



Research and development strategy for environmental technology in Japan: A comparative study of the private and public sectors



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ABSTRACT

Environmental protection technology plays an important role in a sustainable society, simultaneously promoting economic development and pollution control. This study examines the determinants of technology inventions related to environmental protection in Japan. We use patent application data in a decomposition analysis framework. We find that environmental patent applications increase according to the prioritization of environmental patents by private companies and according to efficiency improvements in patent applications in the public sector. Additionally, patent applications related to emission trading increased rapidly among private companies, mainly due to their increased priority after 2005. The different determinants of environmental technologies between the private and public sectors are useful for formulating effective policies to promote environmental innovation.

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1. Introduction

Environmental protection technology (hereafter, environmental technology) plays an important role in effectively and economically controlling pollutant emissions. In this way, such technology contributes to the creation of a sustainable society, that is, one balancing economic development and environmental protection (Sun et al., 2008). The global importance of environmental technology has been increasing. Environmental technology is listed as a high priority in Japan's 5th science and technology basic plan, which covers 2016 to 2020. Similarly, the U.S. government budgeted approximately 7.4 billion U.S. dollars for clean energy technology programs in 2016. Additionally, Germany's high-tech innovation strategy, introduced in 2014, includes creating a sustainable economy and energy supply as one of its six priority tasks. These research and development strategies focus on the expansion of the environmental business market and are intended to improve international market competitiveness.

However, not all environmental technologies contribute equally to improved pollution control and resource conservation. Technology for environmental protection is diverse and comes in many forms. Some of these are pollution control technologies applicable to waste management, air pollution control, and wastewater treatment. The resource conservation area includes renewable energy, energy efficiency

improvements, and energy-saving products. It is clear that the market demand for and cost of inventions differs depending on the type of environmental technology. Therefore, it is important to consider the characteristics of each environmental technology when suggesting an economical and effective environmental technology invention system. To understand the characteristics of environmental technologies, clarification is imperative.

The clarification of environmental technology was introduced by the Organisation for Economic Co-operation and Development (OECD, 2009) and the World Intellectual Property Organization (WIPO, see <http://www.wipo.int/classifications/ipc/en/est/>). Meanwhile, previous literature focusing on the characteristics of environmental technology patents (hereafter, environmental patents) is limited, and most studies focus on the U.S. and European countries (Fujii, 2016). In recent years, several academic studies have focused on specific environmental technologies, such as wind energy technology in Europe (Lindman and Söderholm, 2015) and green chemistry in Japan (Fujii, 2016).

Fujii (2016) applied a factor decomposition analysis to identify the determinants of patent applications related to green chemistry in Japan. This study addressed green chemistry but not the other environmental technologies. Therefore, pollution control and alternative energy technologies, which have different characteristics from green chemistry, are not discussed in Fujii (2016). Additionally, few previous studies have used Japanese environmental patent data. Therefore, there is no previous research providing a factor decomposition analysis of the determinants of environmental patents in Japan that focuses on the characteristics of each technology. However, the results of such a factor

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analysis, which considers the characteristics of specific environmental technologies, are important for creating effective research and development policy.

This study tries to clarify the determinants of Japanese environmental patents from 2001 to 2010. During this period, the so-called “lost decades,” the Japanese economy experienced slow growth due to high appreciation of the yen and reduced consumer spending in the domestic market (Hamada and Okada, 2009; Lise et al., 2014). Studies of how research and development advanced in Japan during the lost decades are limited, especially concerning environmental technologies. However, according to the Organisation for Economic Co-operation and Development (OECD) (2014), Japan led the world in high-value inventions in environmental technology between 2009 and 2011. This pattern shows that Japan was highly competitive in research and development technology in 2011. Interestingly, Japan invented environmental technologies during an economic depression, during which reductions in R&D expenditures would normally be expected.

Fig. 1 presents the number and share of patent applications for environmental technologies from 1990 to 2010. The bars illustrate the number of patent applications for environmental technologies by type of technology, following the WIPO environmental patent classification. Fig. 1 also shows the GDP growth rate. During the 1990s and 2000s, the GDP growth rate in Japan stagnated around 0%; it dramatically declined in 1998 and 2009 due to the Asian financial crisis in 1997 and the global financial crisis triggered by the collapse of Lehman Brothers in 2008, respectively. Fig. 1 shows that the share of environmental patent applications, out of total patent applications, gradually increased from 3% to 9% over the 1990–2010 period. One interpretation of this change is that market and social demands for environmental protection were increased by worsening environmental problems, such as climate change (Jin, 2015).

Table 1 summarizes both Japanese policies and international events related to environmental technology invention. Table 1 lists the pollution control policies focusing on the early 1990s. Environmental management and climate change mitigation were required beginning in the late 1990s. Since 2000, both climate change mitigation and appropriate handling of toxic chemical substances have been subject to strong international demand (Ermoliev et al., 2015). These policy trends are reflected in increasing environmental patent application shares. As

Table 1
Policies and international events related to environmental technology inventions.

Year	Japanese policies and international events
1990–1994	Business council for sustainable development created (1990)
	United Nations conference on environment and development (1992)
	Law concerning special measures for total emissions of nitrogen oxides and particulate matter reductions in Japan (1992)
	Convention on biological diversity (1993)
	Basic environmental law in Japan (1993)
	Framework convention on climate change (1994)
	The basic environmental plan in Japan (defined concept of environmental risk) (1994)
1995–2000	ISO14001 certificate started (1996)
	Environmental impact assessment law in Japan (1997)
	Kyoto Protocol adopted (1997)
	Home appliance recycling law in Japan (1998)
	Law concerning the promotion of measures to cope with global warming in Japan (1998)
2000–2004	Act on special measure for industrial revitalization (Japanese Bayh–Dole Act) (1999)
	Cartagena Protocol on biosafety (2000)
	Basic law for establishing a recycling-based society in Japan (2000)
	Act on promoting green purchasing in Japan (2000)
	Law concerning special measures against dioxins in Japan (2000)
2005–2010	World summit on sustainable development (2002)
	Amendment of chemical substances control law in Japan [introduced concept of environmental risk impact into ecological system] (2003)
	Kyoto Protocol entered into force (2005)
	Effect on RoHS directive (2006)
	Amendment of air pollution control law in Japan [emission restrictions on VOCs] (2006)
	Eco-point system for energy-saving electric products in Japan (2009)
	Government subsidy program for eco-friendly cars (2009)
	Carbon emission trading system is started in Tokyo, Japan (2010)

seen in Fig. 1, the number of patent applications for waste management, including pollution control technologies, increased during the early 1990s. Since the late 1990s, energy conservation and alternative energy production have increased each year. In addition, the administrative, regulatory, and design aspects of technology, including emission trading technologies, increased dramatically after the Kyoto Protocol, which entered into force in 2005.

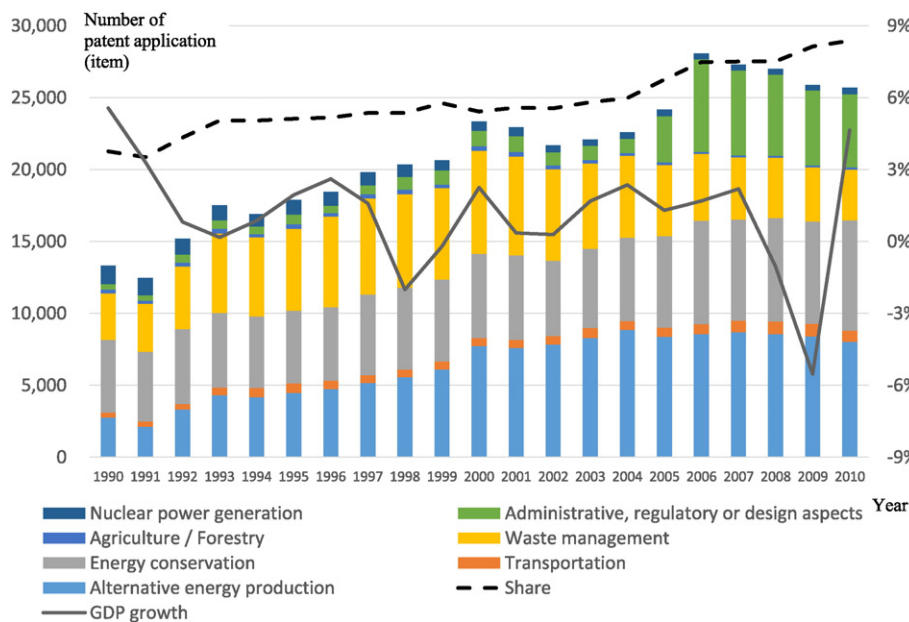


Fig. 1. Trends in Japanese environmental patent applications by type of technology. Note: The share is calculated as the number of environmental patent applications/number of total patent applications. Source: Patent data are from patent database published by the Institute of Intellectual Property. GDP growth is from World Development Indicators published by the World Bank.

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