Trade in Renewable Energy Equipment

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Motivation

- Rapid growth in renewable energy deployment and clean energy technology transfer across the world considered critical in Kyoto/ post-Kyoto and WTO.

- Evidence on increasing sophistication of manufactured exports from emerging countries.

=> Global international trade can play an important role in accelerating innovation and cost reduction in green technology, and help to set stringent greenhouse gas emission targets.

Literature on trade in green technology equipment

- Competition from Chinese imports (at 6-digit level) stimulate further innovation and patent activity among Western European firms in a bid to survive and increase profits (Bloom et al 2011).

  i.e. product quality or technology differentiation of imports from China not withstanding!

- Constantini and Crespi (2008) found more stringent environmental regulation has been a crucial driver of export among EU nations (a la Porter-Linde hypothesis).

Understanding the cross-national pattern of US import of wind and solar energy equipment

- Choice of US import market since it ranks among the leading nations in renewable energy technology, as well as trade => products entering the market require quality-conformity.

- Renewable energy forms of wind and solar have been the fastest growing power-generation technologies in the last twenty years.

- 1990s considered to be the take-off period in the long-term diffusion of wind turbine and solar cell technologies (Jacobson and Lauber, 2006)

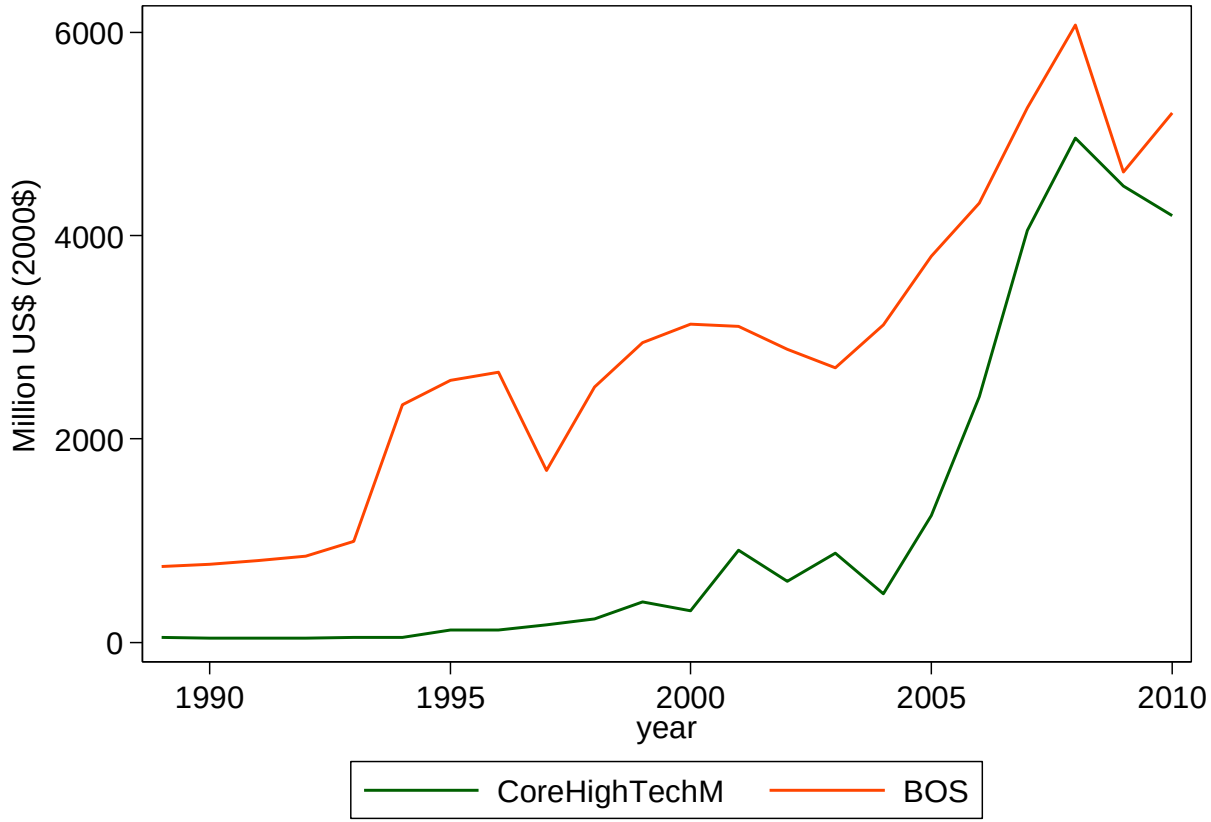
- We distinguish between imports from relatively rich vs poor countries. (Total 24 countries, which together accounted >90% of US imports by value in each of products)

- Period of analysis: post-liberalization years.

- Product coverage (10-digit US HTS codes)
  - 5 products - core high-technology equipment (*blade* , *hub, wind turbine, solar photovoltaic cells* & *modules*)
  - 22 products - balance of system equipment (anemometer, gearbox, rectifier, tower, etc.) Including obsolete codes

- *Nature of the products*: components and final products.

US imports of solar and wind energy equipment increased from US$0.8 bn in 1989 to US$9.4 bn in 2010



- Although Denmark, Germany, Japan, United Kingdom, have experienced drastic erosion of market share in the US, they continue to maintain dominant shares in some products– reflecting the lead in innovation and high-value products.

- ***Selected countries' US market shares at the initial and end points :***

Country	***Blades***		***Wind Turbines***		***Hub& Drive***		***Solar Modules***		***Solar Cells***	
	1989	***2010***	***1996***	***2010***	***1995***	***2010***	***1989***	***2010***	***1989***	***2010***
China	0.97	7.22	0.04	0.39	0.12	12.70	0.04	43.72	0.00	13.75
Denmark	1.13	10.72	95.37	45.92	2.02	1.94	0.00	0.00	0.19	0.00
Germany	31.29	14.37	0.43	7.55	19.48	9.51	0.88	1.87	5.13	24.14
India	0.00	9.74	0.00	10.04	0.52	1.13	0.79	0.95	0.00	0.72
Japan	10.45	3.59	0.23	17.29	18.01	9.64	53.59	10.99	25.14	2.08
Mexico	0.12	8.69	0.00	0.06	3.66	35.67	34.74	23.36	7.31	0.31
Spain	0.67	4.14	0.00	11.41	0.00	2.93	0.00	0.12	0.00	0.07
United Kingdom	18.10	5.20	3.65	3.67	7.05	2.55	1.91	0.02	0.25	0.28

- In the case of “green energy” trade, the poorer South is emerging as a key provider of cheap equipment for renewable-power generation to the North for its production and consumption of clean energy.

- What are the macro factors driving this export surge into the US?

$$\log\left(Import_{ijt}^{us}\right) = \alpha_j + \beta.t + \delta\log\left(GDP_{j,t-1}\right) + \gamma.\log\left(FDI_{m,j,t-1}\right) + \mu.\log\left(RenewElec_{j,t-1}\right) * Core + trend\ \&\ FDI\ interaction\ terms + Dummy_c + Dummy_m + \epsilon_{ijt}, \quad i = 1, \ldots, 27\ products \in Category;\ j = 1, \ldots 24\ countries$$

We examine the role of

1) Home market size;
2) Domestic renewable energy sector size; and
3) US sector-specific FDI outflow

- Since home market effect is stronger in industries with more differentiated products (Krugman 1980, Hanson and Xiang 2004)
- Supportive government policies have led to rapid growth in renewable energy across the countries (Lewis and Wiser 2007, Yu et al 2009). We use a proxy of size.
- FDI flows can serve as an important channel of technology diffusion and export and economic growth in the host countries (Barrell and Pain 1997, Borensztein et al 1998, OECD 2009)

Data

- Trade data: Feenstra's database 1989-2006, USITC (2007-2010)
- FDI data: USBEA (NAICS 3 digit)
- Price indices: US Bureau of Labour Statistics
- Country-specific data: World Bank

Key findings

- Larger countries are exporting significantly more

- Domestic renewable power generation played a significant role in the export of core high-tech wind and solar equipment.

=> Government support in the sector has significant positive impact on export performance

- For the poor countries, US sector-specific FDI (lag of 1 year & 3 years) exhibits significant positive elasticity of export in core equipment.

  (But not for the rich countries)

	1	2	3	4	5	6
Trend	0.0532***	0.0337***	0.0534***	0.0436***	0.0566***	0.0406***
T*Core	0.0855***	0.0851***	0.0843***	0.0867***	0.0844***	0.0676***
T *Poor	0.0410***	0.0149	0.0165*	0.0187	0.0290**	0.0242*
T* Poor*Core	0.0214*	0.0273	0.0111	0.0114	0.0199	0.0095
T*China			0.1739***	0.0670***	0.1535***	0.0414
T*China*Core			-0.0145	0.0027	-0.0329	-0.0201
T*India			0.0881***	0.0262	0.0786***	0.0096
T*India*Core			0.1236***	0.1104***	0.1163***	0.0855***
Log(FDI_{t-1})		0.3237***		0.3233***		0.2598***
log(FDI_{t-1})*Core		-0.3716***		-0.3529***		-0.4755***
log(FDI_{t-1})*Poor		0.2306***		0.2050***		0.2496***
log(FDI_{t-1})*Poor*Core		-0.0686		-0.0535		-0.0013
Log(GDP_{t-1})		0.6641**		0.2081		0.464
Log($RenElec_{t-1}$)*Core						0.2600***
$Dummy_c$	-1.4058***	1.1766***	-1.3861***	1.0247***	-1.2953***	-3.6794***
$Dummy_m$	0.1623***	0.0186	0.1563***	0.0231	-0.0065	-0.0859**
Constant	12.0696***	1.4292	12.0693***	7.3094	12.5900***	4.7262
Observations	9155	9155	9155	9155	7744	7744
R-squared	0.2632	0.2959	0.2721	0.2983	0.2722	0.2978

	1	2	3	4	5	6
Trend	0.0556***	0.0266***	0.0554***	0.0479***	0.0570***	0.0394***
T*Core	0.0789***	0.0842***	0.0802***	0.0873***	0.0860***	0.0760***
T *Poor	0.0493***	0.0165	0.0274***	0.0218*	0.0441***	0.0317**
T* Poor*Core	0.0186	0.0022	0.0115	-0.0076	0.0189	0.0025
T*China			0.1641***	0.1519***	0.1529***	0.1135***
T*China*Core			-0.0097	-0.018	-0.0256	-0.0421**
T*India			0.1060***	0.0984***	0.0803***	0.0615**
T*India*Core			0.1241***	0.1380***	0.1173***	0.1231***
$Log(FDI_{t-3})$		-0.0204		-0.019		-0.0352
$log(FDI_{t-3})$*Core		-0.0708		-0.0662		-0.1730***
$log(FDI_{t-3})$*Poor		0.0232		-0.0234		-0.0838
$log(FDI_{t-3})$*Poor*Core		0.1765**		0.2268***		0.3371***
$Log(GDP_{t-1})$		1.3354***		0.3656		0.9105**
$Log(RenElec_{t-1})$*Core						0.1940***
$Dummy_c$	-1.2743***	-1.2132***	-1.2928***	-1.2680***	-1.2923***	-5.2065***
$Dummy_m$	0.1507***	0.1481***	0.1491***	0.1497***	-0.0076	-0.0046
Constant	12.0067***	-5.0807	11.9922***	7.3308*	12.5112***	0.6744
Observations	8933	8933	8933	8933	7609	7609
R-squared	0.2793	0.2822	0.2864	0.2874	0.2868	0.2923

- At the broad industry level our analysis does not identify the exact role of FDI in the export growth (spillover, technology transfer, etc) of sophisticated clean energy equipment.

- i.e. the processing component of exports from developing countries (Koopman et al 2008; Wang and Wei 2008), or embodied imports (distinct HTS) is not evident.

- Trend of technology access through mergers and acquisition in the renewable energy sector.

- Firms from developing countries like China and India have engaged in acquisition of component-specialist firms in a bid to access technology, apart from licensing technology or entering into joint-ventures.

- Firm-level data could explore channels of technology diffusion and its role in the growth of trade in the renewable energy industry.

- Thank you