Case Study 6: Achieving a low carbon transition in Japan: The role of motor vehicle lifetime

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Introduction

In order to achieve climate change mitigation goals, reducing greenhouse gas (GHG) emissions from Japan's household sector is critical. These emissions, arising from household heating and cooling, and transport, increased by 60% from 1990 to 2012 (Ministry of the Environment, 2014). In light of this sharp increase in GHG emissions, attention has turned to the production and consumption of durable goods (e.g. passenger vehicles, air conditioners, and refrigerators) that consume large amounts of energy. Accomplishing a transition to low carbon and energy efficient consumer goods is particularly valuable as a policy tool for reducing emissions in the residential sector. In this case study, we present an analysis of the lifetime of personal vehicles in Japan, and consider the optimal scenario in terms of retention and disposal, specifically as it relates to GHG emissions.

As a policy measure to reduce the carbon dioxide (CO_2) emissions originating from the transport sector, the Japanese government introduced a vehicle replacement scheme (April 10, 2009 to September 30, 2010) which provided a subsidy of ¥250,000 (approximately 2,300 US$) to vehicle owners, to incentivise the replacement of older vehicles with more fuel-efficient new vehicles (e.g., hybrid passenger cars with high energy efficiency more than 35km per litre). As a result of this policy, ownership of hybrid passenger vehicles increased by 233% in the four years between 2010 and 2014, reaching 4.7 million hybrid vehicles (Next Generation Vehicle Promotion Centre, 2016). The scheme aimed to curb driving-related CO_2 emissions by increasing the fuel-efficiency of motor vehicles. However, the market expansion of fuel-efficient vehicles could contribute to increased environmental impacts through CO_2 emissions occurring in production and pre-consumer phases.

As the lifetime of passenger vehicles increases (i.e. the average vehicle age rises), the number of newly registered vehicles generally decreases (Kagawa *et al*., 2011), resulting in fewer new vehicle sales, which has an adverse economic impact (Kagawa *et al*., 2009). On the other hand, a decrease in vehicle production and sales will reduce embedded energy and the associated GHG emissions of the industrial activities. However, fuel consumption for the residential sector is affected by a range of factors including changes in fuel economy and distance travelled (see Greening *et al*., 2000), a higher number of older vehicles, which often have a relatively poorer fuel economy than newer vehicles, which can increase fuel consumption and GHG emissions for the residential sector (Kagawa *et al*., 2011).

By retaining private vehicles for longer, consumers will not need to purchase new vehicles and are therefore likely to respond in one of two ways: (1) Save the money, or (2) spend the money on other goods and services. Any money spent will stimulate the production and consumption of other goods and services, which, depending on the specific goods or services, will indirectly increase secondary energy consumption (Kagawa *et al*., 2008). The production and consumption of goods is of particular interest to this case study, since the consumption profile is of critical importance to a low carbon mobility transition and the ownership of private motor vehicles. Thus, changes in the lifetime of durable goods have interesting and important impacts on the environment, and a clear significance for Japan's transportation industry and its ability to achieve GHG emission reductions (Kagawa *et al*., 2011).

The production and consumption of motor vehicles in Japan

The production of motor vehicles in Japan increased rapidly from 1950 to 1990, with peak annual production reaching approximately 10 million vehicles in the year 1990, due to Japan's so-called 'bubble economy' (Figure 1) (Japan Automobile Manufacturers Association [JAMA], 2016). After the Japanese asset price bubble burst in early 1992 (Horioka, 2006), Japanese car production declined sharply to 1995 before increasing again from 1996 to 2008 (JAMA, 2016). Figure 1 depicts the impact of the global financial crisis on Japanese car production, with a strong decline in 2009. A similar trend can also be seen in the net exports of new passenger cars from Japan (JAMA, 2016).

Figure 2 shows the evolution of passenger vehicle ownership in Japan between 1950 and 2014. During the period between 1975 and 2014, an average of 4 million new passenger cars per year entered the Japanese vehicle fleet, whereas an average of 3 million old cars per year left the vehicle fleet. The stock addition of new passenger cars reached 5 million vehicles in 1990 (Figure 2). Between 2011 and 2014, new vehicle sales increased, and consequently the total number of passenger vehicles has grown to 60.7 million (JAMA, 2016). If we divide this number by 52 million, the

approximate number of Japanese households in 2014, the national average vehicle ownership rate is estimated to be 1.17 per household, an average of at least one car for each household. The vehicle ownership per 100 people in 2005 and 2014 were 44.7 and 47.7, respectively compared to other countries the national average vehicle ownership rate of Japan is similar to Belgium (46.9), Norway (44.1), and Netherlands (43.4) (OECD, 2009). Thus Japan's vehicle ownership per capita is relatively high and car ownership contributes to increasing CO_2 emissions through the life-cycle of passenger cars during pre-consumer and driving phases.

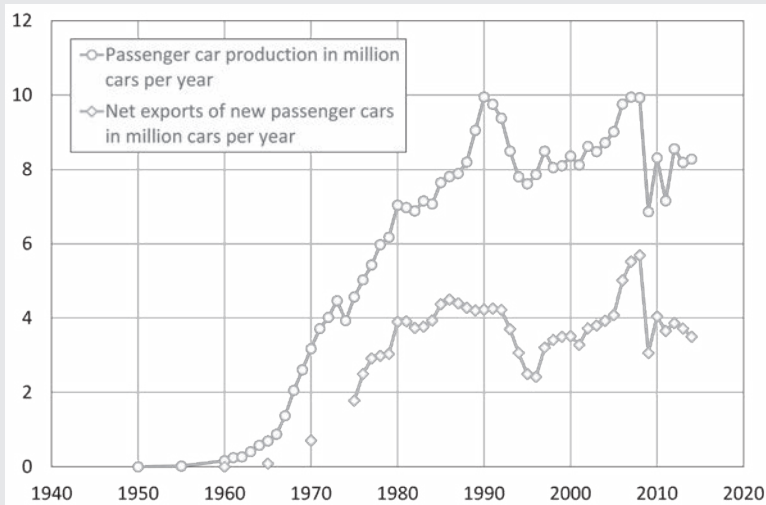

Figure 1: Evolution of productions (left axis) and net exports of new passenger cars (right axis) in Japan (1950-2014). Source: Author's diagram using data from Japan Automobile Manufacturers Association (2015).

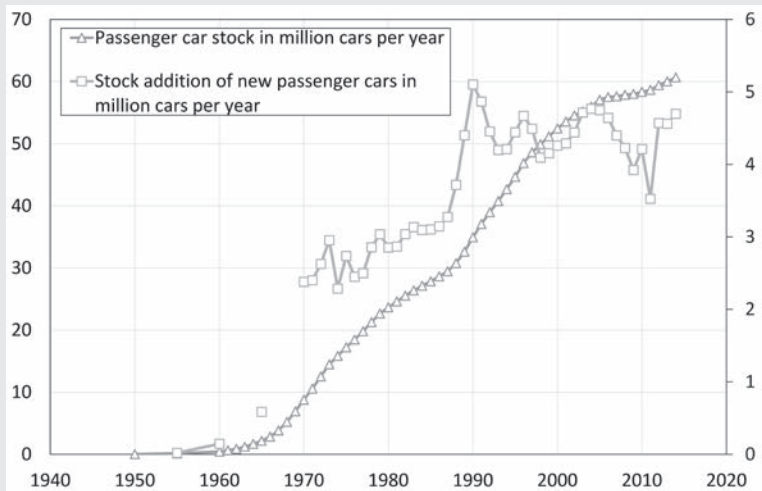

Figure 2: Evolution of passenger car ownership and stock addition of new passenger cars (right axis) in Japan (1950–2014). Source: Author's diagram using data from Japan Automobile Manufacturers Association (2015).