

FIRM PRODUCTIVITY, ENERGY EFFICIENCY AND EXPORT IN ASIAN EMERGING AND DEVELOPING COUNTRIES

by

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Agenda

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1. Motivation

- Porter hypothesis implies that impactable environmental policies provoke firm efficiency, innovation and performance.
- Energy efficiency-related productivity benefits are larger than the energy-related benefits. High productive firms are the key elements of the economy's aggregated economic growth.
- According to the global economic growth projections, the industrial sector required high energy efficiency in energy consumption in the developing world. The primary international energy use of developing Asia is expecting to increase by 56% in 2035 from 34% in 2010 (ADB 2013).
- The sustainable development goals (SDGs) also highlight energy efficiency improvement, expansion in energy infrastructure investment, and sustainable energy services in developing countries.
- The goal related to energy efficiency improvement leads this study's motivation in two aspects: first, present research utilizes the measures of energy efficiency, assessing the firm performance related to energy efficiency in terms of the environment across Asian emerging and developing countries.
- Second, this paper analyzes the impact of a firm's energy efficiency on exports of firms for several Asian emerging and developing countries.

2. Literature Review

- Many studies examine the validity of Porter hypothesis; however, the results are mixed.
- Prior research failed to conclude the clear result about the validity of Porter hypothesis because different studies use different environmental variables and definitions (Zeng et al., 2010).
- Hammamoto, (2006); Alpay et al. (2002); Berman and Bui (2001); Harrington et al.(2000) found the strong validation of porter hypothesis.
- Kreickemeier and Richter (2014) also support the argument that "high environmental efficiency is associated with firm's high productivity".
- Cohen et al. (1995); Hart and Ahuja (1996); Russo and Fouts (1997) also find a positive relationship between environmental and firm's profit performance.
- Andrew et al. (2007) highlighted that firms play a role in mediating international trade and attract trade flows in the economy.
- Eifert et al. (2005); Worrell et al. (2003); Boyd and Pang (2000) investigate the similar relationship for different industries, regions and time period and find positive correlation.

3. The Pooled OLS Model

- $$\ln y_i = \alpha_0 + \alpha_1 L_i + \alpha_2 \ln K_i + \alpha_3 EE_i + \alpha_4 QC_i + \alpha_5 EX_i + \alpha_6 FS_i + \alpha_7 T_i + D_c + D_{in} + \varepsilon_i$$
- Where y_i indicates the log of firm productivity proxied by labor productivity measured as the total revenue of a firm per worker.
- L_i symbolizes labor, it refers to the numbers of permanent full-time workers.
- K_i uses for a firm's capital intensity in log form and is calculated as a fixed investment per worker.
- EE_i Presents the energy efficiency of a firm, using three different measures of energy efficiency. (1) The inverse of the proportion of energy cost to total revenue. (2) The inverse of the ratio of energy cost to annual value-added. (3) The inverse of energy cost to total variable cost ratio.
- QC_i is dummy variable labelled as if firm is having quality certificate from foreign company.
- Firm exports indicate by EX_i , followed by a firm involved in direct export.
- FS_i is used to account for firm size.
- T_i shows if firm use technology license.
- D_c and D_i are country and industry dummy variables, respectively. ε_i denotes the white noise error term.

3.1 The Probit Model

- The study uses a binary probit model for the empirical analysis of the association between export, energy efficiency, and firm productivity
- $$EX^* = \sum_{m=1}^m \beta_m X_m + \epsilon$$
- $$EX = \{1 \text{ if } EX^* > 0 \text{ and } 0 \text{ otherwise}\}$$
- EX^* depends on m observable variables X_m where $m = 1, \dots, M$
- the observable variables are energy efficiency, firm productivity, foreign-owned firms, labor, technology use, and firm size.

4. Data

- We use 15 Asian Emerging and Developing Countries:
 - By definition of the IMF, Asian emerging and developing countries are: Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Mongolia, Myanmar, Nepal, Philippines, Papua NG, Solomon Islands, Sri Lanka, Thailand, Timor Lieste, Vietnam (IMF 2017).
- Cross sectional data over the time period of 2011 to 2016 collected from:
 - World Development Indicator (WDI) Database for 2010 exchange rate
 - World Bank Enterprise Survey (WBES) for firm-level variables

4.1. Data Description I

Table 1.1: Summary Statistics of Key Variables

Variable	Obs.	Mean	SD	Min	Max
Firm Productivity	6,940	109.19	687.86	.05940	18818.82
Capital Intensity	6,940	53.937	677.998	.00137	47277.29
Energy Intensity1*	6,940	.1885	.0413	7.81e-07	.2666
Energy Intensity2**	6,940	0.179	0.194	1.33e-06	01
Energy Intensity3***	6,940	0.066	.0622	1.90e-06	.3839
Employees	6,940	89.60	126.601	5	810
Technology use	6,940	.1452	.352	0	1
Exports	6,940	.1945	.3958	0	1
Foreign-owned firms	6,940	.0646	.2460	0	1
Quality certificate	6,940	.3809	.4856	0	1
Firm Size	6,940	1.948	.746	1	3

4.2. Data Description II

Table 1.2. Measures of energy intensity by Countries

Country	Year	Energy intensity 1*	Energy intensity 2**	Energy intensity 3***
Mongolia	2009	0.052	0.200	0.086
Mongolia	2013	0.035	0.191	0.043
Sri Lanka	2011	0.047	0.207	0.075
China	2012	0.048	0.171	0.080
Lao PDR	2012	0.052	0.178	0.080
Lao PDR	2016	0.055	0.184	0.093
Bangladesh	2013	0.035	0.168	0.052
Nepal	2013	0.043	0.189	0.069
Myanmar	2014	0.042	0.139	0.071
Bhutan	2015	0.021	0.099	0.043
Vietnam	2015	0.032	0.155	0.051
Indonesia	2015	0.038	0.175	0.059
Philippines	2009	0.052	0.021	0.084
Philippines	2015	0.058	0.254	0.087
Malaysia	2015	0.087	0.266	0.151
India	2014	0.041	0.200	0.059
Cambodia	2016	0.076	0.233	0.139
Thailand	2016	0.037	0.140	0.063
		0.047	0.176	0.076

4.3. Data Description III

Table. 1.3. Measures of energy intensity by firms

Firm Size	Total Firms	Exporting firms	Energy intensity 1*	Energy intensity 2**	Energy intensity 3***
Small Firms	2,123	129	0.049	0.212	0.075
Medium Firms	3,053	511	0.042	0.191	0.065
Large Firms	1,764	710	0.036	0.154	0.056
Total & Avg. values	6,940	1,350	0.042	0.185	0.065

4.4. Data Description IV

Table 1.4. Measures of energy intensity by Industry

Industry	Total firms	Exporting firms	Energy intensity 1	Energy intensity 2	Energy intensity 3
Food	979	163	0.045	0.195	0.073
Garments	705	231	0.034	0.131	0.054
Fabricated Metal	506	85	0.038	0.172	0.061
Textiles	607	137	0.040	0.173	0.062
Plastic & Rubber	712	118	0.056	0.226	0.088
Chemicals	598	115	0.041	0.167	0.066
Basic Metals	391	46	0.041	0.193	0.058
Non- Metallic Minerals	498	59	0.048	0.191	0.078
Transport Machines	313	53	0.041	0.176	0.062
Others	1,631	343	0.040	0.176	0.062
Total & Avg. values	6,940	1,350	0.042	0.18	0.066

5.1 Results: Impact of measure of energy efficiency on Firm productivity

Firm Productivity	All Firms	Small Firms	Medium Firms	Large Firms
ener_Eff1	0.00141 (0.00186)	0.215*** (0.0782)	-0.000187 (0.000652)	0.00904* (0.00532)
Export	0.281*** (0.0406)	0.267** (0.112)	0.373*** (0.0625)	0.266*** (0.0602)
Cap_Ints	0.291*** (0.00965)	0.212*** (0.0153)	0.306*** (0.0150)	0.338*** (0.0199)
labor	0.0982*** (0.0205)	0.0681* (0.0361)	0.106*** (0.0337)	0.0957** (0.0386)
Quality_cert	0.299*** (0.0356)	0.215*** (0.0652)	0.314*** (0.0525)	0.316*** (0.0738)
Tech_license	0.308*** (0.0464)	0.299*** (0.0979)	0.434*** (0.0706)	0.150** (0.0741)
Firm size	0.111***			
_cons	5.891*** (0.143)	6.793*** (0.196)	5.751*** (0.279)	5.606*** (0.403)
N	6940	2123	3053	1764
R ²	0.398	0.466	0.368	0.383
adi_R ²	0.395	0.456	0.360	0.370

5.2 Results: Impact of energy efficiency1 on firm productivity in different industries

	food	Garments	Fabricated	textile	plastic & Rub	chemical	basic metals	non-met minerals	transport	others
ener_Eff1	0.515*** (0.0882)	0.230*** (0.0820)	0.659*** (0.115)	0.567*** (0.133)	-0.00192*** (0.000714)	0.00506*** (0.00182)	0.282*** (0.0334)	0.371*** (0.0902)	0.359*** (0.0808)	0.233*** (0.0847)
Export	0.381*** (0.119)	0.227** (0.109)	0.0637 (0.131)	0.522*** (0.122)	0.231** (0.111)	0.571*** (0.136)	0.0793 (0.162)	-0.189 (0.181)	0.115 (0.128)	0.287*** (0.0766)
Cap_Ints	0.288*** (0.0250)	0.227*** (0.0253)	0.228*** (0.0328)	0.280*** (0.0315)	0.280*** (0.0294)	0.335*** (0.0299)	0.294*** (0.0362)	0.305*** (0.0456)	0.211*** (0.0341)	0.271*** (0.0198)
labor	-0.0325 (0.0536)	0.0401 (0.0582)	0.0648 (0.0690)	-0.0109 (0.0582)	0.0820 (0.0590)	0.0920 (0.0619)	0.124 (0.0804)	0.146 (0.0898)	0.303*** (0.0809)	0.0889** (0.0387)
Quality_cer	0.367*** (0.105)	0.282** (0.124)	0.387*** (0.112)	-0.0170 (0.124)	0.312*** (0.0973)	0.429*** (0.122)	-0.0715 (0.116)	0.0267 (0.150)	0.280** (0.123)	0.220*** (0.0690)
Tech_licens	0.211* (0.119)	0.210* (0.115)	0.154 (0.144)	0.205 (0.148)	0.361** (0.154)	0.545*** (0.144)	0.598*** (0.221)	0.663** (0.265)	0.249** (0.123)	0.00393 (0.0832)
Firm size	0.313*** (0.0853)	0.0155 (0.0880)	0.217** (0.101)	0.175** (0.0839)	0.0752 (0.0868)	0.126 (0.0916)	0.256** (0.116)	0.125 (0.121)	-0.122 (0.121)	0.0849 (0.0590)
_cons	5.891*** (0.309)	6.493*** (0.307)	8.214*** (0.330)	5.458*** (0.431)	6.409*** (0.427)	5.845*** (0.440)	4.716*** (0.420)	5.429*** (0.478)	5.345*** (0.385)	6.137*** (0.436)
N	979	705	506	607	712	598	391	498	313	1631
R²	0.504	0.431	0.433	0.523	0.373	0.441	0.406	0.440	0.527	0.436
adj. R²	0.494	0.414	0.413	0.506	0.356	0.423	0.377	0.419	0.505	0.425

5.3 Results: Probit estimation of Impact of firm productivity on exporting firms

	All Firms	Small Firms	Medium Firms	Large Firms
ener_Eff1	0.000124 (0.000640)	-0.0372* (0.0202)	-0.0396 (0.0358)	0.0345* (0.0204)
firm_prod	0.119*** (0.0168)	0.134*** (0.0473)	0.154*** (0.0269)	0.0966*** (0.0289)
ln_Cap_Ints	0.0227* (0.0137)	0.0111 (0.0369)	0.0453** (0.0221)	0.00603 (0.0218)
lnlabor	0.357*** (0.0286)	0.426*** (0.0602)	0.373*** (0.0446)	0.293*** (0.0499)
qualitycert	0.341*** (0.0476)	0.450*** (0.122)	0.341*** (0.0686)	0.302*** (0.0801)
foreign_owned	0.799*** (0.0768)	0.639** (0.251)	0.973*** (0.118)	0.755*** (0.112)
Tech_license	0.116** (0.0536)	0.305* (0.169)	0.144* (0.0807)	0.0408 (0.0791)
Firm size	0.0924** (0.0442)			
N	6927	2062	3037	1763

6. Conclusion

- This study finds the connection between energy efficiency, firm productivity, and exports in Asian emerging and developing countries.
- The following research highlights a relevant outcome in the environmental context of energy saving on exporting and productivity.
- The empirical results specify the positive correlation between energy efficiency and labor productivity and consistent with three different proxies of energy efficiency.
- The probit estimates are also supporting the positive relationship between exports and energy efficiency for large firms and vice versa for small firms.
- These findings are consistent with the results of (Montalbano & Nenci, 2019) they also found that labor productivity has a positive relation with energy efficiency.
- These results also support porter hypotheses, which implies that environmental policies to increase energy efficiency also increase productivity.
- These results indicate significant policy implications related to energy saving.
- Improving energy efficiency could reduce the necessity for investments in energy infrastructure, fuel price volatility, low fuel costs, high competitiveness, improved total well-being, and enlarged energy affordability.

Thanks for your Attention