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Catch-up as a Survival Strategy in the Solar Power Industry☆

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ABSTRACT

We evaluate the strategies of the emerging market firms in the context of nascent industries. We use the Indian solar power industry as the empirical setting, against the backdrop of the evolution of the global industry, While in traditional industries emerging market firms learn from advanced economy multinational enterprises (MNEs) and slowly upgrade their capabilities, in the intensely competitive environment of nascent innovative industries, emerging market firms are exposed to global competition in their home market right from the early years. This shortens their catch-up clock. As a result, their long-term survival depends on their ability to catch-up fast, both in output and innovation capabilities. In the solar power industry, we find that innovations stem, in the main, from advanced economy firms. Further, Chinese firms are beginning to move from cost-based imitation to innovation. In contrast, with a few key exceptions, most firms in the Indian solar industry remain locked within a narrow niche of downstream site-based installation. Their operations are opportunistic, short term, and without specific catch-up goals, a scenario that does not bode well for the industry's future in India.

1. Introduction

The international business and international trade literatures document the rapid shift from trade in goods to trade in activities or tasks (Grossman and Rossi-Hansberg, 2008; Mudambi, 2008). This process is being driven by MNEs that are taking advantage of globally dispersed sources of value creation and value capture. Increasingly, firms combine the comparative advantages of locations with their competitive advantages (McCann and Mudambi, 2005) to decide what part of the value chain to control and where to locate it. The location and control strategies of the firms result in the industry value chains that are increasingly disaggregated across geographies and across firms.

While advanced economies often participate in the sophisticated activities of R & D and marketing in the industry value chain, emerging economies feature in the low value-added activities such as manufacturing (Mudambi, 2008). Many of the firms from emerging economy associate with the local subsidiaries of the advanced economy MNEs (AMNEs) as their lower-end partners conducting basic activities. Through such cooperative partnerships, emerging economy firms upgrade their output capabilities in their home market. Over time, their catch-up in output capabilities leads the way to developing innovation capabilities (Awate et al., 2015, 2015) as they focus on moving up the value chain. This model describes the most common pattern of emerging economy firm catch-up where the initial stages involve close collaboration with an AMNE partner. Over time, it inevitably changes to competition as the

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successful emerging economy firms become MNEs (EMNEs) and start competing with AMNEs for the same markets.

The model of EMNE catch-up is studied in a number of industries at different stages of lifecycle and with varying competitive intensities (Kumaraswamy et al., 2012; Awate et al., 2012; Lorenzen and Mudambi, 2013). We study this model in a nascent industry experiencing intense foreign competition in the local emerging economy. The nascent industry is the solar power industry in the emerging economy of India. The Indian solar power market is growing rapidly. It is highly competitive with AMNEs from North America and Europe, EMNEs from China, and domestic Indian firms. We find that the AMNEs and the Chinese MNEs are better positioned than Indian firms in this competition. The competitive advantage of the AMNEs is due to their technological lead. Chinese MNEs too are slowly shifting to innovation-based strategies. Indian firms on the other hand are mainly conducting low-end installations and maintenance.

Further, comparing the state of the Indian solar industry with the early years of the Chinese solar industry, we note the different approaches of the two governments. While Chinese government encouraged domestic industry development in early years, the Indian government is mainly encouraging capacity additions to increase the market size and meet its renewable energy goals. We note that, in nascent industries, such government policies encourage foreign competition and disproportionately benefit foreign firms that are already established in the industry. The local firms in such settings lack the luxury of time as well as collaboration with the established MNEs. We propose that, in nascent industries, as local firms face global competition from their early years, a focus on catch-up right from the inception becomes critical to surviving even domestically.

In the following sections, we provide the details of the global solar power industry, the innovations in this industry, and the specific case of the Indian solar power market. We then discuss the findings and their implications in the final section.

2. The global solar power industry

Solar energy is the most abundant of all energy sources, with a potential to exceed global energy demands, and at a very low water footprint, as compared to other renewable energy sources (Gerbens-Leenes et al., 2008). In 2015, it provided for a little over 1% of the global electricity consumption (Energy Post, 2015), but it is growing rapidly. The pace of growth of the solar energy investments is more rapid in emerging markets than advanced markets (Randall, 2015). The existing energy infrastructure in emerging markets is often based on traditional energy sources, but in most cases, there is a significant gap between production and demand. In India for example, the countrywide peak-period electricity deficit was 3% in 2015, with a few states reporting deficits as high as 15% (CEA, 2016). With traditional energy sources lagging demand by such large margins, there are enormous opportunities for renewable energy sources such as solar.

2.1. Solar industry background

The industry is based on converting the incident solar radiations into heat and electricity, for residential and industrial applications. The most widely used method is the direct conversion of solar energy into electricity. It is based on the photovoltaic effect that uses semiconductor material. The photonic energy of the incident sunlight frees the semiconductor electrons from their orbits thereby creating electric current. The industry primarily uses silicon to make photovoltaic (PV) cells. The cells are arranged on a glass to form PV modules or panels for installing on rooftops for residential use, or in solar parks for grid-connected utility scale electricity generation. Over the years, PV technologies have become dominant in the industry[1].

Common PV modules are rated between 80 Watts (W) and 250 W. There are three major variants of PV cells, namely monocrystalline, polycrystalline and thin-films. The three forms differ greatly on their manufacturing cost and efficiency. Solar cell efficiency indicates the fraction of the incident sunlight that gets converted into electricity. Monocrystalline silicon PV cells use the most refined silicon resulting in efficiency as high as 27% (NREL, 2016). However, the efficiency comes at a very high production cost and a sophisticated manufacturing process. Polycrystalline silicon PV cells use less pure silicon resulting in cheaper production but at the cost of reduced efficiency in the range of 21% (NREL, 2016). In thin-film products, instead of crystalline silicon, other photovoltaic material is deposited on a substrate such as glass. These material include amorphous silicon, cadmium telluride, or copper indium diselenide. Thin film PV cells have a slightly higher efficiency than polycrystalline silicon cells, of about 22–23% (NREL, 2016). The cost-efficiency trade-off has made polycrystalline silicon PV cells and their modules the most widely used.

As shown in Fig. 1, the manufacturing process of these PV modules starts with the extraction of silicon from silica to obtain solar-grade crystalline silicon. The technology used for this activity is standardized but requires heavy investment. As a result, the major share of polysilicon production is concentrated with a few firms, namely Wacker Chemie (Germany), Hemlock Semiconductor Corporation (US), and OCI Corporation (South Korea) (Sontakke, 2015). The crystalline silicon is then formed into silicon ingots with the required semiconductor properties. The ingots are then cut into thin slices called wafers. The technology used in these activities is standardized and requires less investment than upstream polycrystalline silicon production. Until 2008, the market leadership for ingot and wafer manufacturing remained with the Japanese manufacturers. However, by 2013, the industry became less concentrated with entry of several Chinese solar cell manufacturers that backward integrated into wafer manufacturing. The top wafer manufacturers in 2015 were the Chinese firms GCL-Poly, Yingli Green, Trina Solar, and Jinko Solar, as well as the US firm ReneSola, which

[1] An alternative approach involves converting solar energy into thermal energy by concentrating solar radiations on water or oil. The heated oil or steam is used for cooking and purification, or as industrial heat for melting, or generating electricity. The technologies involved in such indirect conversion are called concentrated solar power (CSP) technologies.