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Fertility-rate recovery and double-income policies require solving the carbon gap under the Paris Agreement

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ABSTRACT

In 2015, in response to the Paris Agreement for mitigating an increase in global temperatures, the Japanese government committed itself to reducing greenhouse gas (GHG) emissions by 26% below 2013 levels by 2030. In the same year, the government also committed itself to overcoming the barriers to economic growth imposed by an aging society with a low birthrate by implementing socio-economic policies referred to as "A Society in Which All Citizens are Dynamically Engaged". Regarding achievement of these two national targets, this study examines the extent to which increases in the total fertility rate and the number of double-income households would impact the domestic carbon footprint (CF) associated with household consumption in 2030. The findings show that the total household CF in 2030 would range from 683 to 815 Mt-CO_2eq/y, depending on the consumer preferences resulting from implementation of the socio-economic policies. This implies that, compared with a business-as-usual scenario, the GHG emissions associated with household consumption would need to be reduced by more 7.8–29% in order to meet the CF target that can be set using the CF for 2009 and the reduction target proposed in the Paris Agreement. Furthermore, the household CF for non-energy commodities would need to be reduced by 17–28% in order to satisfy the trade-off between the socio-economic policies and the emissions mitigation target for 2030, even if the current CO_2 emissions targets for household energy use and private car use are achieved.

1. Introduction

Mitigation of climate change is one of the most urgent global environmental issues. In an attempt to mitigate global climate change and reduce emissions of greenhouse gases (GHG), the Paris Agreement was adopted at the Conference of Parties (COP) 21 held in Paris in 2015 (United Nations of Framework Convention on Climate Change (UNFCCC, 2017). The Paris Agreement came into force in 2016, and as of May 1, 2017 had been ratified by 144 nations (UN, 2017). Japan, one of the world's largest producers of carbon dioxide (CO_2) emissions (IEA, 2015), also ratified the agreement and pledged to reduce its GHG emissions by 26% below 2013 levels (Prime Minister of Japan, 2016a). Although Japan met its GHG mitigation targets in the period 2008–2012, viz., 6% below 1990 levels, which is in line with the Kyoto Protocol adopted at COP3, recent emissions are still a long way from fulfilling the Paris Agreement, mainly because of the suspension of almost all electricity generation at nuclear power plants due to the Great East Japan Earthquake of 2011.

Using well-developed consumption-based accounting methods (Munksgaard et al., 2000; Peters, 2008), it has been found that in advanced nations over half the direct and indirect GHG emissions associated with economic activity (i.e., the carbon footprint (CF)) are induced by household consumption (Hertwich, 2011). Numerous studies have examined household CF characteristics (Takase et al., 2005; Peters and Hertwich, 2006; Nansai et al., 2007, 2008; Druckman et al., 2011; Jones and Kammen, 2005; Chitnis et al., 2012; Minx et al., 2013; Girod et al., 2014; Kawajiri et al., 2015; Steen-Olsen et al., 2016; Brizga et al., 2017; Markaki et al., 2017). Similarly, numerous studies quantifying the impact of differences in household income, household size (number of people in a household), sex, and other parameters on household CF have been published (Wier et al., 2001; Roca and Serrano, 2007; Weber and Matthews, 2008; Kerkhof et al., 2009; Kronenberg, 2009; Girod and de Haan, 2010; Druckman et al., 2012; Chitnis et al., 2014; Ivanova et al., 2016; Wang et al., 2016; Wiedenhofer et al., 2016; López et al., 2016). In Japan, household CF accounted for 61% of the country's total CF in 2005, with approximately two-thirds of this household footprint

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being generated domestically (Nansai et al., 2012a). In addition, the per-capita CF of households in the highest annual income quintile was 1.4 times that of households in the lowest annual income quintile (Shigetomi et al., 2016).

Japan is currently facing serious problems associated with its aging population and low birthrate. In 2013, people over 65 years old accounted for more than 25% of the total population. The proportion of elderly people in the total population is projected to reach 31.6% in 2030 and 40% in 2060 (Cabinet Office: Government of Japan, 2016). Although this demographic trend is expected to lead to a decrease in household CF and GHG emissions (Shigetomi et al., 2014), economic damage in the form of a decrease in the workforce and an increase in the cost of social welfare will be difficult to avoid. In response to these concerns, The Government of Japan introduced a set of policies to realize "A Society in Which All Citizens are Dynamically Engaged" in the same year as COP21 (Prime Minister of Japan, 2016b). These policies, "the Plan to Realize the Dynamic Engagement of All Citizens" (hereafter referred to as the "Dynamic Engagement Plan") is intended to increase the country's population by increasing the fertility rate and boosting incomes, improving childcare support, encouraging double incomes, and re-employing elderly people. However, boosting household income and household size and doubling household income are likely to increase household consumption, in turn leading to an increase in household CF. Nevertheless, to the best of our knowledge, no study has yet addressed the trade-off between household social policy (i.e., the Dynamic Engagement Plan) and household CF. Furthermore, studies on future perspectives of consumption-based GHG emissions (Guan et al., 2008; Kronenberg, 2009; Barrett and Scott, 2012; Chitnis et al., 2012; Girod et al., 2014; Shigetomi et al., 2014) are very limited compared with those concerning production-based (territorial) GHG emissions (e.g., van Vuuren et al., 2017).

Against this background, we have attempted to highlight the impact of changes in the demographic composition and structure of consumption expenditure under the Dynamic Engagement Plan proposals on domestic household CF. In addition, scenario analyses have been carried out to identify the ramifications of household consumption on the targets set out in the Paris Agreement for Japan in 2030. Finally, we have attempted to elucidate the gap between the Dynamic Engagement Plan and the mitigation targets, and how to reduce it.

This paper is organized as follows. Chapter 2 describes the methodology and data employed to estimate changes in demographic composition, household consumption and household CF in Japan. Chapter 3 presents the results of these estimates according to several different scenarios. Finally, Chapter 4 discusses policy implications and assesses the outlook based on the results obtained.

2. Method and data

This research examined the following socio-economic effects associated with the Japanese Government's Dynamic Engagement Plan proposals: (1) the increase in the number of households of parents with children as a means to recover the overall fertility rate, (2) the increase in double-income households of parents, (3) the increase in consumption in response to higher household income. For (1), a target increase in the average fertility rate from 1.42 in 2015 to 1.80 in 2030 has been proposed by the government, which will result in an increase in the number of households with children. In order to accurately project the total number of households with children in 2030, it is essential to take into account cohort changes caused by the estimated increase in the average fertility rate year-on-year. We therefore estimated the household composition in 2030 based on the cohort changes. Further, the effect of (3) was assumed to be related to both (1) and (2).

In Japan, the number of households with children is declining mainly because young adults are concerned about their economic wellbeing, particularly in terms of cost of living and child support (Prime Minister of Japan, 2016b). We therefore assumed that these relatively younger households may have children if they become double-income households and if the labor environment improves. According to the Japanese Government, household consumption is expected to increase by 20.4 trillion Japanese yen (JPY) by 2025 as a result of to the increase in wages induced by implementation of measures under the Dynamic Engagement Plan. We assumed this growth would be generated by an increase in the number of double-income households with children and by extending the retirement age to 70 years old.

We therefore conducted scenario analyses to estimate household composition and consumption in 2030 under the Dynamic Engagement Plan measures mentioned above. The following subsections elaborate the methodology used clarify the future scenarios adopted in this study.

2.1. Quantifying consumption expenditure and CF based on household attributes

This research quantified the consumption and CF of households in the domestic supply chain using a consumer expenditure survey (National Survey of Family Income and Expenditure; NSFIE), which is a population statistic (National Institute of Population Social Security Research, Population Statistics of Japan; IPSS), and the intensity of direct and indirect GHG emissions (Nansai et al., 2012b).

Firstly, to comprehend the current structure of household consumption, the row vector $\mathbf{g}^{Age,Property,Child} = [g_k^{Age,Property,Child}]$ was obtained from the NSFIE (2009). The element $g_k^{Age,Property,Child}$ denotes the monthly consumption expenditure per household for expense item k (k = 1…72) for individual household attributes which are displayed as superscripts, viz., $g_k^{Age,Property,Child}$. The left-hand superscript, *Age* = 20s, 30s, 40s, 50s, 60s, 70s and older, is the age (years) of the house tenants. The center superscript, *Property* = 1…4, indicates whether the household is a one-person household, a non-nuclear family (defined as a household that does not fit into the other household categories listed) or a single-parent household, a single-income household with two parents, or a double-income household, respectively. The right-hand superscript, *Child* = 0…3, indicates the number of children (0, 1, 2, not less than 3). Note that *Child* can only take the value 0 when *Property* = 1 or 2. In particular, $g_k^{Age,Property=,2,Child=0}$ only applies to non-nuclear families and single-parent households because it is impossible to identify the consumption expenditures of these households when there is a difference in the number of children in a household (thus, *Child* ≠ 1, 2, 3 when *Property* = 2); Table 1 summarizes the definitions of these variables. For example, $\mathbf{g}^{Age=40s,Property=3,Child=2}$ is a vector of consumption expenditure for single-income households with parents in their 40 s with two children.

Secondly, to calculate the CF using household attributes, we converted the monthly values for $\mathbf{g}^{Age,Property,Child}$ to annual values, and obtained the column vector $\tilde{\mathbf{g}}^{Age,Property,Child} = [g_i^{Age,Property,Child}]$ (Million JPY (M-JPY)/y) by mapping the expense items on the NSFIE onto the

Table 1
Structure of household attributes considered in this research.

Age of householder (*Age*)	Household property (*Property*)	Number of children (*Child*)
20s: ≤29	1: One-person household	0
30s: 30-39 40s: 40-49	2: Non-nuclear family and one-parent household	N.A.*
50s: 50-59 60s: 60-69	3: Single-income household of a couple	0 1 2 3
70s: ≥70	4: Double-income household of a couple	

[a]It is not possible to differentiate between the expenditures of non-nuclear and single-parent families with different numbers of children. Thus, *Child* for those households can only be 0, and not "N.A.".