Exports and Participation in Clean Development Mechanism [CDM] in Technology Intensive Industries in India

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Abstract

This study attempts to find out the relationship between exports and participation in Clean Development Mechanism [CDM] in technology intensive industries in India. Firm level data are used from the PROWESS, CMIE and Verified Carbon Units VCU-database from 2007 to 2012. Results of this study indicate that firm size, age of the firms, profitability and R&D intensity are the major determinants of export intensity. In addition, technology imports and multinational affiliation also help firms in exporting more. The CDM participation in terms of higher VCU, and energy related technological advancements at firm level are also found to be major determinants of export intensity. India, unlike other established European carbon markets is not a platform for trading but the country is known for its creation of VCU and selling them. Government should focus more on smaller and less profitable firms and create a wider platform for them to be an active participant. Technology spillovers created by bigger and profitable firms which attract more benefits from Verified carbon offsetting should pool the entire interested ready-to-participate firms and attain a common goal, i.e. economically viable and environmentally sustainable and the leaders in the international export market.

Keywords: Exports, CDM, Technology Intensive Indian Manufacturing Industries

JEL Classification: L15, L52, Q37, Q48

1 Introduction

India is clearly the main receptor of Clean Development Mechanism [CDM] projects (316); accounts for more than one third of all projects. China, Brazil and Mexico each host over a hundred projects. These four countries jointly account for 76% of the registered CDM projects. Perhaps this ranking can also be explained by the dynamism of their emerging economies, in the case of India and China, with a high growth potential. The CDM projects should foster several goals simultaneously: GHG emission reduction, technology transfer and sustainable development. In fact, it is worth to note that for a CDM project to be considered for registration, project

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participants must first the approval from the host country, stating that the project assists them in achieving its sustainable development targets. However, some authors argue that the CDM may not achieve these goals, like Muller (2007) and Olsen (2007).

The main problem concerning sustainable development benefits is that this aspect is not incorporated into the market benefits of the mechanism. The CDM only provides monetary incentives linked to one of the purposes of the CDM projects, namely GHG reduction. According to Ellis et al. (2007), projects producing large amounts of emissions reduction usually generate small benefits for local development, whereas smaller projects that deliver fewer CERs have direct benefits for local communities (e.g. increases in household energy efficiency). In that sense, Olsen and Fenhann (2008) suggest to improve the sustainability assessment in the approval process carried out by the designated national authorities (DNA) in host countries in order to select the most suitable projects to achieve sustainable development. Concerning technology transfer, researchers agree on the fact that CDM projects may encourage technological change in developing countries. Technology transfer is very heterogeneous across product types and it is more common in large projects, as shown in studies by Haites et al. (2006) and Dechezleprête et al. (2007). According to De Coninck et al. (2007), a significant proportion of the projects use technology from outside the host country, mainly in large-scale non-CO_2 greenhouse gas projects and in wind energy. These technology transfers would most likely induce capital accumulation and economic growth.

In March 2008, the UNFCCC secretariat published a study, prepared by a team of consultants analyzing information on technology transfer used in CDM. The main results indicate that 39% of the projects claim to involve technology transfer. In addition, 56% of the projects that involve technology transfer include both equipment and knowledge transfers; 32% of the projects claim transfer of equipment only. The main sources of equipment and knowledge transfer are Japan, Germany, the USA, France, and the United Kingdom. The potential for these transfers has not been exhausted and will continue to be a source of potential benefits for developing countries hosting CDM projects. The trends published in the above mentioned UNFCCC report are thus likely to continue during the period 2008-2012.

One way to analyze the potential economic effect of CDM projects on host countries is to compare these investments with other sources of foreign transfers/investment flowing from developed to developing countries. These flows include foreign direct investment (FDI) and official development aid (ODA). While FDI flows became a dominant element in the 1990s, ODA remained relatively stable over the period in absolute terms. However, at the beginning of the 2000s FDI flows decreased for many receiving countries, whereas aid transfers increased according to UNCTAD and OECD statistics. The number of CDM projects is higher in India, where FDI flows are less important than in other developing countries (India ranked 21st in terms of inward FDI in 2006, according to UNCTAD FDI statistics, whereas it ranked first in terms of number of CDM projects). In terms of ODA, the amount received by Vietnam, Indonesia and China is more than twice the amount received by India and is much higher than that received by other recipient countries, such Brazil, Chile and Peru. In the post-liberalization period India has slowly but steadily tried to smoothen the progress of the inflow of foreign direct investment (FDI). However, studies have shown that the impact of FDI on export performance of industries will vary not only with respect to the conditions specific to the host economy but also according to types of industries that FDI enter. Studies for the Indian economy have found that FDI in India have not entered the export-oriented industries and have little impact on the exports of India. It has therefore been concluded that FDI in Indian manufacturing has been domestic market oriented and not efficiency seeking in nature (Sharma 2000, Aggarwal and Goldar 1999, Kumar 1995).

2 Review of literature and methodology

Two main conceptual approaches exist in modeling the determinants of export performance (Wakelin, 1998): ‘neo-endowment’ models in which firms’ competitive advantage is based on factor endowments and, ‘technology-based’ models in which competitive advantage derives from the quality of firms’ products or services. Studies in the neo-endowment tradition argue that factor-based advantages may be important if the firm has either a natural monopoly of a particular factor for example the location. Extending the more traditional range of factors included in such models beyond labour and capital to include different dimensions of human and organizational resources, emphasizes the parallels between this type of explanation and resource-based models of firm competitiveness. The argument then becomes one of identifying the types of productive resources that determine firms' competitive advantage in export markets. In terms of firms' internal resources, Wakelin (1998a) identifies positive links between export performance and average capital intensity among UK firms, while Sterlacchini (1999) identifies a positive relationship between the technological level of firms' capital stock and the export intensity of small Italian businesses. Roper and Love (2001) also emphasize the potential benefits of being part of a multi-firm group in the UK, at least, group-members were likely to have higher export intensity than similar single-firm businesses. Another common finding is a positive but non-linear relationship between export intensity and firm size, a variable which may itself be acting as a proxy for the strength of firms' resource base (Kumar and Siddharthan, 1994; Wagner, 1995; Bernard and Wagner, 1997; Wakelin, 1998a; Bernard and Jensen, 1999; Sterlacchini, 1999; Roper and Love, 2001).

Technology-based models of export performance focus primarily on firms' investments or achievements in implementing new technologies or the development of new products or processes. This capability will depend both on the internal strengths of the firm, where applicable its links to other group companies and on the support available from the regional or national innovation system within which the firm is operating (Nelson, 1993; Metcalfe, 1997). The presence of an R&D function within a firm, for example, may stimulate innovation through the type of technology push process envisaged in linear models of innovation. R&D staff may also, however, contribute to firms' creativity as part of multi-functional groups, or may allow firms to utilize extra-mural networks or information sources more effectively (Veugelers and Cassiman, 1999). Braunerhjelm (1996), for example, provides evidence from Sweden that R&D expenditures and investment in skilled labour both have a positive effect on firms' export intensity, while more conventional cost factors have no effect. For firms which are part of multi-firm groups, access to group-wide R&D resources may also be important sources of new technology and product innovation. Taking into account of the findings of previous studies in both the neo-endowment and technology-based traditions, our model of export intensity will include a number of indicators of firms' operating and organisational characteristics. In particular, we allow for the ownership characteristics of firms located in India, where appropriate, for the presence elsewhere within the group of related R&D facilities. This suggests a basic model of the form:

$$X_{it} = \beta_0 + \beta_1 R_{it} + \beta_2 C_{it} + \beta_3 S_{it} + \varepsilon_{it} \quad (1)$$

Where: X_{it} is the export intensity (i.e. the share of exports in total sales) of firm i in period t, R_{it} is a set of indicators of firms' internal resource endowments, C_{it} is a set of firm characteristics, and S_{it} is a vector of indicators related to CDM. C_{it} has two components (1) firm characteristics that include firm size, age of the firm, profitability, R&D intensity of firms and multinational affiliation. Firm size is also generally expected to have a positive relationship to export intensity as larger firms have more resources with which to enter foreign markets. Wakelin (1998a) argues, for example, that this may be particularly important if there are fixed costs to exporting such as information gathering or economies of production and/or marketing which may benefit larger firms disproportionately. Scale may be important in overcoming such initial cost barriers but may then be less significant in determining the extent of firms' export activity. Support for this assertion comes from the non-linear relationship between firm size and export intensity found by Kumar and Siddharthan (1994), Willmore (1992), Wakelin (1998a) and Sterlacchini (1999), each of which identifies an inverted-U shape relationship. The first group of determinants of export intensity included in equation (1) relates to the strength or otherwise of firms' internal resource base. Previous studies provide strong evidence that R&D capability contributes to firms' export competitiveness. We expect, therefore, that for any given set of firm characteristics, the effect of R&D on exporting is likely ceteris paribus to be positive. Older firms may have had time to establish and expand their distribution networks and also to establish a market position in export markets. Ownership may also be an important indicator of a firm's export potential if it is able to take advantage of group resources for branding, marketing or distribution. And, the second component is related to technology such as embodied and disembodied technology intensity, OECD classification of industries based on the technology capability. Similarly S_{it} consists of verified carbon units (VCU) and an interaction of CDM and energy related technological advancement.

To estimate equation (1), the preferred method is a panel data model. Given the unbalanced panel of the sample, we begin with the fixed effects models, random effect models. However, the test for the Heteroskedasticity of the panel following the (1) Breusch-Pagan test that confirms the presence of Heteroskedasticity

[F (1, 342)=30.90***] and also Cook-Weisberg test also confirms the presence of heteroskedasticity [chi^2=108.58***]. However, the Durbin-Watson d-statistic estimated value of 0.871 and the test for Multicolinearity of 1.140, reject the presence of the multicolinearity in the sample. Given the presence of heteroskedasticity, the estimation of the fixed/random effects estimates might be inefficient (Baltagi, 1995). Therefore, the preferred method of estimation of equation (1) is a linear regression, correlated panels and corrected standard errors. Equation (1) is estimated as follows:

$$\begin{aligned} X_{it} = \alpha_{it} + \beta_1 FS_{it} + \beta_1 AG_{it} + \beta_1 PF_{it} + \beta_1 RD_{it} + \beta_1 ETI_{it} + \beta_1 DTI_{it} + \\ \beta_1 MNED_{it} + \beta_1 MHD_{it} + \beta_1 HTD_{it} + \beta_1 VCU_{it} + \beta_1 CDMTD_{it} + \mu_{it} \end{aligned} \quad (2)$$

3 Data sources and description of variables

This study uses data collected from the Center for Monitoring Indian Economy (CMIE) Prowess 4.0. Firm-level data of Indian manufacturing industries are drawn from 2007-2012. The sample consists of 344 observations of unbalanced panel of firms that takes part in CDM. For the classification of industry sectors in terms of low technology, medium-low technology, medium-high technology and high technology we have followed OECD classification that is given in Annex-1. The other sources of the data are mainly drawn from different online databases. Such as information on the CO_2 emissions per capita, in metric tonnes are collected from World Bank website. Data on participation in CDM projects are extracted from Verified Carbon Standards (VCS) website that includes data on Verified carbon projects, timeframe, and industry specifications. Under VCS, projects are issued unique carbon credits known as Verified Carbon Units or VCUs. Each VCU represents a reduction or removal of one ton of carbon dioxide equivalent (CO_2e), which can be generated by reducing or removing any of the following greenhouse gases (GHGs): Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur Hexafluoride (SF_6). Firms that are participating in carbon offsetting projects are collected and their financial key attributes are matched from PROWESS database. The construction of variables and definitions are presented in table 1.

Table 1: Definition of variables

Variable	Definition
Export Intensity	Ratio of export to sales
Firm Size	Natural log of net sales
Age of the Firm	Differences of incorporation year to year of reporting
Profitability	Ratio of profit after tax to net sales
R&D Intensity	Ratio of R&D expenses to sales
Embodied Technology Intensity	Expenditure on import of capital goods / Sales turnover of the firm
Disembodied Technology Intensity	Royalty, and technical fees payments in foreign currency / Sales turnover of the firm
MNE Affiliation	If the firm is affiliated to foreign firm takes value 1, or else 0
High Tech	Firms those are listed as high tech in OECD technological classification takes the value 1, 0 otherwise
Medium High Tech	Firms those are listed as medium high tech in OECD technological classification takes the value 1, 0 otherwise
Log of VCU	Natural Log of Verified Carbon Units
CDM Participation and Adoption of Energy Technologies	Interaction between participating in CDM and energy-related technology up-gradation, takes value 1 for participation and energy technology, 0 otherwise

4 Exports and participation in Clean Development Mechanism

In India, R&D expenditure by the private sector industry has been found to be quite low compared with many other developed and emerging economies (Siddharthan & Rajan, 2002). Nevertheless, firms that do put efforts into in-house R&D are likely to produce products that are unique and / or of high quality. Studies, such as Narayanan (2006), found R&D to be unimportant in determining exports. It is often observed that firms in developing countries such as India initially rely on imported technologies to have competitive advantage over their rivals. These imported technologies are either in disembodied or in embodied form. A popular means of acquiring disembodied technology is through import of designs, drawings, blue prints, and formulae against royalty and technical fee payments. These acquired technologies, which generally come with supporting documents, can be quickly assimilated and used for production purposes.

Empirical findings on the role of disembodied technology import and exports are mixed. In the case of high-technology industries, one can find some evidence of a positive relationship between imports of disembodied technology and exports (Kumar & Siddharthan, 1994; Siddharthan & Nollen, 2000). The study carried out by Rennings and Zwick (2001) is based on a sample of eco-innovative firms for five EU countries in manufacturing and service sectors. This study provides evidence related to manufacturing sector and also includes some evidence concerning eco-innovations in service sector too. They find that in most of the firms employment does not change as a consequence of innovations. The econometric results show that, apart from some product innovations, eco-innovation typologies do not influence the level of employment, though as expected, according to their evidence environmentally oriented innovations seem to lead to, a skills based effect. Also, end-of-pipe innovations are related to a higher probability of job losses, while innovations in recycling have a positive effect on employment. Employment effects may thus be unevenly distributed, with strong negative effects from environmental strategies/policies on low skills intensive industries and potentially positive effects on other industries. It could also be argued that product and process eco-innovation strategies may bring about (potentially negative) net effects on employment, attributable to a destruction of the low skilled labour force and a creation of high skilled positions (R&D).

There is a complementary stream of literature that has focused on the various static and dynamic relationships between eco-innovation, environmental performances and firm performances. Konar and Cohen (2001) investigated the effect on firms' market performance of tangible and intangible assets, including two environmental performance-related elements as explanatory factors. Cohen et al. (1997) also analyzed the relationship between environmental and financial performances. Overall, these authors found that investing in a 'green' portfolio did not incur a penalty and even produced positive returns. Analysis on variations over time or growth rates, the relationship between abatement costs and productivity found not to be significant. Greenstone (2001) estimated the effects of environmental regulations, using data for 175 million observations of firms in the 1967-87 US censuses of manufacturers. The EU based study by Ziegler et al. (2008), focused on (1) the effects of environmental strategies on the stock performances of corporations using standard cross section/panel approaches and (2) 'event' studies that analyze whether there are exogenous unexpected policy effects on the short term performance of environmentally minded firms. They conclude that the evidence focusing on stock market performance is limited since the majority of firms; especially in Italy, are of medium or small sized and do not appear in stock market data. Innovation dynamics are close to productivity trends which in the end are the main engines of firm performance.

Carbon emissions have become a financial asset ever since Kyoto protocol was introduced on 11 December 1997 in Kyoto, Japan. United Nations framework Convention on Climate Change (UNFCCC) is the first convention to have a distinct outcome with more than 150 participating countries. It is the first convention to take full control of Green House Gas emissions including carbon di oxide discharge. Carbon emission trading specifically targets carbon di oxide (CO_2) calculated in tonnes of carbon equivalent or tCO_2e. Above all, the primary objective is to reduce the carbon emissions in long run by implementing economically viable and environmentally sustainable technologies. Emission trade works by setting a quantitative restriction on emissions produced by emitters. As a result of competing global economic growth, huge amount of carbon dioxide emissions are released in atmosphere and leading them to be one among the major reasons for Global warming.

The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets. India is a highlighting country when it comes to international financial market as the opportunity our country facilitates is always attractive. Carbon trading, unlike other financial assets, has a positive consequence on environment. As a result, carbon trading is a buzzing concept ever since Kyoto protocol came into existence with political debate and international debates. India ranks second on carbon trading after China and have a huge potential to grow. Number of Verified carbon offset projects is exponential and India is achieving its UNFCCC targets. Verified carbon market facilitates a platform for technology mobility and as a result India is receiving a flow of technology know-how through trading. Firms which fall under various industries are the focus of the study and thus the question, what determines the firms to earn Verified Carbon Units (VCU) and the concentration of trading among industry segments is discussed.

Adoption of UNFCCC, the primary vehicle of climate change studies as its main objective has primary responsibility of mitigation on industrialized countries. As per the Kyoto Protocol, industrialized countries (United States did not ratify) have to undertake qualitative emission reduction scheme and achieve a limit of target within the commitment period. Industrialized countries listed in Annex 1 of the protocol have binding commitments to reduce their emissions. Annex 1 parties committed themselves to reducing their overall emissions of GHG by at least 5.2 percent below 1990 levels in the period between 2008 and 2012. The protocol gave a platform of three mechanisms to assist Annex 1 countries in meeting their national targets cost effectively, an emission trading system, Joint Implementation (JI) of emission reduction projects between Annex-1 countries and Clean Development Mechanism (CDM) to encourage JI projects between Annex 1 and Non-Annex 1 (developing) countries. Since progress towards meeting the targets of UNFCCC were not satisfactory and real time climate change became a focus of study and led to intense debate. The conference of parties adopted, at the 13th conference in Bali, and an action plan to enhance the implementation of UNFCCC up to and beyond 2012, precisely known as Bali Action Plan (BAP). It came up with four major attributes of climate change, i.e., GHG mitigation, adaptation to climate change impacts, technology development & cooperation and finance. Low carbon inclusive growth recognizes that policies for climate change mitigation affect the objectives of development. Low carbon policies that are inclusive need to be differentiated across sectors based on national priorities and transaction costs of implementing the policy. There was an active exchange form of trade in India.

Multi Commodity Exchange (MCX) and National Commodities and Derivatives Exchange (NCDEX) were the major Indian stock exchanges which facilitated the platform for carbon trading in the forms of Carbon Emission Reduction (CER) credits. One CER credit is equivalent to 1 metric tonne of carbon dioxide (CO_2) emitted. 2008 and 2009 had witnessed a very active market for CER credits in Indian stock exchanges. Reason being unknown, there was a sudden shift from exchange driven trading to Over the Counter trading (OTC). The OTC market has led to a new concept called Verified carbon offsetting. Instead of CER credits, one earns Verified

Carbon Units (VCU), which is equivalent to 1 metric tonne of CO_2. Firms of different sectors are the major participants in this form of trade. Participating in CDM for the Indian firms have helped them in the following technological advancements (1) Aluminium Smelter, (2) Biogas & Bagasse, (3) Biomass, (4) Chemical Recovery, (5) Grid, (6) Hydro Power, (7) Hydro Project, (8) Hydro-electric Power, (9) Natural Gas, (10) Replacement of Base Transceiver Station, (11) Electronics, (12) Rice Husk Fired Boiler, (13) Waste Heat, and (14) Wind Power. These technological advancements have sectoral scope for the (1) Energy (renewable/non-renewable), (2) Energy demand, (3) Manufacturing Industries in general, (4) Chemical Industry, and (4) Metal production industries.

4.1 Exports from Technology Intensive Industries in India

Recent surge in India's exports has been on account of technology intensive exports, particularly by the medium technology intensive exports. It may be noted that exports items are classified into five groups on the basis of technology contents in these products, and items falling under the category of medium and high technology are considered as technology intensive products in this report. Since the mid-90s, technology intensive products maintained high growth in the export sector surpassing other sectors such as primary, resource-based and low technology intensive sectors. Profile of the Indian export sector indicates that export sector received major impetus since 2000, may be on account of complete recovery of the world economy from the 'Asian Economic Crisis'. Export performances of technology products have sown significant progress during the period 2000-08. During the 'global financial crisis', slump in the world exports had an adverse impact on technology intensive exports, but such impacts differ significantly across different product segments of technology intensive exports. While the exports performance in medium technology intensive exports registered a sharp decline, exports of high technology products were not affected much in 2009. Resource-based exports also suffered significantly due to global recession. In the manufacturing exports, technology intensive exports are growing faster than other sub-sectors since the mid-90s such as primary, resource-based and low technology intensive product groups. Technology intensive exports are not only registered high growth performances as compared to other export sub-sectors, but also improved its export share in the manufacturing sector during the last one and half decades.

During the period 1995/97-2001/03, export growth rate of both medium and high technology intensive sectors were much higher than primary, resource based and low technology export sectors and similar performances were repeated during the period 2001/03-2007/09. It is imperative from table 2 that low technology intensive export has been the largest export earning sector in the manufacturing sector, but it is gradually replaced by technology intensive sector. If low technology sector continues to maintain low export growth in future, technology intensive sector is likely to dominate the manufacturing export sector. In the technology intensive sector, exports of medium technology products growing faster than the high technology products. Despite of low trade base of high technology intensive products, its sectoral growth rate is almost similar to those of medium technology products.

Table 2: Structure of Exports in Technology Intensive Industries in India

Technology Intensity Sectors	Share (%)			CAGR (%)	
	1995-97	2001-03	2007-09	1995-97/ 2001-03	2001-03/ 2007-09
Primary Products	1.9	1.6	4.9	5.0	43.1
Resource Based	25.6	27.1	22.7	8.9	15.9
Low Technology Intensive	50.8	46.2	36.0	6.2	14.6
Medium Technology Intensive	15.0	16.9	25.3	10.1	27.8
High Technology Intensive	6.6	8.1	11.1	11.6	25.9
Total	100.0	100.0	100.0	7.9	19.4

Data Source: Compiled from Comtrade Online, The World Bank, Washington D.C.

Total export of technology intensive exports was over US$ 45 billion in 2009. Exports of medium intensive technology constituted US$29 billion, sharing nearly 64.2% of total technology intensive exports. It may be noted that coverage of medium technology intensive exports are more widely spread across various product groups than high technology intensive sectors. High technology exports is mostly originated from four sectors including chemicals, machinery & appliances, automobile & transport and optical & cinematography, but sizable exports are confined to first two sectors. Export growth rates in these two sectors have been robust during the period 2003-09. Though several sectors export similar type of technology intensive products, performances differ across sectors, both in terms of volume and growth performance.

India's export destinations are diversified so far as its technology intensity of exports are concerned. Among the top ten counties in each of the five technology intensity of exports, India's exports are targeted towards both developed and developed countries.

As we move from low to high technology intensive exports, number of India's top ranking export destinations goes up in favour of developing countries. When we move in the reverse order, i.e., from low technology intensive to primary products, export destination are more from developing countries. Therefore, India has large export market in developing countries for both high technology intensive and primary products, whereas developed counties are largely for India's low technology intensive products. India is exporting high technology intensive products to 209 countries and volume of exports exceeds more than a million US$ in almost 114 countries. In case of medium technology intensive products, India is exporting to 210 counties and out of which exports volume exceeding more than a million S$ in case of 161 countries. Important export destinations for India's technology intensive exports are China, Indonesia, Malaysia, Nigeria, Singapore, South Africa and UAE among developing coutries during the period 2007-09. Among most important export destination of India's technology intensive products in developed countries are the US, Germany, the UK, the Netherlands and Italy. The export intensity of Indian manufacturing industries, are showing an increasing trend from 2007-2012. However, year 2008 experienced the highest export intensity for Indian manufacturing industries. The mean export intensity of the sample is calculated to be 17.63%. However from 2010 the export intensity is decreasing till 2012. The research intensity of Indian manufacturing was highest for 2008. When we compare the R&D intensity from 2007-2012, we can see an increasing trend. The mean R&D for the full sample is calculated to be 0.55%.

The mean disembodied technology intensity of the full sample is computed to be 0.79%. The least disembodied technology intensity is calculated for the year 2008 and the highest in 2012. However, from 2007-2012, the disembodied technology intensity is following an increasing trend. The mean embodied technology intensity for the sample is found to be 99.06%. All the four major technology classification industries have improved export and the inter-group difference has reduced. The rise in export intensity is higher for the medium hi-tech industries. The mean export intensity for the hi-tech industries is calculated at 17.28%, for the medium hi-tech it is 16.10%, for the medium low-tech it is 16.65% and for the low-tech it is calculated to be 19.85%. The mean export intensity for the hi-tech industries is calculated at 22.56%, for the medium hi-tech it is 20.97%, for the medium low-tech it is 22.93% and for the low-tech it is calculated to be 27.20%. The mean export intensity of the foreign firms is calculated to be 18.10%, which is higher than the sample mean of 17.63%. The mean export intensity for the domestic firms is calculated to be 13.04% which is less than compared to the sample mean as well as from the foreign firms.

Table-3: Trends in Exports and Firm Characteristics of the Sample

Year	EP	RDI	DTI	ETI	HT	MHT	Foreign	Domestic
2007	20.75	1.14	0.07	5.70	18.92	20.51	21.31	15.52
2008	18.58	0.75	0.58	32.30	20.07	17.91	18.77	16.53
2009	20.17	0.74	0.58	12.07	19.99	18.20	20.34	18.27
2010	19.36	0.59	1.29	732.63	20.30	17.77	19.49	17.88
2011	19.92	0.65	1.46	45.02	21.34	21.36	20.21	16.64
2012	12.64	0.25	0.58	96.89	11.77	9.44	13.18	7.13
Total	**17.63**	**0.55**	**0.79**	**99.06**	**17.28**	**16.10**	**18.10**	**13.03**

Note: Author's calculation based on CMIE data, Sample size (344), figures are in %, and Information is from 2007 to 2012, Data Sourse: PROWESS, CMIE; EI: Export Intensity, RDI: Research and Development Intensity, DTI: Disembodied Technology Intensity, ETI: Embodied Technology Intensity, HT: Hi-tech Industries, MHT: Medium High-tech Industries, Foreign: Multinational Affiliated Firms, Domestic: Domestic Firms

4.2 CDM Participation of Technology Intensive Industries in India

Indicators related to the CDM participation in Indian technology intensive industries are presented in table 4. The indicators of CDM participations are classified as (1) the vintage time, (2) total vintage quantity, (3) Verified carbon units, (4) Verified carbon units difference, and (5) income from carbon credits. With a sample of 344 firms participating in CDM the highest number of firms participated was continuously from 2007 to 2009 however, number of firms participating after 2009 has reduced and reached to 42 firms in 2012. The mean vintage time varies from 14 to 19 months. The standard deviation in vintage time is more or less similar across firms and across year. However, in case of total vintage quantity gained by firms differs annually as well as at the firm level. There is also evidence that few firms are also not meeting to the assigned carbon units and the inter-firm differences in the Verified carbon units are also present for the sample. However, income from carbon credit (deflated) is increasing over the year from 2007 to 2012.

Further, given the nature of the data in question, we have observed that most of the CDM projects in India are related to improvements in the energy related technologies. Hence, we have created a sub-sample in order to understand the differences/similarities between the CDM indicators for firms those are in energy related technologies and others. Table 5 focuses on the result. We can observe that out of 344 sample firms 304 firms are participating in CDM related to the improvements in energy related technologies. These firms are getting higher vintage time as compare to the non-energy technology CDM participating firms. The vintage quantity gained is also much higher for the group 2 firms (energy related technologies). These firms are also reported to gain higher Verified carbon units. However, inter-firm differences are also high for the group 2 firms in gaining the Verified carbon units as compared to the group 1 firms. From 2007 to 2012, firms those are participating in energy related technology in the CDM are reporting higher income from carbon credits as compared to the other firms.

Table 4: Average of indicators related to CDM from 2007 to 2012

Year/ Observations	Vintage Time	Total Vintage Quantity	Verified Carbon Units	Verified Carbon Units Differences	Income from Carbon Credits
2007	17.187	1959829	261939.6	1697889	1.427
(N=64)	(34.146)	(8485309)	(828217.5)	(8076972)	(7.424)
2008	14.925	1864675	229239.8	1635436	5.738
(N=64)	(30.013)	(8471366)	(791671.7)	(8074365)	(18.466)
2009	14.856	1860491	227805.2	1632686	9.884
(N=64)	(30.043)	(8472220)	(791958.7)	(8074900)	(52.628)
2010	15.004	1934101	233783.5	1700318	9.308
(N=62)	(30.530)	(8601055)	(804106.9)	(8198565)	(49.691)
2011	17.544	2460031	284400.5	2175631	9.735
(N=48)	(34.240)	(9734324)	(909234.6)	(9285082)	(57.468)
2012	18.814	2791692	317984.0	2473708	10.960
(N=42)	(36.291)	(10400000)	(968634.1)	(9904310)	(61.421)
Full Sample	**16.187**	**2090368**	**254407.4**	**1835961**	**7.546**
(N=344)	**(32.115)**	**(8871998)**	**(835277.4)**	**(8456618)**	**(43.993)**

Note: N in column 1 refers to number of firms in each year; for other columns figures in brackets represents the standard deviation, Data Sources: VCU, 2012, Sample size (344)

Table 5: Average of CDM indicators of firms using energy technology vs. other technologies from 2007-2012

Groups	Vintage Time	Total Vintage Quantity	Verified Carbon Units	Verified Carbon Units Differences	Income from Carbon Credits
1	4.716	357419.5	115980.70	241438.9	0.03
(N=40)	(3.241)	(320567.1)	(80976.89)	(276767.2)	(0.005)
2	17.697	2318387.0	272621.40	2045766.0	8.539
(N=304)	(33.861)	(9414965.0)	(886614.90)	(98975832.0)	(46.715)
Full Sample	**16.187**	**2090368.0**	**254407.40**	**1835961.0**	**7.546**
(N=344)	**(32.115)**	**(8871998.0)**	**(835277.40)**	**(8456618.0)**	**(43.993)**

Note: Group 1: Firms upgrading technologies other than energy technologies, Group 2: Firms upgrading technologies related to energy technologies, N in column 1 refers to number of firms in each year, for other columns figures in brackets represents the standard deviation, Data Sources: VCU, 2012, Sample size (344)

5 Export intensity and participation in CDM

From the review of literature it is evident that select firm characteristics determine the export intensity of firms. This study is important in order to include the technology related firm characteristics and indicators for the CDM participants. The millennium goal has certainly looked at the sustainable manufacturing and more specifically gives important to emit less. In emitting less either the firm has the choice of shifting from traditional fuel or to increase the production efficiency through technology adoption. This study assumes that apart from other firm characteristics the CDM participation is also one of the major determinants of export intensity. The estimated results of equation (2), is presented in table 6.

From the results of the linear regression, correlated panels and corrected standard errors; we can observe that the estimated R^2 is 0.32 and the Wald Chi^2 is statistically significant at 1% or higher. The results also indicate that there is no autocorrelation in the time series properties of the panel data in question. The result indicates that firm size is positively related to the export intensity of the sample firms. That essentially indicates that, firms those are big in size (in this case higher net sales) are those who export more than the smaller firms. However, age of the firm has a negative and statistically significant relation with the export intensity. This result indicates that older firms are exporting less as compared to the younger firms in the sample. Given the sample selection of firms' that participate in the CDM; this result is justifiable. For the bigger and the younger firms it might be possible to adopt new technology in the production process. However, the smaller and older firms might not be able to adopt the new technology either due to scale economy or due to capital constrains in adopting such technologies.

Profitability is an indicator of firm performance. This is one of the major variables determining the export intensity. Our result suggests that firms that are profitable also exporters more (given the positive relationship). Similarly, firms that are investing more in the Research and Development are also found to exporting more as compared to their counterparts. Hence bigger, younger, profitable and R&D intensive firms are exporting more compared to other firms in the sample. R&D intensity is one of the technology related variable that this study uses in determining the export intensity. Apart from the R&D intensity, we also have tried to link the embodied and disembodied technology intensity of firms with the export share of firms. The result of this exercise indicates that embodied technology intensity is positively related and disembodied technology intensity is negatively related to the export intensity of firms. Given the nature of the sample, that are participating in the CDM, most of the firms have adopted in un-gradation of technology in order to achieve efficient production and limiting negative externality. These firms depend on both the embodied and disembodied technology import in achieving the above objectives. However, as most of the CDM projects are related to energy related development in technology front, they might be importing the raw materials those are embedded. Hence, firms those are importing higher embodied technology are those who also export more.

The results of the multinational affiliation of firm with export intensity indicates that multinational firms are exporting higher compared to the domestic firms. For firms those are affiliated with the multinationals it is easier for technology transfer and hence become efficient in production. Given the CDM participation in Indian case are associated with the technology intensive industries, we have created two dummies that categories the hi-tech and the medium hi-tech industries. The result indicates the high-tech industries are exporting more as compared to the other industries in the sample. Indicator that explains the components of CDM are Verified Carbon Units (VCU) and the interaction dummy of CDM and adoption of energy related technology change. The result indicates that VCU is positively related to export intensity with statistically positive and significant result. Hence, firms those are having higher VCU are those who are exporting more. The interaction dummy of CDM and adoption of energy related technology change also indicates that firms those are improvising the technology directly related to energy front are exporting higher compared to others. The findings of the econometric exercise confirms that apart from the firm characteristics, CDM and its components are also one of the major determinants of export intensity for the Indian firms. Hence, for a sustainable production and export target Indian firms should participate in the CDM process to increase production due to advancement of technology and efficient production.

6 Summary

This study is an attempt to understand the relationship between exports and CDM participation for the technology intensive industries in India. The study finds that the export intensity in technology intensive firms in Indian manufacturing sector follows an increasing trend. R&D intensity, disembodied technology intensity, embodied technology intensity are also following increasing trend from 2007 to 2012. The medium hi-tech and the low-tech firms are exporting more compared to other industries groups. The multinational affiliated firms also export more than the domestic firms. With this background, this study attempts to determine the factors explaining inter-firm differences in export intensity of technology intensive firms those are participating in CDM in India.

The results of this study suggest the following conclusions. (1) Larger firms are exporting more compared to the smaller ones. (2) Older firms are exporting less as compared to the younger firms. (3) Profitability is one of the major drivers of firms in export market. (4) Higher Research and Development intensity lead firms to export more. (5) Embodied technology intensity is positively related and disembodied technology intensity is negatively related to the export intensity of firms. Hence, firms those are importing higher embodied technology are those who also export more. (6) Multinational affiliation helps firms in achieving higher export intensity. (7) The result indicates the high-tech industries are exporting more as compared to the other industries. (8) VCU is positively related to export intensity hence, firms those are having higher VCU are exporting more. And (9) Firms those are improvising technology directly related to energy front are exporting higher compared to others. In general, the findings of the econometric exercise confirm that apart from the firm characteristics such as Firm Size, Age of the Firm, Profitability, R&D Intensity, Technology Imports and MNE Affiliation; CDM and its components are also major determinants of export intensity for the Indian firms.

Verified carbon offsetting is an alternative for Carbon Emission Reduction (CER) units that came into existence over the period of time. An active Verified carbon offsetting is on its way and it shows India has a huge potential to grow and awaiting great opportunities to grow. With the strong industrial base and vast technical human capital it will lead the country to highlight for its own achievements in economically viable and environmentally sustainable projects. India, unlike other established European carbon markets is not a platform for trading but the country is known for its creation of VCU and selling them. Government should focus more on smaller and less profitable firms and create a wider platform for them to be an active participant. Horizontal and vertical technology spillover integration is suggested as an initiative. Technology spillovers created by bigger and profitable firms which attract more benefits from Verified carbon offsetting should pool the entire interested ready-to-participate firms and attain a common goal, i.e. economically viable and environmentally sustainable and the leaders in the international export market.

Table 6: Determinants of Export Intensity in Indian Manufacturing Industries

Independent Variables		Fixed Effects Regressions		Random Effects GLS regression		Linear regression, correlated panels corrected standard errors (PCSEs)	
		Coefficient	t value	Coefficient	z value	Coefficient	z value
Firm Size		8.957	4.270***	4.100	2.370***	6.614	8.190***
Age of the Firm		-0.262	-0.890	-0.450	-2.420***	-4.489	-6.830***
Profitability		0.284	2.870***	0.392	3.930***	1.036	2.160**
R&D Intensity		0.020	1.990**	0.018	1.980**	0.346	2.087**
Embodied Technology Intensity		1.494	1.120	0.562	0.420	4.052	4.660***
Disembodied Technology Intensity		0.098	2.260***	0.157	3.680***	-0.371	-2.030***
MNE Affiliation [dummy]		4.541	0.580	2.424	0.310	6.268	2.070**
Medium High Tech [dummy]		0.027	0.170	0.127	1.165	1.127	1.016
High Tech [dummy]		-0.972	-1.932**	-1.972	-2.184**	-0.572	-2.509***
Log VCU		0.056	2.444***	0.756	2.816***	0.836	2.089**
CDM in Energy Technologies[dummy]		0.760	1.819*	0.231	1.968**	0.654	2.819***
Constant		-1.046	-0.110	29.350	3.120***	10.966	8.910***
Industries Dummy		Yes		Yes		Yes	
sigma_u		51.217		35.784		Autocorrelation: no	
sigma_e		19.716		19.716		Estimated autocorrelations: 0	
Rho		0.871		0.767		-	
	Within	0.092		0.0738			
R^2	Between	0.053		0.0354		0.322	
	Overall	0.024		0.0404			
F (11,333)		8.53***		-		-	
Wald $chi^2(7)$		-		47.61***		922.27***	
Correlation (u_i, Xb)		-0.473		0 (assumed)		Estimated covariances: 966	
Hausman Test Statistics				chi^2 (7) =23.42***			
Number of observations: 344							

Note: S.E.: Standard Error, *** signifies statistically significant at 1%

Annex-1: Technological Classification of Manufacturing Industry [OECD Classification]

Sl No.	OECD Classification	NIC-2008	Activities
1	Hi-Tech	21	Pharmaceuticals, medicinal chemical and botanical products
		26	Computer, electronic and optical products
2	Medium Hi-Tech	20	Chemicals and chemical products
		27	Electrical equipment
		28	Machinery and equipment
		29	Motor vehicles, trailers and semi-trailers
		30	Other transport equipment
3	Medium Low-Tech	32	Other manufacturing (Jewellery, Bijouterie and Related articles)
		19	Coke and refined petroleum products
		22	Rubber and plastics products
		23	Other non-metallic mineral products
		24	Basic metals
4	Low-Tech	10	Food products
		11	Beverages
		12	Tobacco products
		13	Textiles
		14	Wearing apparel
		15	Leather and related products
		16	Wood and products of wood and cork, except furniture
		17	Paper and paper products
		18	Printing and reproduction of recorded media
		58	Publishing activities

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