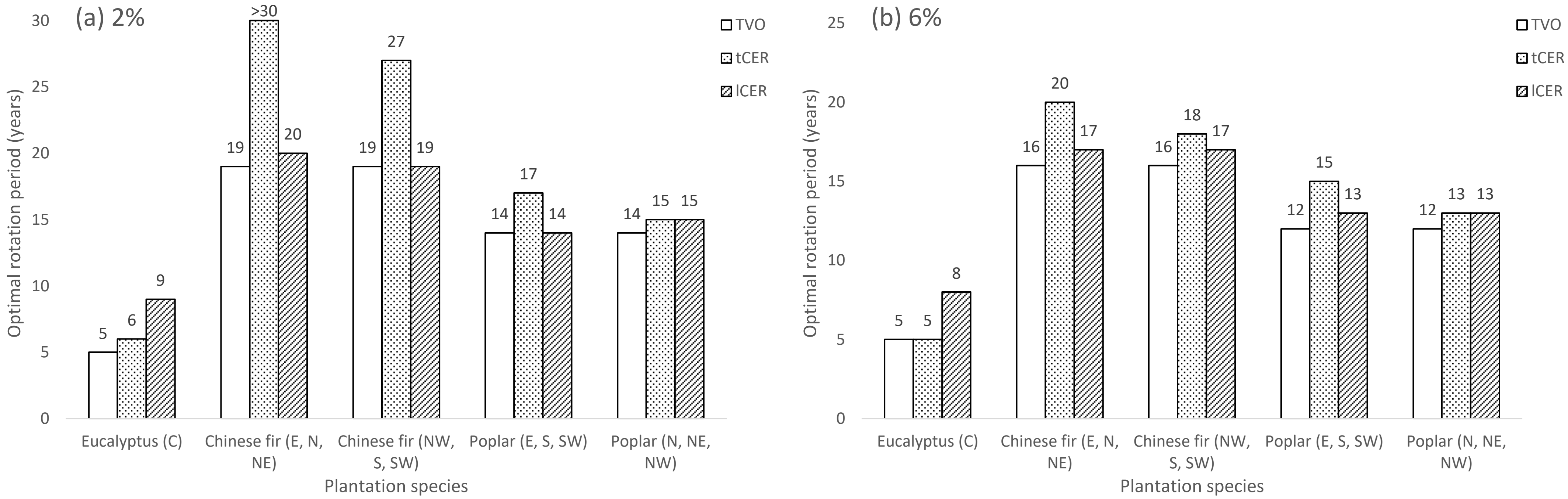

Fig. 6. Optimal rotation period under various carbon accounting methods with different discount rates.

Note: TVO = timber value only, tCER = temporary carbon credits, lCER = long-term carbon credits. C, E, N, NE, NW, S, and SW stand for China, and the eastern, northern, northeastern, northwestern, southern, and southwestern region, respectively.

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5. Conclusions

- The optimal rotation period increases when considering the joint production of timber and carbon sequestration.
- Carbon accounting regimes have a significant impact on the optimum rotation and on the revenue calculations.
- Forest managers have an incentive to apply tCER accounting to finance slow-growing plantations, and lCER for fast-growing ones.
- Carbon accounting regimes also affect the sensitivity of optimal rotation period of different plantation species to the changes of carbon prices and discount rates.
  - Chinese fir - highly sensitive - under tCER accounting,
  - Eucalyptus - most sensitive - under lCER accounting
  - Poplar - minimal impact - under both regimes

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Thank you and welcome questions!