Acquisition of technological capabilities through the Clean Development Mechanism: Some quantitative explorations

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Layout of Presentation

- Introduction
- Objective
- Technology acquisition, absorption and capability building: Theoretical framework
- Review of Literature
- Methodology, Data base
- The Model
- Estimates & conclusion
The context

• Post Kyoto protocol: future of CDM uncertain

• Intense worldwide debate on the usefulness of CDM

• The present study contributes to this debate.

• Explores the contribution of CDM in building capabilities of developing countries in green technologies with a particular focus on Indian manufacturing firms.
Objectives

- Distinguishes between technology acquisition, technology absorption and technological capabilities
- Focuses on absorption and capabilities
- Investigates the role of CDM in technology absorption and building technological capabilities in Indian manufacturing in terms of
  - R&D efforts (an indicator of absorption), and
  - Firms’ performance indicators
Theoretical framework:
1. Technology matters

- New growth theories’ approach
  - Human skills an important determinant of growth

- Evolutionary approach (inter alia, Nelson and Winter 1982; Nelson, 1993; and Lundvall 1992)
  - Firm level heterogeneity in technological capabilities an important determinant of performance
2. Technology acquisition a necessary condition for tech capabilities in developing countries

• Developed countries: Technological capabilities are organically developed through own R&D

• Developing countries: Distinction between
  - technology creation,
  - technology acquisition, and
  - technology learning and technological capabilities

• Three major modes of technology imports:
  - Imports of capital goods (embodied),
  - technology licensing (Disembodied) and
  - FDI (disembodied)
3. Tech acquisition is not a sufficient condition for tech capabilities

- The relationship is ambiguous.

- FDI: latest technologies acquired through FDI but may not have spillover effects to upgrade domestic firms’ capabilities; Subsidiaries may remain dependent on parents);

- Technology licensing: Market acquisition: may have substitution or complementary effects

- Imports of capital goods: may induce incremental changes.

- Several firms and country specific factors affect the impact of technology acquisition on local R&D and tech building
CDM and technology transfer

• CDM implies technology transfers through three mechanisms

  – FDI if equity stake by foreign partners
  – Technology licensing if contractual
  – Capital goods imports if unilateral
But does that mean upgrading in green technologies?

Two hypotheses

H1: CDM involvement strengthens technological capabilities of domestic firms in terms of R&D efforts.

H2: CDM involvement results in enhancement of firms’ performance.
Strong possibility of technology transfers through CDM

- CDM: project based
- Eligibility criteria: sustainable growth and additionality
- Rules and processes
- Implemented through the CDMA
- Additionality criterion and its strict implementation has strong implication for technology transfer
Our interviews: Mixed reactions

- No technology transfer, purely indigenous technology but in the process new technologies developed indigenously
- Developed countries are unwilling to share for the fear of spill overs.
- Suppliers in the value chain might be undertaking R&D
- DCs have moved on to least developed countries for CERs purchase: Political economy of CDM

- GIZ: Undertaking a vast study for the development effects of CDM but technology components is ignored,

- Policy makers have a positive view of CDM; Keen to know the results.
Global CDM projects

- Total projects initiated 6079 by March 2011
- Investment: $143 billion

- Total projects registered: 4730 by October, 2012

- India: 860 by June end 2012.
Where does India stand in global CDM projects?

Sources: unfccc website
Growth of CDM projects in India:
India’s total number of CDM projects registered from 2000 to 2011. Slow down in the number of CDM projects:
- Global slow down.
- Fall in the international prices of CERs.
- EU focus of obtaining CERs from least developed countries instead of the major CDM countries.

Source: IGES CDM Project Database
Distribution by types of projects in India: Registered CDM Projects 31 May 2012.

<table>
<thead>
<tr>
<th>Project Type</th>
<th>No. of Projects</th>
<th>Avg. Annual Emission Reductions (t-CO2)</th>
<th>Amount of Issued CERs t-CERs)</th>
<th>Review Requested</th>
<th>Rejected</th>
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<tbody>
<tr>
<td>Wind Power</td>
<td>290</td>
<td>32,507</td>
<td>13,255,604</td>
<td>60</td>
<td>8</td>
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<td>Biomass</td>
<td>191</td>
<td>38,850</td>
<td>10,194,695</td>
<td>65</td>
<td>16</td>
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<td>Hydro Power</td>
<td>93</td>
<td>82,775</td>
<td>3,657,286</td>
<td>24</td>
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<td>Energy efficiency</td>
<td>79</td>
<td>108,702</td>
<td>1,486,622</td>
<td>21</td>
<td>9</td>
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<td>Waste gas/heat utilization</td>
<td>73</td>
<td>74,834</td>
<td>12,991,240</td>
<td>34</td>
<td>9</td>
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<tr>
<td>Fuel switch</td>
<td>23</td>
<td>372,162</td>
<td>9,801,005</td>
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<td>0</td>
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<td>Cement</td>
<td>17</td>
<td>114,708</td>
<td>1,382,047</td>
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<td>4</td>
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<td>Biogas</td>
<td>19</td>
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<td>786,306</td>
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<td>Methane avoidance</td>
<td>14</td>
<td>76,770</td>
<td>66,392</td>
<td>3</td>
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<td>A forestation &amp; reforestation</td>
<td>7</td>
<td>72,246</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>HFC reduction/avoidance</td>
<td>7</td>
<td>1,577,424</td>
<td>87,702,841</td>
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<td>0</td>
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<td>Other renewable energies</td>
<td>10</td>
<td>20,647</td>
<td>0</td>
<td>2</td>
<td>0</td>
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<tr>
<td>N2O decomposition</td>
<td>5</td>
<td>406,915</td>
<td>354,329</td>
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<td>0</td>
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<tr>
<td>Transportation</td>
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<td>207,362</td>
<td>82,317</td>
<td>0</td>
<td>0</td>
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<td>Methane recovery &amp; utilization</td>
<td>2</td>
<td>94,254</td>
<td>88,873</td>
<td>0</td>
<td>0</td>
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<tr>
<td>PFC reduction</td>
<td>1</td>
<td>433,551</td>
<td>33,624</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>835</strong></td>
<td><strong>79,037</strong></td>
<td><strong>141,883,181</strong></td>
<td><strong>229</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>
Unilateral vs Bilateral/ Multilateral projects in India: technology licensing and equipment acquired important modes of technology acquisition

- Unilateral project: 82%
- Bilateral/Multilateral projects: 18%

Source: IGES CDM Project Database
Two broad categories of studies:

• Those that do not differentiate between technology acquisition and absorption: PDD based studies
  • Country-based/Inter-country
  • Focus on determinants of TT

• Those that make distinction between the two:
  • Survey based: Doranova, 2009;
  • Original CDM document based : Das 2011
Das (2011): identified 3 categories of technology learning: new tech development, in-house efforts, **training**: qualitative analysis.

Doranova (2009) identified technological learning at three levels: **Basic level, Intermediary level, Advanced level**:

Hansen (2011): CDM not directly entails technology and knowledge acquisition.

Wang (2009): updated machinery and raw material in a firm have significant effect on the development of technologies through CDM projects.

FICCI (2012): shows CDM do not contribute to technology transfer in India, neither in the unilateral or bilateral/multilateral projects.
No quantitative analysis

• Little analysis of the impact of CDM involvement on firms behaviour in terms of R&D efforts or their performance.

• To the best of our knowledge, this is the first study in this direction.
Our hypothesis and Methodology

H1: CDM project leads to increased R&D efforts by the implementing firms.

Methodology:

• Difference in differences (DID) technique on a panel data use to measure the effect of implementing a CDM project on R&D efforts of the firms.

• DID method compares the difference in the performance between the periods prior to CDM-adoption (pre-period) and after CDM adoption (post-period) and with the difference between CDM and non-CDM firms.
Difference-in-Difference

- **CDM Firms** (treated firms): firms that have implemented large and/or multiple CDM projects.

- **Non CDM firms** (the comparison group): Firms that have implemented a single small project.

The model

\[ Y_{it} = \alpha + \alpha_1 CD_{it} + \alpha_2 CD_{it} \times \text{td} + \alpha_3 \text{td} + \sum \alpha_i \text{CONTROLS} + e \]

Where \( Y_{it} \) is the dependent variable.
The dependent variables

Two indicators of R&D efforts are considered for the analysis:

• **R&D intensity**: R&D expenditures normalized by sales

• **Environment expenditure intensity**: Expenditures incurred on environment expenditure normalized by sales.
Independent variables

Main variables:

**CDM**: A dummy that takes value 1 for firms implementing large/multiple projects and 0 for those implementing a single small project.

**td**: classifies each year as pre or post CDM period for all firms based on their year of CDM activity. It assumes value 1 in the post CDM years and 0 in the pre CDM years.

**CDM*td**: the DID coefficient (interaction dummy that multiplies the dummies CDMii and tdt). Its coefficient would measure the difference in differences estimator of the CDM effect on the acquiring firms.

Control variables:

**PBT_intensity**: Profits before tax normalized by sales

**Sales**: log of sales

**GFA**: Gross fixed assets to sales ratio

**Ititeprofes_Intensity**: IT expenditures – sales ratio

**Man_intensity**: Managerial salary-sales ratio

**EXP_intensity**: exports-sales ratio
Data Sources:

Data from two sources

- CDM database of the Institute for Global Environment Strategies (IGES)

- Centre for Monitoring Indian Economy’s PROWESS database of large and medium Indian companies.

Building CDM database for the study:

- Information from IGES for all 835 projects registered in India.

- Identified 584 renewable energy projects involving 576 host firms.

- Merging host firms taken from IGES into PROWESS database with more 40 variables, to create a panel dataset for the years 2001 to 2012.
Renewal energy projects

1. Growth of CDM projects in renewable energy:

Source: PROWESS, IGES
Renewal energy projects
2, SCALE

Source: PROWESS, IGES
Renewal energy projects
3. Financing patterns

Source: PROWESS, IGES
Renewal energy projects
4. Composition by category

- Wind Power: 34.73
- Biomass: 22.87
- Hydro Power: 11.14
- Other renewable energies: 1.20

Source: PROWESS, IGES
## Estimation Results with R&D intensity as dep variable

<table>
<thead>
<tr>
<th>Variables tested</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital intensity</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Size (log of sales)</td>
<td>Insignificant</td>
</tr>
<tr>
<td>CDM*td</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Intensity of IT professionals (Management attitude)</td>
<td>Significant positive</td>
</tr>
<tr>
<td>Profit sales ratio</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Dummy for CDM</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Dummy for CDM implementation years</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Management intensity</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Export-Intensity (Outward orientation)</td>
<td>Significant positive</td>
</tr>
</tbody>
</table>
### Estimation results: environmental expenditure intensity

<table>
<thead>
<tr>
<th>Variables tested</th>
<th>NPB: 155</th>
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<tbody>
<tr>
<td>Capital intensity</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Size (log of sales)</td>
<td></td>
</tr>
<tr>
<td>CDM*td</td>
<td>Significantly negative</td>
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<tr>
<td><strong>Intensity of IT professionals</strong></td>
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<tr>
<td>Profit sales ratio</td>
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<tr>
<td>Dummy for CDM</td>
<td>Significantly positive</td>
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<tr>
<td>Dummy for CDM implementation</td>
<td></td>
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<tr>
<td>Management intensity</td>
<td></td>
</tr>
<tr>
<td>export_Intensity</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

• CDM implementation may not have significant impact on R&D efforts of implementing firms.

• CDM implementing firms appear to substitute their environment related expenditures by CDM projects. Thus, seek to convert the challenges of technology transfer into opportunities

• CAVEATS:

  • Preliminary results only

  • Substantially more work is required for generating robust results
Major Issues to discuss

• Do you agree with the conclusions?
• Can CDM be treated as a mechanism of technology transfer?
• If not, why?
• Are we missing the boat in capturing green tech markets because R&D is given a low priority by Indian companies?
• Are developed countries reluctant to share their technologies?
• What has been the Chinese experience?
• Which aspects of the firms’ conduct and performance should be considered to evaluate the impact of CDM implementation?
• Can we say that CDM has helped in technology diffusion and not technology learning?
• Does carbon price fall mean the potential death of this tool?
• Should it be replaced by other instruments?
Thank You