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An analysis on investment policy effect of China's photovoltaic industry based on feedback model

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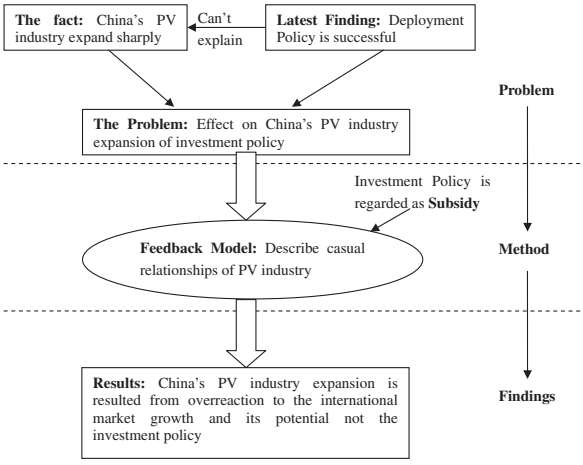
HIGHLIGHTS

- China's PV investment policies are some kinds of subsidies.
- China's PV investment policy has little effect.
- China's companies overreacted to global PV development.

GRAPHICAL ABSTRACT



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ABSTRACT

China's photovoltaic industry developed sharply, and now it is the only country whose production covers the installed. Since R&D policy and deployment policy of China's PV industry should not increase its production, this paper focuses on impact of investment policy, regarded as subsidy, on the photovoltaic industry. Feedback model of China's photovoltaic industry is built, and the parameters of the model were estimated. And then simulation is done based on the model. The results show that the expansion is mainly caused by overreaction to the potential of the industry, but not the investment policy. In fact, investment policy only causes price fluctuations and industry overcapacity to some extent. Therefore, China's investment policy on PV industry investment should be reduced properly or even canceled, or at least it should be combined with deployment and R&D.

1. Introduction

Solar Photovoltaic (PV) emerged as one of the most promising technologies for power generation in the World. From 2002 to 2012, the global PV industry had nearly an average annual growth rate of 50%. In 2012, PV industry experienced more remarkable

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growth than the past decade, and now is on its way to become a mature source of electricity. The world's cumulative PV capacity surpasses 100 GW which actually has already reached 102-gigawatt (GW). This capacity is capable of producing as much annual electrical energy as 16 coal power plants or nuclear reactors of 1 GW each [1].

In China, PV industry grew even faster. In some years after 2002, its growth rate even exceeded 100%. Since 2009, its production has ranked the first in the world for consecutive four years. And in 2012, its production accounted for 60% of world production, as shown in Fig. 1 [1]. With such a large share of the global PV industry, China's PV industry has great impact on global PV market. Moreover, China is the only country that can cover its own growing market with 320% more production than its need, as shown in Fig. 1. It is necessary to identify the reasons that caused the high-speed capacity expansion.

As a global practice, policy support for PV industry is an important driving force of its development. Muntasser et al. propose a new framework for evaluating quantitatively the effect of carbon taxation with the tax revenues only as a subsidy for installing Photovoltaic Power Generation Systems on houses [2]. Dincer studies current PV electricity generation status of the leading countries, including some European countries, United States of America, China and Japan, and future policies are further analyzed [3]. Hsu uses the system dynamics approach to develop a simulation for assessing the promotion policies. And it is found that when adopting only FITs or capital subsidies with a fixed upper limit of ROI, increasing the FIT price or subsidy was a good approach; when the upper limit of ROI was fixed, the effect of different combinations of FIT prices and subsidies on the accumulation of solar PV applications would be insignificant. Nevertheless, the promotion policy with the higher subsidy and lower initial FIT price had a lower average cost of CO_2 emission reduction [4]. Grau [5] survey policies in Germany and China and the industrial actors they could encourage to pursue innovation, including deployment support, investment support for manufacturing plants and R&D support measures. While deployment support had been successful, investment support for manufacturing in these nations had not been sufficiently tied to innovation incentives, and R&D support also had been comparatively weak [5]. Lüthi & Wüstenhagen argue that industry's growth to date had been largely driven by public policy, notably feed-in tariffs due to relatively high cost, and suggest that project developers who make a decision between PV investment opportunities in different countries carefully weigh feed-in tariff-induced returns against a set of policy risks, and choose the country with the most favorable risk-return profile [6]. Silveira et al. present a technical and economic study on a 15 kW solar plant installed in an isolated community, highlighting the importance of the need for financial subsidy from the government [7]. de Martino Jannuzzi and de Melo present a prospective analysis of grid connected PV systems in the Brazilian household sector, by evaluating scenarios of technology diffusion up to 2030 with policy mechanisms to foster the development of grid connected PV generation [8].

As China's government performs to be more powerful in economic activities, its PV policies have received more attention. Zhao et al. summarize China's photovoltaic policy, including Renewable Energy Law of China, the Renewable Energy Resources Mid-long Term Plan, "Jintaiyang Project", the amend of Law on Regenerable Energy Resources, and a series of local policies and recommendations on the PV market, and argue that the optimistic future of China's PV market was attributed primarily to the support of the government [9]. Zhao et al. apply a diamond model approach to identify and analyze factors that have significant impacts on the development of China's PV power, and it is found that the government played a key role to regulate the renewable power market, especially when the current industrial environment was not mature [10]. Da Zhang et al. carry out a detailed study to quantify the co-benefit from the replacement of traditional coal-fired power by the large-scale photovoltaic power comprised of polycrystalline cells in China [11].

These studies comprehensively summarized the PV policies among EU, USA, China and other countries or regions. These policies generally can be divided into three categories: R&D policies which support PV industry technology development, deployment policies which enhance PV equipment installation and power generation, and investment policies which promote the production and manufacture of PV equipment. Most of these researches mainly focused on deployment policy, and the results show that deployment policy in promoting power generation is remarkable. But these studies, including those on China's PV policy, still could not well explain the rapid expansion of production and overcapacity of China's PV industry.

Therefore, the main purpose of this paper is to reveal whether there is a strong causal relationship between China's policy and its PV industry overcapacity. China's PV policies can also be divided into three categories, namely R&D policy, deployment policy and investment policy [5]. R&D policy is aimed to encourage scientific and technological development of PV industry, and deployment policy will promote the installation of PV electricity system. Both of them will not directly promote the sharp increase of China's PV industry production. While, it is China's PV investment policy which may have effect on the expansion of China's PV industry production.

China's central government policy is the framework to promote the development of PV industry, and the local governments have

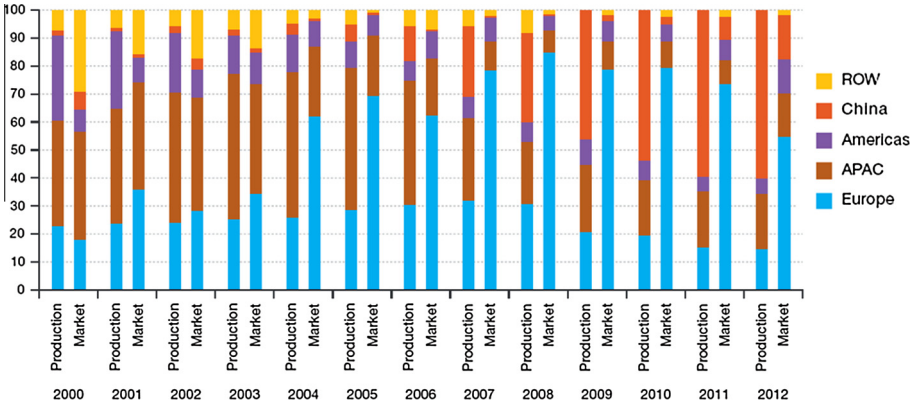

Fig. 1. Historical PV market vs. production by region (%). Resource: EPIA, GLOBAL MARKET OUTLOOK 2013–2017.