Financial Development and Renewable Energy Diffusion

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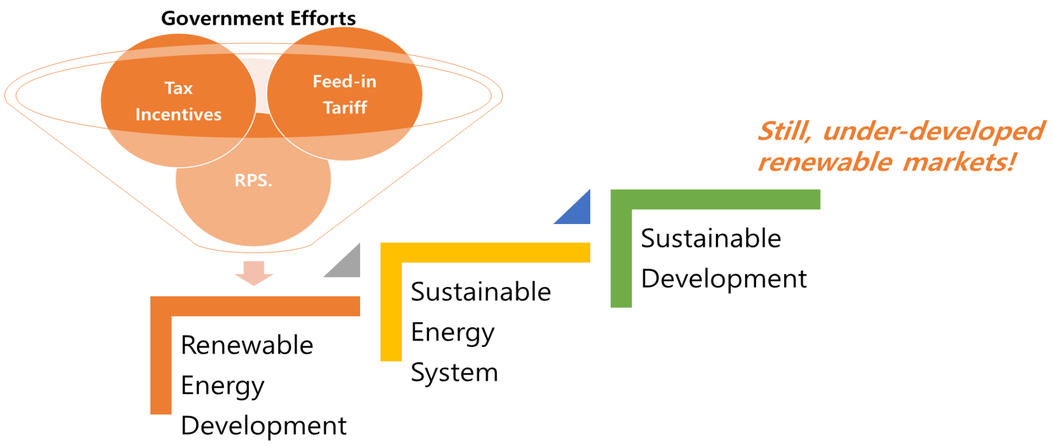
This research examine whether financial market development promotes the renewable energy diffusion by reducing external financing costs. We use a cross-technology cross-country panel data for the period 2000-2013 to argue the relationship between financial development and renewable energy growth. The main finding of this research is that renewable technologies that are relatively more depend on external financing develop disproportionately faster in countries with developed financial markets.

Situation



3 Main Barriers for Developing Renewable Energies

I. High Upfront Capital Costs
- IEA (2003), Sonntag-O'Brien, V., and E. Usher (2004)

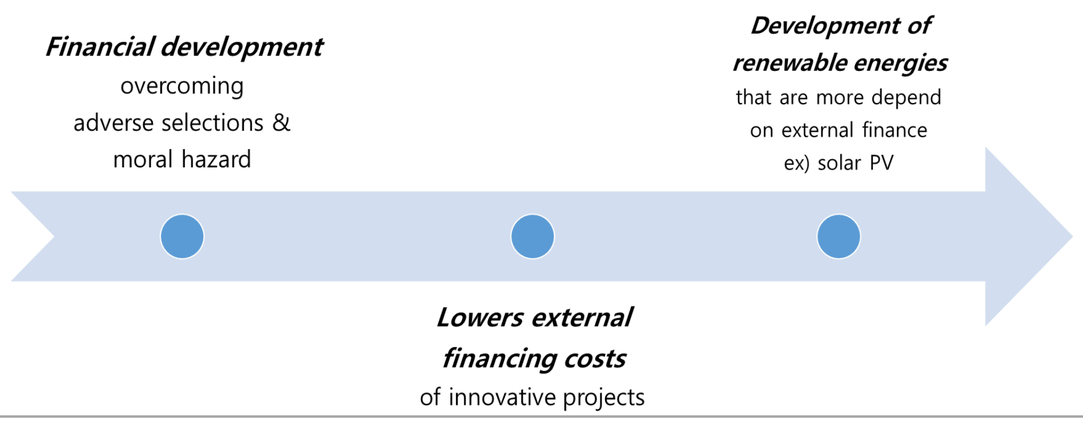
II. High Information Asymmetries
- Sonntag-O'Brien, V., and E. Usher (2004), Brunnschweiler (2010)

III. High degree of specificity for assets
- Balakrishnan and Fox (1993), Stoneman (2001), IEA (2003)

High External Financing Costs!

Needs for well-functioning financial markets that reduces external financing costs

Main economic mechanism



Research Questions

Does the development of financial market
promote renewable energies
that are heavily depend on external financing?

Main Findings

I. Equity market development encourages renewable energies that are more depend on external-finance.
- Especially, solar PV which is the most external-finance dependent grow faster in developed equity markets.

II. Credit market development promotes renewable energies that are more depend on external-finance.
- Especially, solar PV grow faster in developed credit markets.

Hypothesis development: Equity market development and renewables

Reducing adverse selections
- Informationally valuable equilibrium prices (Grossman 1976; Hsu, Tian, and Xu 2014)
- Amelioration of liquidity risks by facilitating trades (Levine 1997)
- Amelioration of idiosyncratic risks by providing diversification tools (King and Levine 1997; Levine 2005; WEIO 2014)

Reducing moral hazard problems
- Takeovers aligning managerial incentives with shareholders' (Scharfstein 1988; Levine 1997)

Promoting innovative projects
- None of collateral requirements that relieving possibility of financial distress (Brown, Fazzari, and Petersen 2009)

Hypothesis 1:
Equity market development encourages renewable energy sectors that are relatively more depend on external finance.

Hypothesis development: Credit market development and renewables

Reducing adverse selections
- Efficient allocation from selecting most promising firms and managers by banks (Greenwood and Jovanovic 1990)

Reducing moral hazard problems
- Monitoring managers by banks through long-run relationship with firms (Gerschenkron 1962; Levine 1997)
- Economizing aggregate monitoring costs by banks (Diamond 1984)

Promoting innovative projects
- Staged financing from banks (Stulz 2000)

Hypothesis 2:
Credit market development encourages renewable energy sectors that are relatively more depend on external finance.

Econometric Model

Building on the seminal works of Rajan and Zingales (AER, 1998) and Hsu, Tian and Xu (JFE, 2014):

For technology 'j', country 'i', and year 't'

$$\text{Renewable energy development}_{j,i,t+1} = \alpha + \beta(\text{Financial development}_{i,t} * \text{Dependence}_j) + \gamma\ \text{Share of electricity generation}_{j,i,t} + \delta_{i,t+1} + \mu_j + \varepsilon_{j,i,t+1}$$

- $\delta_{i,t+1}$: Country-year fixed effects absorbing time-variant country characteristics
- μ_j: Technology fixed effects
- Clustering standard errors by country and technology

	Annual Renewable Capacity$_{j,i,t+1}$			Cumulative Renewable Capacity$_{j,i,t+1}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Equity$_{i,t}$ × Dependence$_j$	0.010** (0.005)			0.019*** (0.005)		
Credit$_{i,t}$ × Dependence$_j$		0.012** (0.005)			0.016*** (0.005)	
Overall$_{i,t}$ × Dependence$_j$			0.005** (0.002)			0.008*** (0.002)
Share of electricity generation$_{j,i,t}$	2.488*** (0.351)	2.399*** (0.328)	2.418*** (0.329)	3.204*** (0.705)	3.148*** (0.648)	3.148*** (0.643)
Country-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Technology fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.540	0.554	0.548	0.574	0.593	0.587
Observation	1259	1241	1225	1268	1250	1234

Model (1)
- **Solar PV** (Dependence=2.76) **develop faster annually by *2.15%*** (=0.010*78.05*2.76) in the 75th percentile (103.38) developed equity market compared with the 25th percentile (25.33) developed equity market.

Model (2)
- **Solar PV** (Dependence=2.76) **develop faster annually by *4.34%*** (=0.012*131.06*2.76) in the 75th percentile (171.52) developed credit market compared with the 25th percentile (40.46) developed equity market.

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