Does Financial Development Favor Clean Technology Adoption?

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EEA, 2025

Traditional Wisdom

- Financial development is believed to promote clean technology adoption because
  - clean technology requires a high initial investment;
  - financial development alleviates firms' financing constraints and allows more firms to adopt clean technology.
- Existing studies find that financially constrained firms tend to use dirty technology and pollute more (Andersen, 2016; Xu and Kim, 2022; Bartram et al., 2022).

Contribution

- I propose a new mechanism through which financial development impedes the adoption of clean technology:
  - Investment $\begin{cases} \text{External Finance: } \uparrow \\ \text{Internal Finance (accumulated profits): } \downarrow \end{cases}$
- I build a general-equilibrium model of firm dynamics where
  - (i) the conventional wisdom holds in partial equilibrium: a positive effect.
  - (ii) an additional negative general-equilibrium effect.

    Financial development lowers the profits of firms as wage and interest rate increase in general equilibrium. $\rightarrow$Less internal funds.
- I find an inverted-U shape between financial development and the share of clean production.

Model

(Midrigan and Xu, 2014)

Model

- A continuum of entrepreneurs + monopolistic competitive market

$$\max_{c_t, a_{t+1}} \quad \sum_{t=0}^{\infty} \beta^t \ln(c_t) \quad \text{s.t.} \quad c_t + a_{t+1} = \pi_t + (1+r)a_t$$

- Credit constraint: the amount that the firm could borrow is limited by a constant fraction of their collateral

$$k_t \leq \underbrace{a_t}_{\text{Internal Fund}} + \underbrace{\theta k_t}_{\text{External Fund}} \Rightarrow k_t \leq \frac{1}{1-\theta} a_t$$

  Financial development means the increase in $\theta \in [0, 1]$.

- More assets allows for more capital and more profits.

Technologies: Clean vs Dirty

- Dirty technology $\xrightarrow{\text{Upfront Cost, } \kappa}$ clean technology
- Clean technology and dirty technology (Taylor and Copeland, 2013):

$$F^c(l,k) = sk^{\alpha}l^{1-\alpha}; \qquad F^d(l,k,z) = z^{\rho}(sk^{\alpha}l^{1-\alpha})^{1-\rho}$$

  - s:firm-level stochastic productivity.
  - z: the amount of firm-level pollution

- Incentive for clean technology: firms earn more profits each period with clean technology.

$$\pi^c(a,s) = \left\{ \max_{k,l} F^c(l,k)^{\frac{\sigma-1}{\sigma}} - wl - (r+\delta)k \quad \text{s.t. } k \leq \frac{1}{1-\theta}a \right\}$$

$$\pi^d(a,s) = \left\{ \max_{k,l,z} F^d(l,k,z)^{\frac{\sigma-1}{\sigma}} - wl - (r+\delta)k - \underbrace{\tau z}_{\text{tax}} \text{ s.t. } k \leq \frac{1}{1-\theta}a \right\}$$

Value Functions

$$V^c(a, s_i) = \max_x \ \ln\left(\pi^c(a, s_i) + (1+r)a - \gamma_L x\right) + \beta \sum_{j=1}^{N_p} f_{ij} V^c(x, s_j)$$

$$V^d(a, s_i) = \max_x \ \ln\left(\pi^d(a, s_i) + (1+r)a - \gamma_L x\right) + \beta \max\left[\sum_{j=1}^{N_p} f_{ij} V^d(x, s_j),\ \sum_{j=1}^{N_p} f_{ij} V^c(x-\kappa, s_j)\right]$$

- x: net assets that an entrepreneur brings to next period.

Technology Adoption Decisions

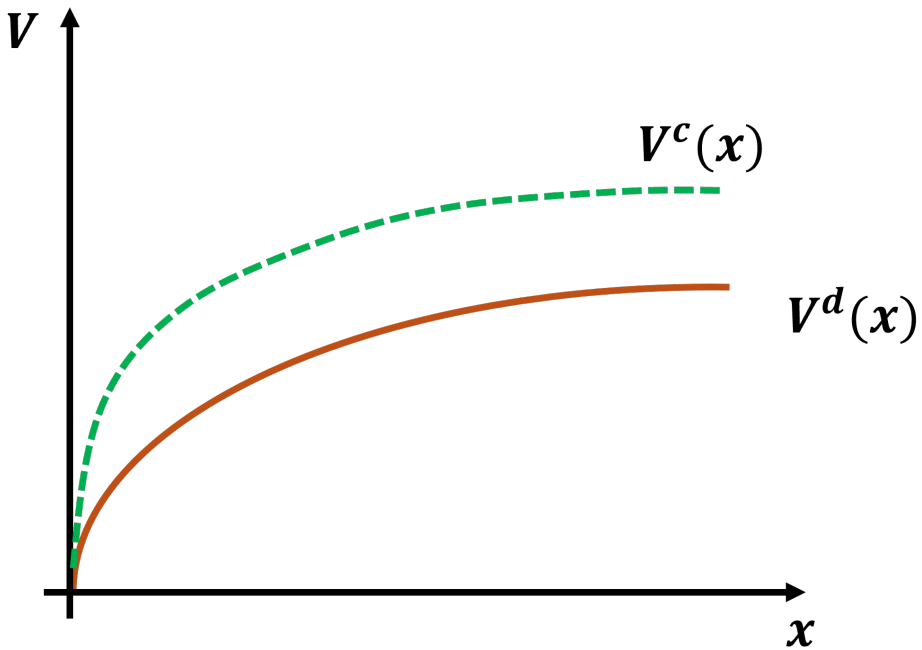


Figure 1: Value Functions

- Given net asset, clean technology renders higher profits, $V^c(x) > V^d(x)$.

Technology Adoption Decisions

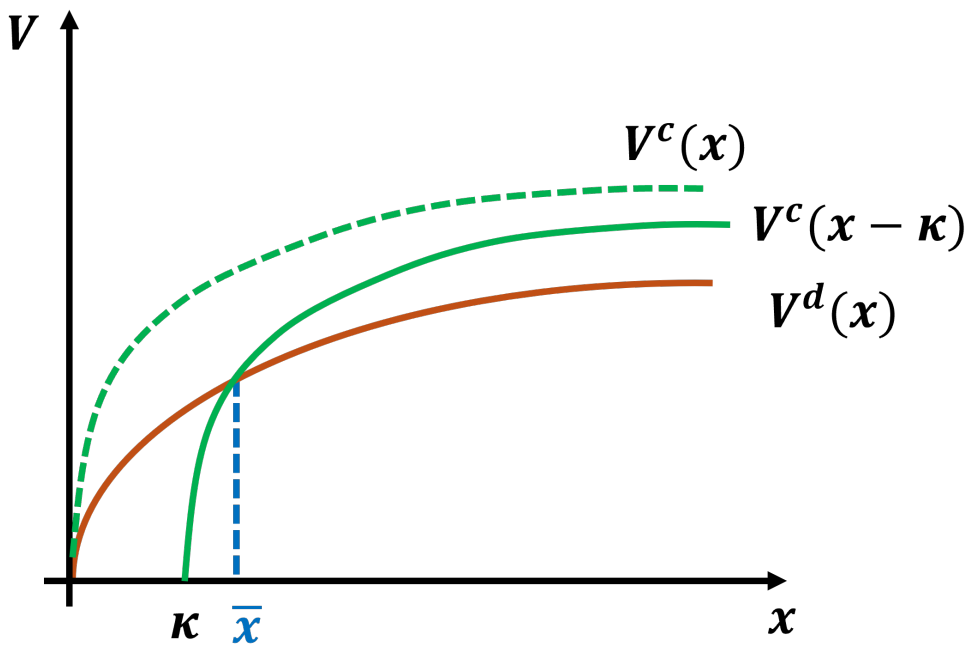
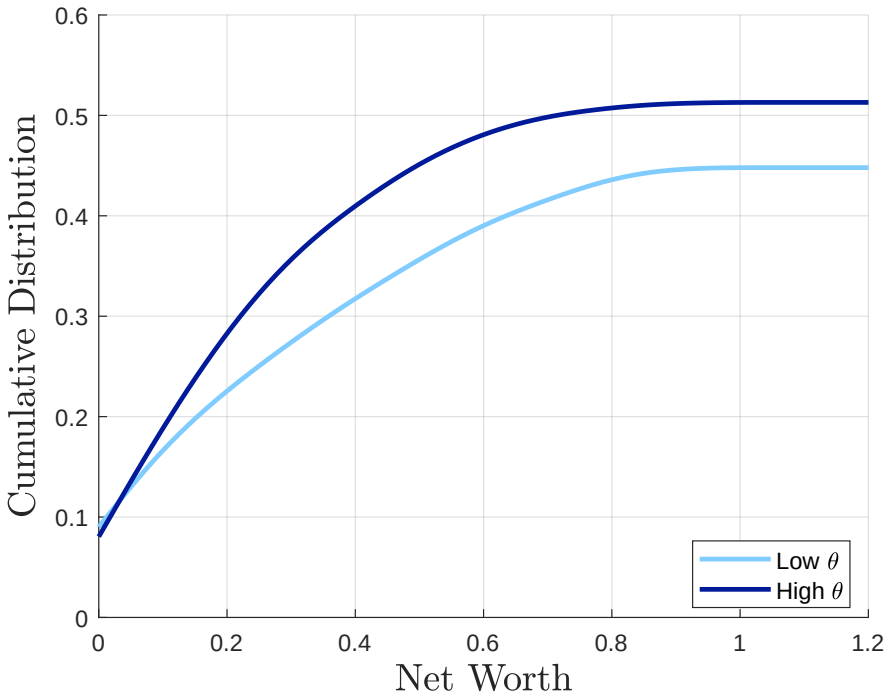


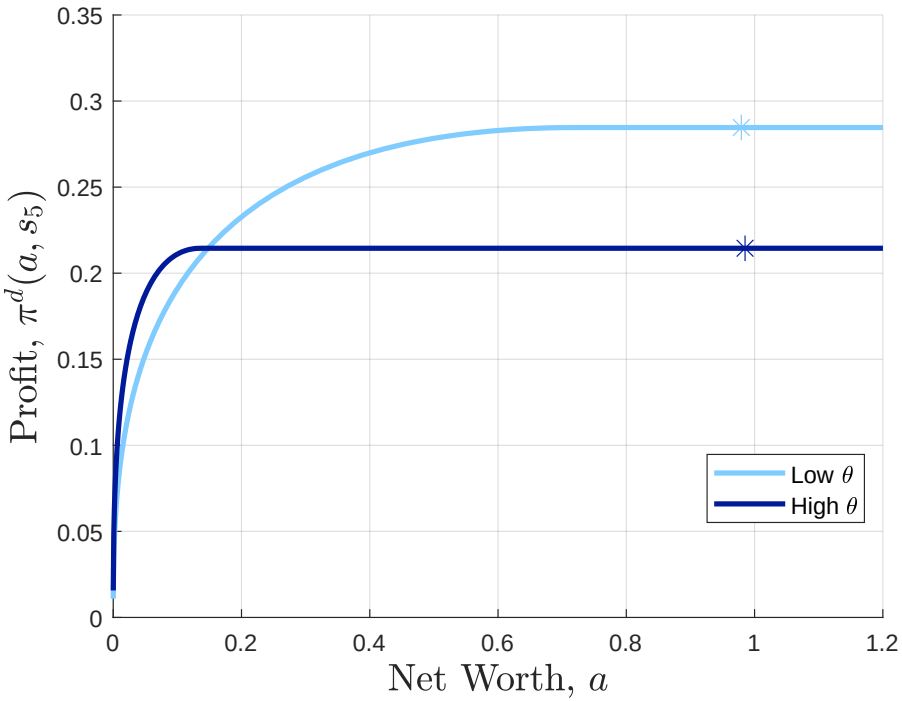
Figure 2: Value Functions

- Given net asset, clean technology renders higher profits, $V^c(x) > V^d(x)$.
- Only large firms adopt clean technology because clean technology requires upfront cost.
- The threshold decreases with θ: borrow more, less internal fund.

Dirty Firm Distribution



(a) Distribution



(b) Profits

Figure 3: Dirty Firm Distribution and Profits

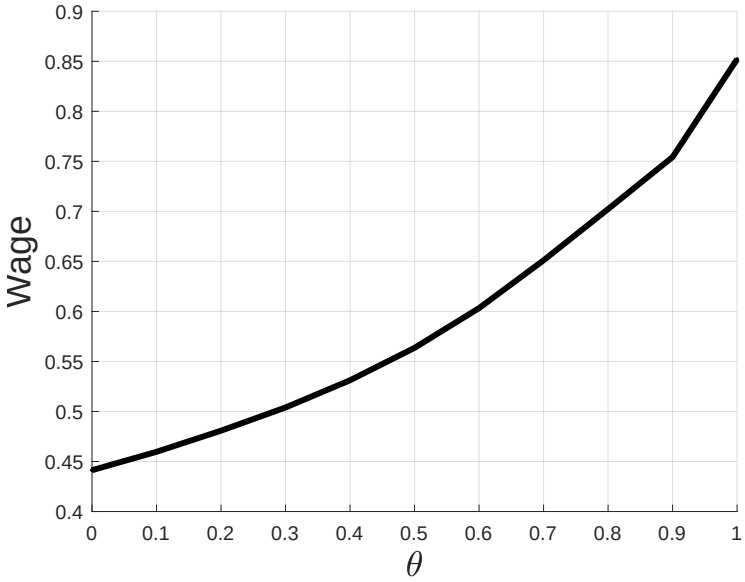
Quantitative Analysis

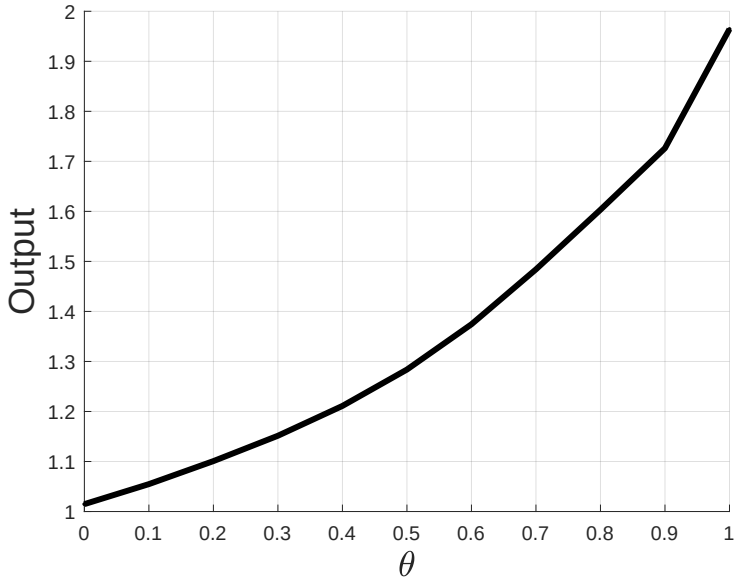
Calibration

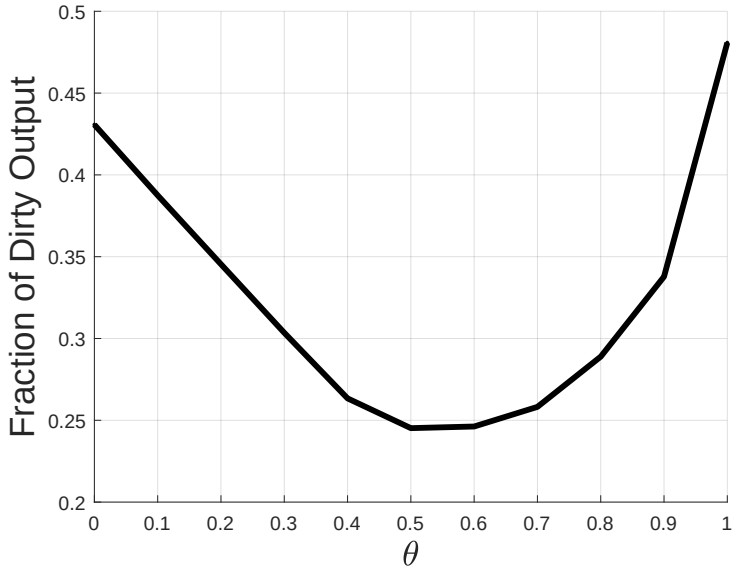
Table 1: Parameters Value – Benchmark Economy

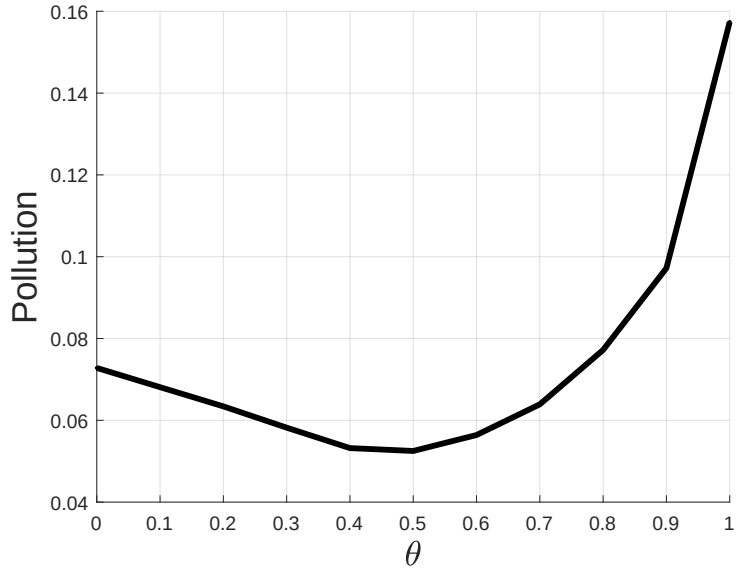
Parameter	Description	Value	Source
Standard Parameters:			
β	Discount factor	0.98	Standard
σ	Elasticity of substitution between intermediate goods	3.00	Hsieh and Klenow (2009)
α	Capital share	0.33	Greenwood et al. (2013)
δ	Capital depreciation rate	0.06	Greenwood et al. (2013)
γ_L	Growth rate of the economy	1.04	Standard
Firm Dynamic Parameters:			
ρ_s	Persistence in the AR(1) process of firm productivity	0.10	Midrigan and Xu (2014)
σ_s	Variance in the AR(1) process of firm productivity	0.50	Midrigan and Xu (2014)
υ	Rate of producers' entry and exit	0.05	Cooley and Quadrini (2001)
Environmental Parameters:			
ρ	Efficiency of abatement effort	0.05	Shapiro and Walker (2018)
τ	Environmental tax rate	0.20	

Effects of Financial Development: Open Economy









Effect Decomposition

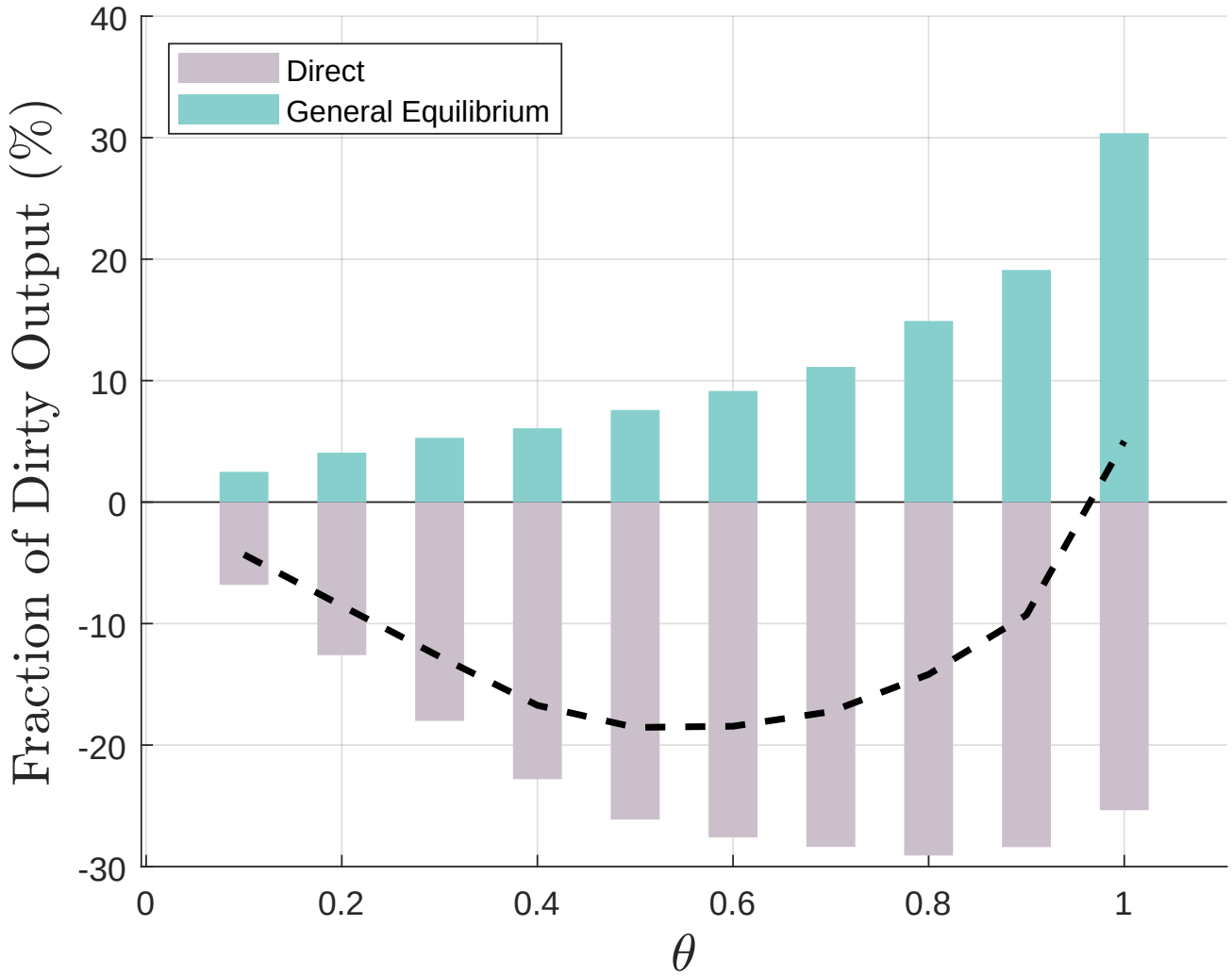


Figure 5: Effects Decomposition

Conclusion

- The study has two main findings:
  - (i) Financial development favors adoption of clean technologies primarily in underdeveloped financial markets.
  - (ii) Lower upfront costs make financial development more conducive to green production.
- Policy implication: different economies should take different approaches to facilitate clean technology adoption.
  - (i) For developing countries, financial development promotes both economic growth and environmental improvement.
  - (ii) Developed countries may need to concentrate more on reducing the upfront cost of clean technology.