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Measuring housing wellbeing for disaster victims in Japan and India: A capability approach

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Foreword

The threat of disaster has been a constant feature of human history, but never has it been more widespread and worrying than it is today, as a result of global warming. The need to identify the best ways to recovery from disasters is correspondingly great. A major element of that is thinking through how to restore people's homes and communities following events such as earthquakes, floods and fires, to allow residents to rebuild their lives. But sometimes the rebuilding can be done in ways which, however well intentioned, create their own problems.

I am therefore delighted that the Property Research Trust is publishing this report that sets out a framework for thinking through the appropriate factors to consider in designing and implementing post-disaster housing strategies. Based on empirical research undertaken in Japan and India—two very different nations, both of which often face daunting disasters—this report offers guidance to policy makers in governments and non-governmental organisations around the world. I am grateful to the distinguished team of academics who undertook the research and who have written this report. I hope it will make a contribution towards a more humane approach to post-disaster recovery planning.

Alan Dalgleish
Chair, Property Research Trust

Key messages

- **This research identifies housing wellbeing determinants as a functioning achievement when seen through the lens of Sen's 'capability approach' within the context of Japan and India.**
- **Important questions asked in this research are: What are the determinants of housing wellbeing? How do personal characteristics impact housing wellbeing? What is the influence of disaster vulnerability on housing wellbeing?**
- **Relocation should not be detrimental for households in securing income opportunities.**
- **Housing should respond to the requirements of households. In this context, it is important that the community is involved in the process of designing their living environment.**
- **During post-disaster reconstruction, it is necessary to avoid disrupting social systems which are based on trust and care for each other and particularly for children.**
- **Post-disaster reconstruction should make efforts to ensure social equity and empowerment of women, which will not only have a positive impact on the health of women, but will also improve the overall wellbeing of households.**
- **Mechanisms for protection of assets/houses and income of low-income households through public insurance or other safety nets should be devised.**
- **It is necessary to resettle households in a way which does not disadvantage them through social stratification or affect their self-identity. This implies that as far as possible reconstruction should be in-situ or, if relocation is necessary, it should not be at a distant location.**

Executive summary

Aim

There are multi-dimensional short- and long-term impacts of disasters on human well-being, which extend beyond loss of assets. For post-disaster reconstruction, an important aspect of the reconstruction process is to estimate losses of the affected persons. Restitution strategies of government, non-government and multilateral agencies have predominantly relied on asset-based approaches to measure disaster losses and craft strategies for recovery. Though disaster-related public expenditures have increased, the approach of reconstruction has been criticised by affected people for its inadequacy.

Asset-based compensation, usually in monetary form, is marred by challenges in identifying compensable disasters; identification of eligible claimants; identification of compensable losses; and valuation of losses. The largest asset a household possesses is typically their house, and the most significant damage that occurs due to disasters is to housing. The losses go beyond the asset itself and affect many dimensions of human well-being.

This research aims to identify personal, social, economic, and physical losses, in terms of 'capabilities' and 'functionings' associated with housing, that disaster-affected people suffer in Japan and India. It identifies determinants of housing wellbeing as achievement of functionings when seen through the lens of Sen's 'capability approach', including geographically and culturally contextual factors for Japan and India, and develops principles for satisfactory reconstruction of losses of affected persons.

Research questions

This research asks the following questions: What are the determinants of housing wellbeing? How do personal characteristics of individuals impact their housing wellbeing? What is the influence of disaster vulnerability on housing wellbeing? How does relocation impact on housing wellbeing? What principles may guide satisfactory post-disaster reconstruction of losses of affected persons?

Data

India

A primary survey was conducted between July and August 2021 to collect data from 458 respondents from three different purpose-built resettlement colonies in Chennai, namely Kannagi Nagar, Ezhil Nagar and Perumbakkam. The random sampling method was used to identify and interview respondents.

Japan

The data employed for Japan are from the Japan Household Panel Survey (JHPS) from 2011 to 2018. From 2011, the JHPS asked respondents to indicate their satisfaction with housing along with their socio-economic and demographic factors.

Methodology

Sen's capability approach has created a (relatively) new debate on the definition and measurement of 'wellbeing'. Among multiple approaches to welfare economics, subjective wellbeing (SWB) and the capability approach are the two most prominent approaches to understand people's well-being, though neither is without limitations. This research amalgamates SWB and the capability approach to identify crucial determinants of housing wellbeing.

Japan

We use methods of pooled ordinary least squares and a fixed effects panel model to estimate household housing wellbeing function. Housing wellbeing is measured through self-reported satisfaction on a scale of 1 to 10 and is hypothesised to be a function of a range of factors, including personal characteristics of the respondent – which could either be static over time (such as highest level of education attained by the household head, parental background) or change dynamically over time (such as income, expenditure, debt) – housing characteristics, employment, location, and family characteristics.

India

Given that the purpose of the paper is to examine satisfaction of households with their houses in resettlement colonies, a multi-nomial logit model is estimated. Households express their satisfaction on a scale of 1 to 5, with 1 being 'very dissatisfied' and 5 being 'very satisfied'. While it is possible to address person-specific heterogeneity in panel data (such as the JHPS data), the same was not possible for cross-sectional data. Therefore, five personality variables were used to control for person-specific heterogeneity around empathy, optimism and experience with natural and man-made disasters.

Housing wellbeing is estimated as a function of functionings. Various indicators have been used to proxy functionings.

Findings

Findings suggest that the satisfaction from housing is a combined outcome of personal, familial, financial, and locational attributes. In case of Japan, an individual's satisfaction with housing increases from having the opportunity to own a house (as opposed to renting); having the control over one's physical environment; and being able to insure the house against disasters such as earthquakes. People over 65 years of age reported greater satisfaction from housing as their mortgage repayment obligations declined and, due to

retirement from employment, their ability to spend more time in the house increased.

Households that have been able to secure higher household income, and hence savings, are able to improve or modify their living environment. Findings from India reveal that opportunities for higher household income are not equally distributed for all those who have been resettled. The importance of neighbourhood security and social capital in the constitution of housing wellbeing for poor and vulnerable communities is underscored. Safety levels in the neighbourhood and access to an informal/social system for childcare are significant contributors to housing wellbeing in resettlement colonies which typically contain a heterogenous mix of vulnerable people.

Relocations, which weaken social and economic associations, negatively affect housing wellbeing, as has been the case for many in resettlement colonies. The cultural inappropriateness of housing constructed for post-disaster resettlement is an issue that has affected housing wellbeing. These purpose-built resettlement colonies have not been free from flooding and the subsequent fear of losing an asset/house has a strong negative impact on housing wellbeing of the respondents. On the contrary, having a satisfactory level of protection from disasters (both natural and man-made) adds to the wellbeing of these households, who have already been living in purpose-built resettlement colonies post-tsunami.

Social equity and empowerment of women ensures housing wellbeing. In India, resettlement colonies have faced serious concerns regarding the safety of women within the neighbourhood. In Japan, women's perceived risk of disaster is higher than men's as their main concern comes from the effect of disaster on the health of children, while the latter are more concerned about the effect on income. It is important that the housing wellbeing reconstruction process accounts for the voices of women.

Policy recommendation for Japan

Security of livelihood, income and social ties are important for households for their wellbeing and in post-disaster reconstruction it is even more important. Japanese households derive a greater satisfaction from home ownership (as opposed to rental tenure); landed houses (as opposed to apartments); and a larger house. Housing is also a reason for households to return to their original place after displacement due to disaster.

It is important that the policy for reconstruction focuses on in-situ redevelopment of housing where it has been destroyed and it is possible to rebuild. In addition, strategic intervention is required to improve the penetration of earthquake insurance and make it more affordable and relevant to households' needs post-disaster. Carefully crafted insurance policies for income and property (land and housing) loss may help households to restore their housing wellbeing sooner.

Long-term plans for guaranteeing income security would require restitution of jobs and employment. The loss of life of an earning member takes a toll on emotional and housing wellbeing. Again, insurance policies for the loss of life due to disaster may speed up the recovery process. Immediately after a disaster, mitigating the negative effect of loss of income would require approaches like direct cash transfers.

An important aspect of the post-disaster reconstruction process is that people's satisfaction with their housing and location is addressed and to achieve that it would be necessary to improve: (i) their ability to own housing (as opposed to renting); (ii) access to an affordable disaster insurance covering earthquake flooding, nuclear risk and others; (iii) reduced vulnerability to inundation, radioactive contamination, and other forms of disasters through remodelling and/or seismic retrofitting older houses.

Alongside these, the continuous stream of financial assistance has a significant positive impact on housing wellbeing in the absence of other forms of assistance.

Policy recommendations for India

Our findings suggest that respondents whose income and employment opportunities were affected by disasters or those with poor health status reported lower wellbeing from housing. Connectivity of resettlement colonies through public transport to employment, and accessibility to health and other services, are of utmost importance for satisfactory reconstruction of losses. Further, the existing literature argues that poor design and quality of housing, and a neighbourhood environment that does not meet cultural and social expectations, can aggravate post-disaster trauma and damage the physical and emotional/psychological health of disaster affected persons. Given the large scale of resettlement colonies in Chennai, which are dynamically evolving and expanding over time, it may be worth exploring the opportunity for people (community)-led planning and development that is incremental and inclusive in nature. It is important to take design and non-design steps to create positive social perceptions about resettlement colonies, which are currently viewed as ghettos of impoverished.

Social capital is an important contributor to housing wellbeing for vulnerable communities in resettlement colonies. This can be explained by high interdependence of working families for childcare, aged care, road safety, financial security, psychological counselling, and other similar support services which are otherwise not available or are unaffordable. This research draws the attention of policymakers to these social functions of housing and suggests the necessity for positive relationship building among new settlers through greater involvement of trusted non-governmental and community organisations. Taking inspiration from developed countries like Japan, India may benefit from creating a permanent disaster relief fund for the vulnerable communities and private insurance against disaster.

Chapter 1
Introduction

Asset-based approaches to measuring disaster intensity and losses have long been criticized for excluding non-asset losses such as psychological wellbeing and social capital, which otherwise are crucial contributors to people's wellbeing and thus require satisfactory reconstruction post-disaster (Hallegatte et al. 2017; Walsh and Hallegatte 2019). Further criticism of asset-based post-disaster reconstruction models is that these direct recovery investments favour more affluent households and regions, and are implicitly biased against poor households that otherwise experience more considerable wellbeing losses (Walsh and Hallegatte 2019). Along with other scholars favouring the wellbeing approach over the traditional welfare economics approach to asset losses, Walsh and Hallegatte (2019) justify its use to paint the complete picture of losses and overcoming inbuilt inequality in the asset-based model.

This research argues in favour of designing a comprehensive compensation mechanism for disaster-affected people that takes account of both monetary and non-monetary resources that constitute an individual's wellbeing. The emerging literature on the role of assets in building human capabilities argues that the effect of the loss of property due to natural (or human-caused) disasters extends beyond its asset value to include other dimensions of wellbeing (Rao, 2018).

In her recent work, Rao (2018) studies the role of property for those who lost their land due to the compulsory acquisition and finds that functionings of land include (i) providing a secure means to basic ends; (ii) building self-identity; (iii) building social capital; (iv) building social equity; (v) causing political empowerment; (vi) granting power to the owner to make decisions on land matters; (vii) contributing to familial wellbeing; (viii) creating personal comfort and convenience; and (ix) granting psychological wellbeing. Even though Rao (2018) is concerned with landowners, a reduced form of this list will still be suitable to inform the 'functionings' of housing for renters and other reduced forms of rights on the property.

Examining housing wellbeing of households in Japan and India, this research investigates the valuable 'functionings' of housing (and the location of houses), aspects of 'functionings' of housing that are affected due to disasters and should be rebuilt in post-disaster reconstruction mechanisms.

Sen's (1987) capability theory has created a (relatively) new debate on

the definition of 'wellbeing' and on how to measure 'wellbeing' using the 'capability theory' (Kuklys, 2005). Through an overview of multiple alternative approaches to welfare economics, Binder (2013) finds subjective wellbeing (SWB) and the capability approach to be the two most prominent approaches to understand people's wellbeing, though neither is without limitations. Binder (2013) proposes a new model which combines SWB and 'capability' and overcomes the most challenging problem of hedonic adaptation in the SWB approach and ordering functionings and capabilities in the capability approach.

This research takes inspiration from Binder (2013) and amalgamates SWB and the capability approach to identify crucial determinants of housing wellbeing. Key factors (such as resources, personal characteristics, and household and societal characteristics) have been identified that impact housing wellbeing.

Important questions examined in this research are: What are the determinants of housing wellbeing? Are these the same for the owners and renters? How do disaster vulnerability, inheritance, and 'generational contract' influence housing wellbeing? How do personal characteristics influence the wellbeing of a person?

Answers to these questions will contribute to the ongoing discussions on building resilient communities and the more significant objective of designing a resilient compensation and restitution mechanism that can satisfactorily reinstall or reconstruct the basic capabilities of affected households and consequentially holistically facilitate the self-recovery process.

Chapter 2
Literature

Studies on residential satisfaction emerged as a subject of research in the late 1950s and early 1960s with pioneer works of Gans (1959) in Boston, Rainwater (1966) in St Louis, and Young and Wilmot (1957) in London (Amerigo, 1992). Most of these studies were motivated to inform urban planning and architectural design strategies concerned with housing quality for vulnerable populations in urban slums and public housing. In more recent years, literature has emerged that uses the concept of 'housing satisfaction' to evaluate permanent housing built for disaster victims through a users' satisfaction study (Mohit et al. 2010, Snarr & Brown 1980, Tas et al. 2007).

Amerigo (1992) notices that most studies on housing satisfaction either use 'satisfaction' as a criterion of quality of life (or wellbeing) (Marans and Rodgers, 1975; Gakster and Hesser, 1981; Cutter, 1982; and Weidemann et al 1982; Van Praag et al, 2003) or as a predictor of an activity, such as residential mobility and modification to the residential environment (Brown and Moore, 1970). Focusing on the former, Amerigo (1992) developed a systematic theoretical model to explain how subjective and objective attributes of the residential environment and personal characteristics of an individual form the perception of residential satisfaction and, in turn, their general satisfaction with life.

Amerigo's (1990) theoretical model explains how people transform the objective attributes of housing into subjective ones, and it is the latter that determines their perception of satisfaction with housing. People construct different standards of residential quality, based on which they assess the gap between actual and ideal environments, and as this decreases, their satisfaction with the real residential environment increases[1] (Marans & Rodgers, 1975; Morrissy & Handal, 1981; Canter & Rees, 1982; Bardo & Hughey, 1984; Amerigo & Aragones, 1997; Tomaszewski & Perales, 2014).

Amerigo & Aragones (1997) notice two methodological problems in measuring housing satisfaction: first the problem with a subjective construct of 'desirability' generated by direct questions of the type 'To what extent are you satisfied with. . .?' and second, the difficulty of determining 'objective' levels of residential satisfaction using indirect scales and the associated problem of validating what is measured in satisfaction. Regarding the first problem, an individual's adaption to their poor housing conditions and low standards of comparison may lead to high self-reported satisfaction, and vice

versa (Amerigo & Aragones, 1997). Nevertheless, Amerigo & Aragones (1997) encourage the orientation of future research towards the construction of indirect scales for measuring housing satisfaction.

So far, it has not been methodologically possible to separate the impact of objective and subjective attributes on the housing satisfaction of an individual, mainly due to lack of adequate data on housing conditions in multi-purpose surveys (Tomaszewski & Perales, 2014). To overcome the problem Tomaszewski & Perales (2014) proposed a modelling strategy that allows for objective attributes or housing conditions and exclusively investigates subjective attributes across different population segments in Australia.

In their descriptive analysis of factors through which housing influences subjective wellbeing, Clapham, et al (2018) refer to two distinct yet related groups of research where housing is the central point of discussion about subjective wellbeing. The first group includes works that examine the impact of housing-related factors on the subjective wellbeing measured through self-reported satisfaction with life (refer to Clark & Georgellis 2013, Foye et al 2018; Foye 2017; and Fujiwara 2013, who use BHPS panel data; and Clark, et al 2008; and Zumbro 2014; who use GSOEP panel data).

The second group of works includes studies that focus on identifying factors that impact an individual's satisfaction with housing (refer to Campbell, et al 1976; Galster & Hesser 1981; Rohe & Basolo 1997; Tomaszewski & Perales 2014; Vera-Toscano & Ateca-Amestoy 2008). This research contributes to the latter group of works. Still, it expands the contribution of housing from 'satisfaction from housing' to 'wellbeing' by examining the extent to which housing contributes to functioinings. These functionings then lead to wellbeing, as explained in the theoretical framework below. In addition, the research expands the literature on housing wellbeing by investigating the impact of the disaster. This research uses the term housing well-being as a functioning[2] achievement (as advocated by Sen's 'capability approach') and measures it through self-reported housing satisfaction.

This research furthers the work on designing a comprehensive 'resilient compensation and restitution mechanism' which Shukla et al 2021, (p.1) define as "a combination of monetary and non-monetary strategies that assist affected households in reconstructing capabilities across multiple dimensions of life". However, the focus of this research is set exclusively to the 'dimension' of housing. Through the joint use of SWB and capability approach, this research identifies subjective and objective factors that impact housing functioning achievement. This creates a more detailed picture of how different groups of people with varying characteristics may use the same market and non-market resources to create housing achievement. Findings from this research are beneficial for policymakers, disaster relief organisations, and government agencies concerned with the restitution and recreation of healthy housing conditions post-disaster.

[1] *Objective measurement of housing is widely used and it evaluates the physical characteristics, facilities, services and environment. However, objective assessment is not able to examine and explain the psychosocial aspects of residential satisfaction. Subjective measurement which includes perception, satisfaction, aspiration, and also disappointment is closely related to the psychosocial aspects of a person" (Mohit, et al., 2010, p. 20)*

Chapter 3
A theoretical framework

Our underlying theoretical framework is based on Sen (1987). Using Sen's notations we propose that:

$Q_i(x_i) = [b_i | b_i = f_i (c(x_i)), \text{ for some } f_i(.) \in F_i]$

$Q_i(x_i)$ in the equation above represents "capabilities" or the freedom that a person 'i' has in terms of various alternative bundles of feasible functionings, b_i, given their features F_i (the conversion function of characteristics into functionings) and their command over commodity x_i (entitlements). In the above equation,

c(.) = the function converting a commodity vector into a vector of characteristics of those commodities

$f_i(.)$ = a "utilization function" of person i reflecting one pattern of use of commodities that i can make

(in generating a functioning vector out of a characteristic vector of the commodities possessed).

F_i = the full set of "utilization functions" for person i to choose from.

Then, the set V_i gives the value of wellbeing that a person i can achieve:

$V_i = [v_i | v_i = f_i(b_i) \text{ for some } b_i \in Q_i]$

Further, following Binder (2013), this paper combines the SWB approach with the capability approach to identify determinants of household housing wellbeing, V as a function of a household's characteristics H_i and other determinants $Z_{i,t}$ that could either be static and do not change with time t (e.g, highest level of education attained by the household head, parental background) or change dynamically over time (e.g, income, expenditure).

$V_{i,t} = f(H_i, Z_{i,t})$

Where $V_{i,t}$ is a household's housing wellbeing measure equal to the self-reported satisfaction level from housing.

[2] *In simple words, Sen's theory focuses on the functionings or states of being and doing, such as being well-sheltered, which he explains as intermediate states between possession of resources and achieving happiness (Sen, 1987). 'Capability theory' equates an individual's 'wellbeing' to the level of freedom in terms of choice of functionings. A person's capability is then the chosen bundle of functionings from among various alternative bundles he/she can achieve through choice.*

Chapter 4
Disasters in Japan

Japan has suffered from loss of life and livelihood due to natural and man-made disasters. According to a report from the Cabinet Office on Disaster Management in Japan, between 1993 and 2009, 8,543 people lost their lives or were missing due to various disasters. On 11 March, 2011, a severe earthquake of magnitude 9.0 hit the east coast of Tohoku, which triggered a powerful tsunami that reached up to 40 metres high, as well as the meltdown at three of the nuclear reactors in Fukushima (Lieber, 2017). The Great East Japan Earthquake of 2011 added 15,835 to the toll of those who had lost their lives in disasters (Fukahori, 2012).

The meltdown of three nuclear reactors at the Fukushima Daiichi nuclear plant resulted in contamination of several tens of thousands of square kilometres in Fukushima Prefecture and wider Japan with radioactive caesium and other radionuclides (Burnie et al, 2021). The nuclear accident led the Japanese government to evacuate 11 municipalities in the Fukushima Prefecture (Burnie et al, 2021). The combined event of the earthquake, tsunami, and nuclear accident also destroyed more than 1.2 million buildings, and resulted in the temporary evacuation of more than 380,000 people from their homes. It also disrupted water supply, power distribution, train, highway, and air transport systems in a wide area of eastern Japan.

The impact of disasters on affected people lasts far beyond the immediate destruction and loss of life. Maeda and Oe (2017) find that concerns about chronic physical diseases, worries about livelihood, lost jobs, lost social ties, and concerns about compensation that followed the disaster caused post-traumatic responses from disaster-affected persons.

Morioka (2015) examined gender difference in the perception of the health risk of radiation after the Fukushima disaster. While mothers expressed their concerns, fathers tended to be uninterested in the health effects of the radiation. As central earning members of the family, fathers were less concerned about the potential adverse effect of radiation on children as any action to relocate would have affected their jobs. The findings from Morioka's study illustrate the importance of social context in which gender identity and cultural values are manifested in risk perceptions.

People often have different opinions about the radiation risk and their plans, resulting in reduced resilience that communities and families had before the disaster. After a day of the Fukushima nuclear disaster, the government had ordered the evacuation of residents within 20km of the plant. Akabayashi and Hayashi (2012) question the decision on ethical grounds and assert that the government decision was not merely based on public health concerns, but also to maintain public order.

Horie and Managi (2017) empirically assess the sources of failures in disaster risk mitigation in the short run. Although residential relocation from the cites at risk is one of the effective risk reduction measures, the relocation incurs mobility costs of developing social capital, such as communities or searching for public services such as education and medical institutions. Horie and Managi (2017) show that the residents in the disaster cities of the 2011 Fukushima incident can tolerate higher risks of radiation exposure when they have an attachment to the original residence or higher demands for the public services, and can consequently stay in the cities at risk.

The evacuation and relocation had a serious impact on affected people. In a study on the consequence of the Fukushima nuclear disaster on fathers, Yoshioka-Maeda and Kuroda (2018) find that their respondents who voluntarily chose to evacuate were anxious about radiation exposure but faced work-family conflict, including financial, mental and physical sacrifice. After the government's evacuation order was lifted, it did not lead to evacuees immediately deciding to return as the termination of monetary compensation and housing subsidies that accompanied return had a significant impact on them (Bo, 2020).

For those who had a preference to return, this was due to a strong sense of attachment to their home and the possession of property, job obligations, and having family members in the home location (Bo, 2020). Moreover, opinions among Japanese government officials and evacuees regarding radiation exposure risk and the degree to which infrastructure and social services have been rehabilitated differed (Bo, 2020).

In a study on how far affected people relocated, Do (2019) finds that evacuees whose home location was in the restricted areas, those engaged in permanent jobs, and those who had young children at the time of the nuclear accident tended to move shorter distances. They did not find relation between age, gender, or evacuees' educational and economic status and evacuation destinations. The decision regarding evacuation destinations is strongly driven by human networks and recommendations of local governments and acquaintances. It is influenced less by job-related matters, safety from radiation exposure, accommodation availability, and convenient access to social amenities (Do, 2019).

In terms of returning to original locations after years of relocation, Munro and Managi (2017) find that many respondents do not intend to return,

particularly those from tsunami-affected towns. Still, higher-income households and those who evacuated to the same town were more likely to go back. Intentions to return or not are only weakly responsive to changes in ambient radiation levels. Families with children are particularly unwilling to return to previously radiation-affected areas.

The above discussion raises an important question about the role of residence and location in post-disaster reconstruction. The empirical analysis that follows examines the question further by estimating the functionings that a house can create. The disasters considered in the empirical model of housing wellbeing are the 2011 Great East Japan Earthquake, tsunami and Fukushima nuclear meltdown, referred as the 'triple disaster' in Japan.

4.1 Research methodology

We use methods of pooled ordinary least squares and fixed effect model to estimate household housing well-being function. Housing well-being function presented above takes the following form:

$$V_{i,t} = \alpha_{0,i} + \sum_{c=1}^{c} \beta_c Z_{c,i,t} + \epsilon_{i,t}$$

where, $V_{i,t}$ is a household's well-being measure equal to the self-reported satisfaction level from housing; $Z_{i,t}$ are the determinants, including personal characteristics, that could either be static over time t (e.g, highest level of education attained by the household head, parental background) or change dynamically over time (e.g., income, expenditure); $\alpha_{0,i}$ is the intercept term; β are coefficients for explanatory variables; c is the number of independent variables; and ϵ is the error term.

4.2 Data and Variables

The data used in this research for Japan are from the Japan Household Panel Survey (JHPS) from 2011 to 2018. From 2011, the JHPS asked respondents to indicate their satisfaction with housing on a scale of 0 to 10. In the estimation of housing wellbeing function, the wellbeing variable has been treated as a continuous variable rather than a discrete choice variable. Otherwise, in the estimation of the fixed-effect model, the information on households whose wellbeing does not change will be dropped from the data sample. Methods such as the multinomial logit model were found to be relatively less suitable because, due to the large number of explanatory variables and categories demanded by this research, estimation of a discrete choice model using multinomial logit does not converge. On the other hand, a linear stochastic model ensures consistency.

The indicators used to proxy various functionings for housing wellbeing are presented in Table 1. The mean and standard deviation of indicators used in housing well-being function are presented in Table 2. Table 2 also reports descriptive statistics for owners and renters.

Table 1: Potential indicators for functionings and survey questions in JSPS

Functionings	Potential Indicator(s)	Survey question
Control over one's environment		
	The annual income of the household	What was your household's total income of your household in the past year (January to December), except gain on sale of securities or properties? (Wave 1, JHPS 2009)
	Physical improvement - Renovation	Have you ever repaired or reformed your house/apartment? What degree of repair/reform was it? (Dummy takes the value 1 for medium and major repair (option 2,3) and value 0 for minor and no repair (option1). (Wave 1, JHPS 2009)
	Physical improvement - Seismic retro-fitting	Did your household consider performing a seismic retrofit of your residence? (Wave 1, GEES 2009) Dummy takes values 1,2,3 for performed, considered performing, and not considered performing (option 1,2, and 3) respectively.
	Physical improvement - Power generation system (such as solar)	Did your household consider installing a solar power system or other types of power generation systems? (Wave 1, GEES 2009)
	The building type of the house	Which best describes the building in which you reside? (Wave 1, JHPS 2009)
Living comfortably in a home		
	Adequacy of floor space - Floor space per person	Total floor space of the house OR apartment in sq m (Wave 1, JHPS 2009) divided by the number of people living in the house (Wave 1, JHPS 2009)
	Privacy within home - Number of bedrooms per person	How many rooms does this house/apartment have? Number of rooms (Wave 1, JHPS 2009) divided by the number of people living in the house (Wave 1, JHPS 2009)
	Quality of house - Age of the house	When was the house/apartment constructed? (years) (Wave 1, JHPS 2009)
	Quality of house - Floor number	The floor on which you reside (in an apartment) (Wave 1, JHPS 2009)
	Quality of house - Area of yard/garden	Does the house have any yard or garden? (sq.m) (Wave 1, JHPS 2009)
	Quality of house - Annual income of the household	As described earlier.
	Size of the city	Dummy takes following values: 1 = Government-designated city (No. 1 is the base case) 2 = city: pop. over 50,000 3 = town, village, other

	Quality of house - Value or rent of property as a proxy of quality	For ownership property - Q1. What do you think is the present market rate for this property? (Value of residence and plot separately in 10,000 yen) (Wave 1, JHPS 2009) Q2. What is the area of this plot? (sq m) (Wave 1. JHPS 2009) Variable 1 - Value of house or apartment per unit area = Market rate of residence (10,000 yen) divided by total floor space of the house/apartment (sq m); Variable 2 - Value of land per unit area = Market rate of plot (10,000 yen)/ Area of plot (sq m) For rental property - Monthly rent (excluding utilities and condominium fees) in thousand yen (Wave 01, JHPS 2009) Rent per unit area=Monthly rent (thousand yen)/Total floor space (sq.m)
	Physical improvement - Renovation	As described earlier
	Physical improvement - Seismic retrofitting	As described earlier
	Public transport and commuting	Q1. How long does it take to reach the nearest station/bus stop from your house/apartment? (minutes) (Wave 1, JSPS 2009)
	Mental/Physical ability (as opposed to disability) to use the house efficiently	Q2. Does any member of your family have a physically disabled certificate or a mentally disabled certificate? – Yes, No (Wave 1, JHPS 2009)
Affiliation - Being able to live with others		
	Living with family as opposed to living alone	How many people are currently living in your house? (Wave 1, JHPS 2009)
Affiliation - Being able to live towards others		
	Being able to bring up children	As described earlier (number of children is a proxy here).
	Being able to care for any member of the household	How is the person who needs long-term care related to you? (Wave 1, JHPS 2009)
	Being able to care for other members of the family who need it	Q1. How is the person who needs long-term care related to you? (Wave 1, JHPS 2009) Q2. Does any member of your family have a physically disabled certificate or a mentally disabled certificate? - Yes, No (Wave 1, JHPS 2009)
	Being able to support parents financially	How much financial assistance did you give to your parents last year? (ten thousand yen) (Wave 4, JHPS 2012)
	Living with or in vicinity of parents	Which of the following indicates your living situation with your parents? (Wave 6, JHPS 2014)
	Generational contract	Interactive term (dummy) = Being able to care for parents (Row 25) x Having or expecting inheritance (Rao 39)
Control for 'disfunctioning' of family responsibilities	Number of children	Please list each family member by relationship (Wave 1, JHPS 2009) Total number of 'child' (code 02) responses.
	Age of eldest parent	Age in years
	Age of youngest child	Age in years
	Household size	How many persons are currently living in your house? (Wave 1, JHPS 2009)
Familial wellbeing - Building interpersonal relationship		

	Living with family as opposed to living alone	As described earlier (household size of 1 indicates living alone)
	Living with or in the vicinity of parents	As described earlier.
Familial wellbeing - Security for all generations		
	Generational contract	Described earlier.
	Have inherited or expect inheritance of property in the future	Inheritance - Q1. How was the residence/plot acquired? (Wave 1, JHPS 2009) Q2. How did you acquire the real estate (plot or residence)? (Wave 6, JHPS 2014) Q3. Is there a possibility that you will inherit a parent's home in the future? (Wave 6, JHPS 2014) Q4. Is there a possibility that you will inherit some other housing or land in the future? (Wave 6, JHPS 2014)
Disaster resilience and prepardness - Security of physical space		
	Seismic retrofit	Described earlier
	Power generation system (such as solar)	Described earlier
	The building type of the house	Described earlier
	Residence and household effects damaged by 2011 earthquake	How much damage did your residence and household effects sustain due to the Great East Japan Earthquake? (Wave 1, GEES 2011)
	Earthquake insurance	Did your household subscribe to the following insurance policies before the earthquake? If not, was a subscription to these insurance policies considered? (Wave 1, GEES 2011)
	Fire insurance	Did your household subscribe to the following insurance policies before the earthquake? If not, was a subscription to these insurance policies considered? (Wave 1, GEES 2011)
Disfunctioning - Disaster vulnerability due to location		
	Residence and household effects damaged by 2011 earthquake	Described earlier
	Inundation rate	Percent of the total area flooded during March 2011 Tsunami
	Exposure to the dangerous level of radiation	Dummy takes values 1,2,3 for radioactivity level 1,2,3 respectively
	Region	Dummy variables for regions
Financial security - Store of value		
	Have inherited or expect inheritance of property in the future	Described earlier
	City size	Described earlier
	Value of house (per unit area)	
	Year (in OLS model)	Year dummies
Self-identity with house as memorabilia		

	Duration lived in the current house	When did you/your household move into the current place of residence? (Years) (Wave 1, JHPS 2009)
Self-identity in familial identity and status		
	Living in an inherited property (house or plot)	Q1. How was the residence/plot acquired? (Wave 1, JHPS 2009) Q1. How did you acquire the real estate (plot or residence)? (Wave 6, JHPS 2014)
	Area of the current house	Total floor space of the house OR apartment in sq.m (Wave 1, JHPS 2009)
	Value of current house	What do you think is the present market rate for this house? (Value of residence and plot separately in ten thousand yen) (Wave 1, JHPS 2009)
	Value of land of current house	What do you think is the present market rate for this plot? (Value of residence and plot separately in 10,000 yen) (Wave 1, JHPS 2009)
Social equity and empowerment for female		
	Gender of the household head	The household head is the primary earner (Wave 1, JHPS 2009)
Psychological wellbeing		
	Earthquake insurance	Described earlier.
	Fire insurance	Described earlier.
Dysfunctioning - Financial stress		
	Household debt to income	The amount of mortgage repaid by the household in the previous year (Wave 1, JHPS 2009) divided by the total household income in the previous year (Wave 1, JHPS 2009)
	Job security	Household head is in a full-time job.
	Age of the household head	The household head implies the primary earner (Wave 1, JHPS 2009)
Locational stability		
	Tenure of current residence	What best describes the ownership status of your current residence? Dummy takes values: 1 = Owned (Option 1,2,3,4) 2 = Rented (Option 5, 7, 8) 3= Public rental housing (Option 6)

Table 2: Descriptive statistics

Variable	Description	All respondents		Owners		Renters	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Housing wellbeing	Self-reported satisfaction with housing on a scale between 0 to 10, 0 being the lowest and 10 highest	6.36	2.32	6.57	2.21	4.77	2.54
Age of household head	Years	59.52	13.17	60.36	12.8	53.13	14.21
Age of youngest member	Years	4.81	6.92	4.77	6.93	5.12	6.81

Stay	Number of years in same house	21.64	13.5	22.44	13.32	15.6	13.18
Floor area per person		50.08	130.54	53.09	138.09	27.09	30.76
Household size	Number	3.01	1.29	3.06	1.29	2.68	1.31
Labour income	10,000 Yen	214.94	281.44	218.88	288.8	184.83	214.95
Living Alone	1= yes; 0 = no	0.02	0.15	0.02	0.12	0.07	0.25
Number of children	Number	1.28	1.13	1.30	1.14	1.15	1.10
Age of house	Years	25.27	14.16	24.71	14.17	29.62	13.24
House value per unit area		19.21	20.36	21.73	20.35		
Inundation rate		0.004	0.05	0.005	0.05	0.002	0.027
Radioactive contamination 1	Ionising radiation dose of less than 0.05 microsieverts/hour						
Radioactive contamination 2	Ionising radiation dose between 0.05 and 0.23 microsieverts/hour	0.44	0.5	0.45	0.5	0.38	0.49
Radioactive contamination 3	Ionising radiation over 0.23 microsieverts/hour	0.006	0.08	0.006	0.78	0.01	0.09
Full-time work	1= Yes; 0 = No	0.28	0.45	0.28	0.45	0.27	0.45
Contract work	1= Yes; 0 = No	0.22	0.42	0.21	0.41	0.29	0.45
Other work	1= Yes; 0 = No	0.12	0.33	0.12	0.33	0.14	0.35
Living in the vicinity of parents	1= Yes; 0 = No	0.18	0.38	0.18	0.39	0.12	0.32
House and/or plot as a gift from parents	1=Yes; 0=No	0.045	0.21				
Earthquake insurance (Don't have currently but will take)	1= Yes; 0 = No	0.26	0.44	0.05	0.22	0.22	0.42
Earthquake insurance (Don't have currently and will never take)	1= Yes; 0 = No	0.28	0.45	0.27	0.44	0.64	0.48
Fire insurance (Don't have currently but will take)	1= Yes; 0 = No	0.05	0.22	0.04	0.19	0.15	0.36
Fire insurance (Don't have currently and will never take)	1= Yes; 0 = No	0.09	0.29	0.04	0.19	0.51	0.5
City size 1	1= Yes; 0 = No						
City size 2	1= Yes; 0 = No	0.63	0.48	0.65	0.48	0.51	0.5
City size 3	1= Yes; 0 = No	0.08	0.26	0.08	0.27	0.07	0.25

Commute time to nearest stop	Minutes	8.99	7.46	9.16	7.63	7.75	5.85
Remodelling	1= Yes; 0 = No	0.03	0.16	0.03	0.17	0.005	0.07
House is seismically retrofitted	1= Yes; 0 = No	0.17	0.38	0.19	0.39	0.35	0.18
Interested in seismic retrofitting house	1= Yes; 0 = No	0.09	0.28	0.09	0.29	0.05	0.21
Own house	1= Yes; 0 = No	0.88	0.32				
Apartment	1= Yes; 0 = No	0.17	0.37	0.09	0.28	0.78	0.41
Located in the area affected by the 11 March 2011 earthquake	1= Yes; 0 = No	2.70	1.91	2.71	1.91	2.61	1.95
Damage to the house and household effects due to Great East Japan Earthquake	1= Yes; 0 = No	0.09	0.28	0.09	0.28	0.07	0.26
Generational contract	1= Yes; 0 = No						
Inheritance	1= Yes; 0 = No	0.05	0.22	0.05	0.23		
Future inheritance	1= Yes; 0 = No	0.15	0.36	0.15	0.36	0.15	0.35
Gender	1= Male; 0 = Female	0.87	0.34	0.88	0.33	0.77	0.42
Year 2011	1= Yes; 0 = No	0.15	0.36	0.15	0.36	0.18	0.39
Year 2013	1= Yes; 0 = No	0.14	0.35	0.14	0.35	0.14	0.35
Year 2014	1= Yes; 0 = No	0.13	0.34	0.13	0.34	0.12	0.33
Year 2015	1= Yes; 0 = No	0.13	0.33	0.13	0.33	0.11	0.32
Year 2016	1= Yes; 0 = No	0.12	0.33	0.12	0.33	0.12	0.32
Year 2017	1= Yes; 0 = No	0.11	0.31	0.11	0.31	0.09	0.30
Year 2018	1= Yes; 0 = No	0.08	0.28	0.08	0.28	0.09	0.28
Region – Hokkaido	1= Yes; 0 = No	0.05	0.20	0.04	0.20	0.05	0.22
Region – Kanto	1= Yes; 0 = No	0.31	0.46	0.31	0.46	0.34	0.47
Region – Chubu	1= Yes; 0 = No	0.18	0.38	0.19	0.39	0.12	0.33
Region - Kinki	1= Yes; 0 = No	0.22	0.41	0.22	0.41	0.24	0.43
Region – Chugoku	1= Yes; 0 = No	0.06	0.24	0.06	0.23	0.08	0.27
Region – Shikoku	1= Yes; 0 = No	0.03	0.18	0.31	0.18	0.03	0.18
Region - Kyushu	1= Yes; 0 = No	0.11	0.32	0.11	0.32	0.11	0.32

4.3 Results: Housing wellbeing function for Japan

The estimated housing wellbeing function for households that have not moved from their houses is presented in Table 3. Two equations have been estimated by pooled ordinary least squares (OLS), and fixed effect (FE). Housing wellbeing functions are also estimated for owners and renters separately to identify if dysfunctionings associated with disasters differ for

those who have greater control on their physical environment or house (owners) from those who don't (renters). The variables in the estimates are in their levels.

Table 3: Housing wellbeing

Dependent variable: Reported housing wellbeing index

Variable	All respondents		Owners		Renters	
	OLS	FE	OLS	FE	OLS	FE
Age of household head	0.01*** (0.003)	-0.002 (0.006)	0.013*** (0.003)	-0.002 (0.01)	-0.005 (0.009)	0.003 (0.02)
Age of youngest member	-0.02*** (0.005)	-0.005 (0.006)	-0.02*** (0.005)	-0.003 (0.01)	-0.07*** (0.02)	-0.02 (0.02)
Stay	0.005 (0.005)	-0.33 (0.27)	0.003 (0.005)	-0.53*** (0.12)	0.03*** (0.01)	4.52 (4.69)
Floor area per person	0.0006*** (0.0002)	0.00002 (0.00004)	0.0006*** (0.0002)	0.00002 (0.00004)	0.011*** (0.003)	0.0115*** (0.004)
Household size	0.019 (0.03)	-0.14*** (0.05)	0.05 (0.03)	-0.13** (0.05)	-0.36*** (0.12)	-0.014 (0.29)
Labour income	0.0007*** (0.0002)	0.00007 (0.0002)	0.0006*** (0.0002)	0.00007 (0.0002)	0.002*** (0.0005)	-0.0009 (0.001)
Living Alone	-0.26 (0.20)	-0.02 (0.16)	-0.17 (0.25)	0.14 (0.19)	-0.89*** (0.38)	-0.47 (0.38)
Number of children	-0.023 (0.03)	0.014 (0.04)	-0.06* (0.03)	-0.01 (0.04)	0.62*** (0.13)	0.40* (0.22)
Age of house	-0.028*** (0.004)	-0.03** (0.01)	-0.03*** (0.004)	-0.03** (0.014)	-0.041*** (0.009)	-0.13*** (0.04)
House value per unit area	0.011*** (0.002)	0.002 (0.003)	0.009*** (0.002)	0.002 (0.003)		
Inundation rate	-0.08 (0.64)	1.21 (0.78)	-0.43 (0.74)	1.47* (0.79)	-2.48 (4.34)	0.58 (1.44)
Radioactive contamination 2	0.32 (0.21)	0.12 (0.17)	0.33 (0.22)	0.3* (0.18)	-0.41 (0.66)	-1.51** (0.7)
Radioactive contamination 3	2.21*** (0.5)	1.27** (0.62)	1.62*** (0.47)	1.99*** (0.44)	0.82 (2.11)	-3.66*** (0.81)
Full-time work	-0.31** (0.12)	-0.08 (0.17)	-0.15 (0.13)	0.008 (0.16)	-1.65*** (0.35)	-1.05* (0.62)
Contract work	-0.26*** (0.09)	0.099 (0.13)	-0.19** (0.09)	0.1 (0.13)	-0.16 (0.28)	0.18 (0.44)
Other work	-0.45*** (0.11)	0.26* (0.14)	-0.34*** (0.11)	0.26* (0.15)	-0.52* (0.27)	0.22 (0.4)
Living in the vicinity of parents	-0.26*** (0.09)	-0.16* (0.09)	-0.27*** (0.1)	-0.09 (0.09)	-0.36 (0.33)	-0.73** (0.3)
House and/or plot as a gift from parents	0.09 (0.14)	-0.16 (0.12)	0.098 (0.14)	-0.15 (0.12)		
Earthquake insurance (do not hold but intend to hold)	-0.28*** (0.07)	-0.04 (0.09)	-0.23*** (0.08)	-0.05 (0.1)	-0.6* (0.34)	0.1 (0.37)
Earthquake insurance (do not hold and do not intend to hold)	0.09 (0.08)	0.06 (0.10)	0.1 (0.08)	0.04 (0.11)	-0.003 (0.35)	0.3 (0.41)

Fire insurance (do not hold but intend to hold)	-0.27* (0.15)	-0.20 (0.17)	-0.27 (0.18)	0.05 (0.17)	-0.20 (0.29)	-0.9** (0.43)
Fire insurance (do not hold and do not intend to hold)	-0.17 (0.14)	-0.15 (0.17)	-0.12 (0.17)	-0.02 (0.19)	-0.28 (0.27)	-0.61 (0.41)
City size 2	0.41*** (0.07)		0.19** (0.08)		1.85*** (0.22)	
City size 3	0.33*** (0.13)		-0.02 (0.13)		3.53*** (0.41)	
Commute time to nearest stop	-0.02*** (0.004)	-0.02 (0.01)	-0.013*** (0.004)	-0.014 (0.012)	-0.03** (0.014)	-0.08 (0.06)
Remodelling	0.65*** (0.17)	0.37*** (0.13)	0.65*** (0.17)	0.39*** (0.13)	1.18** (0.53)	0.45 (0.84)
House is seismically Retrofitted	0.57*** (0.10)		0.55*** (0.08)		0.43 (0.65)	
Interested in seismically retrofitting house	-0.37*** (0.11)	-0.19 (0.17)	-0.34*** (0.11)	-0.17 (0.18)	-0.6 (0.44)	0.02 (0.47)
Own house	0.87*** (0.15)	-0.15 (0.20)				
Apartment	-0.29*** (0.1)		-0.48*** (0.12)		0.77*** (0.22)	
Located in area affected by the 11 March 2011 earthquake	-0.06 (0.05)	-0.01 (0.05)	-0.03 (0.05)	-0.06 (0.06)	0.006 (0.17)	0.39** (0.19)
Damage to house and household effects due to Great East Japan Earthquake	-0.57*** (0.13)	-0.26 (0.21)	-0.44*** (0.13)	-0.25 (0.23)	-1.24*** (0.36)	-0.11 (0.40)
Generational contract	0.05 (0.17)	-0.01 (0.13)	0.07 (0.17)	-0.03 (0.14)	0.57 (0.63)	0.05 (0.34)
Inheritance	0.16 (0.15)	0.01 (0.14)	0.14 (0.14)	0.03 (0.14)		
Future inheritance	-0.24** (0.1)	0.08 (0.08)	-0.31*** (0.11)	0.07 (0.09)	0.01 (0.27)	0.03 (0.25)
Gender	-0.16* (0.09)	-0.22** (0.1)	-0.09 (0.09)	-0.20* (0.10)	-0.40 (0.24)	-0.37 (0.40)
Year 2011	0.023 (0.17)	-0.22 (0.30)	0.13 (0.17)	-0.47** (0.18)	-0.45 (0.48)	4.94 (4.57)
Year 2013	-0.09 (0.11)	0.26 (0.28)	-0.07 (0.11)	0.46*** (0.14)	-0.18 (0.30)	-4.55 (4.61)
Year 2014	0.06 (0.11)	0.62 (0.55)	0.13 (0.12)	1.03*** (0.27)	-0.33 (0.37)	-9.01 (9.35)
Year 2015	-0.09 (0.12)	0.83 (0.82)	-0.04 (0.12)	1.41*** (0.4)	-0.39 (0.32)	-13.41 (14.0)
Year 2016	-0.007 (0.11)	1.28 (1.09)	0.001 (0.12)	2.02*** (0.52)	0.15 (0.33)	-17.39 (18.68)
Year 2017	-0.04 (0.12)	1.52 (1.37)	0.04 (0.13)	2.52*** (0.65)	-0.57 (0.35)	-22.45 (23.41)
Year 2018	-0.08 (0.13)	1.79 (1.66)	-0.023 (0.14)	2.96*** (0.81)	-0.47 (0.36)	-26.76 (28.12)
Region – Hokkaido	1.53*** (0.24)		1.57*** (0.25)		-2.84** (1.43)	

Region – Kanto	1.02*** (0.17)		1.04*** (0.16)		-1.62 (1.38)	
Region – Chubu	0.94*** (0.18)		0.99*** (0.18)		-1.33 (1.43)	
Region - Kinki	1.08*** (0.21)		1.18*** (0.22)		-2.74* (1.41)	
Region – Chugoku	0.76*** (0.25)		0.88*** (0.25)		-2.3 (1.4)	
Region – Shikoku	1.07*** (0.25)		1.19*** (0.26)		-2.09 (1.44)	
Region - Kyushu	1.24*** (0.24)		1.40*** (0.24)		-2.35* (1.42)	
Constant	4.63*** (0.39)	14.599*** (5.28)	5.14*** (0.38)	18.79*** (2.51)	8.09*** (1.6)	-52.42 (64.1)
R-squared	0.17	0.03	0.11	0.03	0.38	0.1
Number of observations	5,745	5,745	5,080	5,080	665	665

Note: * p < 0.1, ** p < 0.05, *** p < 0.01.
Numbers in brackets are standard errors

Three types of disaster risks have been included as indicators of dysfunctionings (that reduce housing wellbeing): (i) earthquake, through a dummy variable that implies households living in regions that were affected by the 2011 earthquake, and a dummy for the damage to the house and household effects caused by Great East Japan Earthquake; (ii) flooding following Tsunami – proxied by inundation rate, which measures the flooding risk; and (iii) nuclear meltdown of three plants in Fukushima – proxied by radioactive contamination exposure level measured as microsieverts per hour.

Results are interpreted to comment on the following functionings associated with housing (as identified by Rao, 2018):

Control over one's environment – Be able to improve the physical attributes of the house as per one's likings and needs

Five indicators that have been used to measure the functioning of 'control over one's environment' associated with housing' are (i) annual income of the household (ii) physical improvement of the house through remodelling (iii) physical improvement of the house through seismic retrofitting (iv) intension to retrofit and (v) building type of the house.

The coefficient for labour income in pooled OLS estimates is positive and significant. Higher-income households, as expected, would be able to exercise control over their living environment, which enhances their housing wellbeing. Respondents with higher labour income have more control over their living environment as they can afford and influence their housing through interior design, furnishing, renovations, expansions, and retrofitting, *ceteris paribus*.

The coefficient of labour income in fixed effect estimates is positive, though statistically insignificant, indicating that over time the satisfaction with housing increases. The magnitude of coefficient for labour income for renters is higher (Table 3, Col 6) than owners (Table 3, Col 4). A higher-income household can rent a better house and it is easier for renters to adjust housing consumption by moving to a better house as income increases.

Indicators for physical improvement of the house, dummy variables for remodelling and seismic retrofitting, are positive and significant in OLS. These activities indicate association of self with the place of occupancy and role of physical space in identity creation (Csikszentmihalyi and Halton, 1981; Proshansky et al, 1983) and have a positive impact on housing wellbeing. The remodelling variable remains positive and significant in the FE estimates, which implies that the effect of remodelling for respondents on housing wellbeing has been positive over time.

The indicator of intention to retrofit in future has a negative and significant coefficient. While the respondent has control over their environment (house), the condition of the house may require improvement. The intention to retrofit in future captures the condition, hence has a negative coefficient in OLS and FE estimates. For respondents who have the intention to repair relative to those, housing wellbeing is lower, and this remains so over time. The remodelling variable has a positive and significant coefficient in renters' model as well. While tenants cannot remodel their house, what this is suggesting is that those tenants whose landlords remodel the rental house report higher housing wellbeing.

Living comfortably in a home

A house that provides a comfortable living environment (state of 'being' comfortable for its residents) is associated with higher housing wellbeing. Several indicators associated with quantity and quality of housing have been used to measure comfort, including floor space per person, area of yard/ garden, age of the house, type of house, and value or rent of the house. The income of respondents, which has an impact on quality and quantity of a house, is considered as an indicator. The other indicator that affects comfortable living is the location. This paper uses the size of the city and commuting time to train stops as proxies for location. Physical improvements to houses through renovation or seismic retrofitting also positively impact this functioning associated with housing.

Higher value per unit area of houses or apartments is associated with higher quality and has a positive effect on comfortable living, contributing positively to housing wellbeing. Older dwellings have a negative impact on comfort and wellbeing, mainly due to the obsolescence factor associated with them. The negative impact of age of the house is more pronounced for renters as they have little opportunity to address the obsolescence of their rented house on their own.

Floor area per person is a measure of the degree of congestion and privacy available to household members in the house: a larger area per person increases comfort and results in higher housing wellbeing. This indicator has a higher coefficient for renters. In Japan, the average area of rental houses is small compared with owned houses. Households living in apartments have lower satisfaction than those living in detached houses, as indicated by the negative coefficient. However, for renters, apartments provide higher satisfaction than detached houses, as indicated by positive and significant coefficient for this indicator in renter housing wellbeing function.

Income has a positive impact on comfort. Remodelled houses or seismically retrofitted houses enhance the quality and hence comfort offered by houses.

OLS estimates include a set of indicators related to the size of city where a household resides. The data classify cities into three categories: cities with a population of less than 50,000; cities with more than 50,000; and towns and villages. Two dummy variables (one for cities with less than 50,000 and the other for towns and villages) have been used in the model. The omitted category is cities with a population more than 50,000 (large cities in Japan). The coefficients for the cities with less than 50,000 people is positive, implying that relative to large cities, housing wellbeing for households is higher in smaller cities. The coefficient for 'towns and villages' is positive and significant. The negative externalities of large cities are associated with the location of a house and may lead to less comfortable living and hence reduced housing wellbeing. These effects persist for both owners and renters: for renters they are stronger than for owners.

Living close to a train stop can have positive or negative impact on comfort, depending on whether the positive effect of not commuting to the stop or the negative impact of noise and crowds dominates. The results indicate a negative and significant coefficient of distance from train station (measured as commuting time to nearest stop in minutes) in the OLS model, which suggests that the negative impact of noise and crowding dominates over positive effects of living close to a train station. The effect does not change over time for a respondent, as indicated by the FE estimate's negative, though statistically insignificant, coefficient.

Affiliation – being able to live with others

Living with family members in a house has a positive impact on wellbeing. However, a large household may have negative impact as it reduces people's personal space (Rehdanz et al, 2013). The coefficient for household size is positive, though insignificant in OLS. Over time the coefficient is negative and significant, as the FE estimate indicates. The effect of the household size on wellbeing is negative and significant for renters, because rental houses are small, primarily apartments, posing a significant challenge for privacy.

The other household variable, number of children, has a positive sign in OLS and is significant. This variable, in renters' function, captures purely the effect

of living with children as renters have the opportunity to modify their housing consumption through the ability to move much more easily than owners. For owners, a change in household status through an increase in the number of children reduces housing wellbeing as it alters the expectations from the dwelling. The age of youngest child in the household has negative coefficient and is significant. This coefficient measures the negative impact associated with space requirements in the future as a child grows.

Affiliation – being able to live towards others

A house provides space for care and living for other family members. Housing wellbeing function includes an indicator, 'generation contract', which measures an implicit contract between children (usually eldest) and their parents. As per the contract the child inherits the house in the future in lieu of taking care of their elderly parents. There is no *a priori* expectation of sign for generation contract variable because, even though it may be emotionally satisfying to take responsibility of dependent parents, it may cause congestion and be time-consuming and physically and financially demanding for those who take care of their parents.

Waiting to inherit a house may also reduce wellbeing. The housing wellbeing function includes a dummy variable for future inheritance without responsibility for the care of elderly parents. Results indicate that the future inheritance variable has a negative and significant coefficient in pooled OLS. Households that expect inheritance in the future have lower housing wellbeing than those who don't. It's the uncertainty of inheritance that causes anxiety and negative housing wellbeing. The generation contract variable, which captures expectation of future inheritance and care responsibility, has a positive coefficient but is insignificant. The positive coefficient indicates the functioning associated with affiliation – being able to live towards others. However, if responsibility for the care of elderly parents continues and inheritance is delayed, the wellbeing declines as indicated by the negative coefficient of this variable in the FE estimate.

The number of children may also impact the care aspect of affiliation. The sign, however, is ambiguous as even though having children may indicate healthy family relations, it may reduce social interaction outside family and also cause congestion in the house due to increased demand for space. The number of children variable has a positive coefficient in pooled OLS estimates for renters. This effect persists over time, as indicated by positive coefficient in the FE estimate.

Familial wellbeing – building interpersonal relationships

Living with family instead of living alone may create opportunities for interpersonal relationship building and improve wellbeing (Rehdanz et al, 2013). Living alone has a significant negative impact on housing wellbeing for renters: their wellbeing is 0.89 less at means than those who are not alone.

The household size indicator also proxies familial wellbeing and a positive but insignificant coefficient in OLS estimate indicates that household size does not have much effect on housing wellbeing. The coefficient in the FE estimate is negative and significant, which implies that over time, as the family size of a household increases, wellbeing declines. Renters have negative coefficient for household size in OLS estimates. This may be due to congestion from having a large family in a house and also due to consumption expenses becoming more important than the cost of housing.

The other indicator included in the model to capture family-related housing wellbeing is a dummy for lone households. A negative and significant coefficient for renters indicates that lone households have lower housing wellbeing than other households at means. The effect persists over time.

Living in the vicinity of parents could help in building interpersonal relationships and has positive impact on housing wellbeing. However, if living in the vicinity is due to the care needs of parents, this may have a negative impact on housing wellbeing. The indicator, living in the vicinity of parents, has negative and significant coefficients in OLS (for all respondents and owners) and FE estimates (for renters), suggesting negative effect on housing wellbeing.

Familial wellbeing – security for all generations

The housing wellbeing function includes three indicators to capture the inheritance and generation contract:

(i) Inheritance: a dummy variable with value of 1 if the house is an inherited house and there is no future expectation of inheritance and care responsibility, otherwise 0;

(ii) Future Inheritance: a dummy variable with the value of 1 if the respondent expects inheritance of a house in future and has not inherited a house and has no care responsibility, otherwise 0;

(iii) Generation contract: a dummy variable with a value of 1 where the respondent expects future inheritance and has care responsibility, but has not inherited a house, otherwise, 0.

The base case is that a respondent has not inherited a house, does not have future expectation of inheritance, and may or may not have care responsibility.

Respondents who have inherited a house report positive wellbeing, and this effect persists over time. The effect is weak as it is statistically insignificant. However, respondents who expect to inherit a house report lower housing wellbeing than those who don't (negative and significant coefficient for 'future housing inheritance' dummy variable). This is largely due to uncertainty of timing associated with future inheritance.

For some, households' inheritance is also burdensome if this is an additional house, which may cause negative housing wellbeing. The generation contract

has a positive coefficient, but insignificant. The care aspect may reduce the negative impact of wait associated with future inheritance to some extent, but is not enough to completely offset it and is weak.

Disaster resilience and preparedness – security of physical place

Some indicators are used to proxy disaster resilience and preparedness. Two indicators discussed earlier – physical improvement of the house through remodelling and physical improvement of the house through seismic retrofitting – also represent resilience and preparedness for disasters. Positive coefficients of these indicators in OLS estimates indicate that houses that are remodelled and/or seismically retrofitted provide the functioning associated with security of the place. The positive and significant coefficient for remodelling variable in the FE estimate indicates that the effect persists over time. Households that are interested in seismically retrofitting their homes but have not done so report negative housing wellbeing.

Independent houses would create opportunities for physical improvement and disaster preparedness compared to an apartment. A negative coefficient is expected for a dummy variable for apartments (apartment = 1; independent house = 0). For renters, apartments have a positive and significant coefficient, as rented independent houses are in worse condition than apartments.

Dysfunctioning – disaster vulnerability due to location

Disasters and the destruction they cause to a house create dysfunctioning. Houses that are prone to being affected by disasters have a negative impact on households' wellbeing. Four indicators indicate disaster vulnerability.

The first indicator to measure disaster is associated with seismic risk. This is a dummy variable with value of 1 for those regions and houses which were affected by the 11 March 2011 Great East Japan Earthquake, which affected the Tohoku region. The earthquake was also associated with a tsunami, which led to the Fukushima Daiichi nuclear disaster (Rehdanz et al, 2013). The estimated coefficient is negative though insignificant. The negative coefficient is explained by the fact that the impact of earthquake damage is also being captured by the year and regions dummy.

The second indicator included in the housing wellbeing function is a dummy for damage to house and household effects during the 11 March 2011 earthquake. The coefficient for this indicator is negative and significant. Households whose houses and possessions were damaged report 0.57 less housing wellbeing at means than those who did not. The negative effect on housing wellbeing persisted over time and is much more pronounced for renters than owners. Renters whose house and household effects were damaged reported 1.24 less housing wellbeing 'at means' than those who did not.

The third indicator included in the model is the inundation rate. This indicator

measures the proportion of the total area that was inundated by the tsunami during the 11 March 2011 disaster. Houses located in an area that was inundated were likely to have been affected adversely and damaged. A higher inundation rate was associated with lower housing wellbeing, but the effect is statistically insignificant. Over time, the effect of inundation has reduced, and household wellbeing has increased, particularly for owners. This may, however, be interpreted as self-rating of housing wellbeing by those who have continued to live in a flood-prone area.

Housing wellbeing function also includes indicators related to the level of nuclear contamination. Ionizing radiation dose measured in microsieverts per hour is a measure of its health effects. Locations with higher ionizing radiation dose indicate proximity to nuclear plant. Besides proximity to the nuclear plant, radiation dose also depended on wind direction and rainfall. Based on ionizing radiation dose, two location dummy variables 'radioactive contamination 2' (ionizing radiation dose over 0.05 microsieverts/hour) and 'radioactive contamination 3' (ionizing radiation dose over 0.23 microsieverts/hour) are constructed. The base is locations with ionizing radiation dose of fewer than 0.05 microsieverts/hour. Interestingly, the coefficient of nuclear contamination variable is positive with a higher level of contamination. This is counter-intuitive, but given the extremely low probability of major nuclear disasters and associated fatalities, improvement in economic conditions of these areas as a result of location of nuclear plants, financial subsidies the government provides for social infrastructure in areas where they are located and higher property tax that local governments receive as a result of nuclear plant and facilities (Yamane et al, 2011) more than offset any negative impact resulting in a positive coefficient.

A positive coefficient even after Fukushima disaster is not surprising. These results are similar to Rehdanz et al (2013), who also found no short-term impairments on household wellbeing associated with the level of air radiation dose after Fukushima. The coefficients for renters in FE estimates are negative and significant, implying that those living in rental houses in locations with high ionizing radiation have reported loss of housing wellbeing.

The model also includes seven dummy variables for regions (omitted region is Tohoku). Regions are a proxy for disaster vulnerability, property value and territorial identity. Tohoku was the affected region during the Fukushima triple disaster. As expected, all other regions, such as Hokkaido and Kyushu, have higher housing wellbeing than Tohoku, as indicated by the positive coefficients of region dummies. The coefficients for regional dummies for renters are insignificant, implying that location does not have an impact on their housing wellbeing.

Financial security – store of value

A house is a store of value which provides financial security to its owners. An owned house can be used as a collateral and as house value increases

over time, it may be a hedge against inflation. Three indicators determine this functioning of house: (i) inheritance (ii) unit value of house, and (iii) gift of a house by parents. Gift is different from inheritance as it is a transfer of a house to children while parents are still alive. The positive coefficient of inheritance and house value per unit area indicate that those who have inherited a house or live in a house with higher unit value report higher housing wellbeing.

A house whose unit value increases over time provides higher housing wellbeing to its owners, as indicated by positive coefficient of house value per unit area variable in FE estimates. Households that receive a house as a gift report positive housing wellbeing, but this is insignificant.

Self-identity with house as memorabilia

A house creates memories over time and is a repository of these memories, which contributes to the self-identity of its residents. The paper uses the length of stay in a house as a determinant for this functioning. However, no *a priori* sign is expected because even though spending a long time in a house stores memories, the house deteriorates over time. This variable has a positive coefficient (though insignificant in OLS estimate), indicating weak evidence of positive wellbeing associated with length of stay. However, over time wellbeing declines as obsolescence of the house creeps in, as indicated by a negative coefficient in FE estimates. Rented housing has a positive and significant impact on housing wellbeing in terms of length of stay. A more extended stay is linked to stability of tenure and association with the place.

Self-identity in familial identity and status

As Conley (2001) suggests, housing is a material mechanism by which socio-economic and racial advantage is transmitted from one generation to another. Further, Rao (2018) argues that material possessions like housing are often seen as symbols of social status which boost the relative importance of the individual or family. It is expected that owning a house contributes to self-identity.

Two indicators determine this functioning – ownership of the house and inheritance. Housing wellbeing is higher for households that live in their own housing: housing wellbeing for owners is 0.88 higher than tenants. The FE estimate has negative coefficient for ownership variable, though insignificant.

Social equity and empowerment for female

Decision-making power for the female on housing matters (and other aspects of life) may result in greater satisfaction with housing. Also, ownership of property may create economic empowerment and autonomy, which may further improve a female's satisfaction with life in general, and with housing in particular.

The housing wellbeing function includes an indicator on the gender of household head, assuming that the household head owns the house and is

the decision-maker on issues related to the house. The dummy variable for gender (if household head is male = 1; female = 0) has a negative coefficient in the OLS model. This implies that female heads associate higher housing wellbeing compared with males. The housing wellbeing for females is 0.16 higher at means. With time, housing wellbeing increases for female heads and is significant.

Psychological wellbeing

Two sets of indicators have been used for psychological wellbeing: insurance and job type. Insurance hedges risk of damage to the house and provides psychological comfort, while job type measures the ability of respondents to spend time in the house and enjoy it.

Two sets of variables have been included for insurance: earthquake insurance and fire insurance. The status of earthquake insurance for residence holdings is classified into three categories. The first is the "base category" of respondents who already hold the insurance, the second is "do not hold insurance but intend to hold". The third is "do not hold insurance and have no intention to hold".

Respondents willing to take out insurance have a negative and significant coefficient compared with those who already have insurance. On the other hand, respondents who are not willing to join are not different from those who belong to the base category. This reflects that respondents in the second category appreciate earthquake risk and feel the need for insurance but have not yet held it. On the other hand, the respondents in the third category do not appreciate the earthquake risk and do not feel the need for insurance.

Similar results can be confirmed with estimates of fire insurance. However, earthquake insurance is perceived to be more important than fire insurance for respondents who do not hold insurance but intend to hold it.

With the other variable determining psychological wellbeing, job type, respondents who spend less time in a house reported lower wellbeing. This is confirmed by the dummy variables for job types. Those in full-time work, contractual jobs or are involved in other type of work report 0.30, 0.25 and 0.45 lower housing wellbeing than those who are not working (retired or others not in work). The effect is significant in OLS estimates. Renters indicate much larger housing wellbeing loss if they are engaged in full-time work.

Dysfunctioning – financial stress

A house can also be a cause of financial stress that may result in negative wellbeing. The certainty of income over time reduces financial stress. The job type variables in the FE estimate indicate that those with other work have positive and significant impact on housing wellbeing. Younger households face higher financial stress than older households. The age of the household head variable has a positive and significant coefficient, indicating higher housing wellbeing for older households. A separate estimate by tenure groups

suggests that the age of household head is positive and significant for owners but for renters, is not significant.

Home ownership poses a financial burden for households due to the high capital cost associated with buying a house. Buyers take a loan to buy their house, which is a cause of financial stress. Debt burden reduces at later stage of life as income rises or debt obligations reduce.

Locational stability

An owned house provides locational stability for its owner. The positive and significant coefficient of own house variable confirms the higher housing wellbeing provided by locational stability associated with ownership.

4.4 Discussion

Housing is crucial for attaining many central capabilities that are necessary for a decent quality of life. There is ample theoretical and empirical literature that emphasises the importance of homeownership in households' wellbeing (Rao, 2018). The role of the housing extends beyond its financial functions and overlaps with social, familial, social, and even political dimensions of life (Rao, 2018). The loss of housing therefore entails a simultaneous reduction in wellbeing across multiple dimensions of life. Findings from this research provide empirical support to this argument and identify key constituents/ determinants of housing wellbeing including personal, familial, financial, educational, and locational determinants.

The results from the analysis of households' housing wellbeing in Japan illustrates that Japanese households derive a greater satisfaction from owning (as opposed to renting); landed houses (as opposed to an apartment), for which values are appreciating over time; and a larger house which provides privacy for an individual. Household satisfaction increases with the age of respondent, probably due to an increase in household wealth and income. Greater satisfaction from having earthquake insurance indicates its positive impact on a household's ability to rebuild the house and associated wellbeing to how they were before the disaster. Strategic intervention is required improve earthquake insurance penetration and make it more affordable and relevant to households' needs post-disaster.

An essential finding of this research is identifying the impact of disasters on housing wellbeing. Disasters affect many of the functionings negatively. The aftermath of the Fukushima triple disaster reveals that inundation that followed Tsunami and the earthquake adversely affected housing wellbeing. The effect of the earthquake and ensuing destruction was more significant than inundation.

What is also interesting is that the expected negative impact of radioactive contamination was countered by the financial and other forms of subsidies that households receive for living in areas closer to nuclear plants. The continuous stream of financial assistance has resulted in a significant positive

impact on housing wellbeing despite the risk of radioactive contamination, which is low probability though a high-risk event.

Income contributes to housing wellbeing as higher-income households can afford better houses. However, income is severely affected during natural disasters. Loss of income impacts repayment of housing debt and impacts non-discretionary expenditures (such as home maintenance), which reduces housing wellbeing. Carefully-crafted insurance for income and property (land and housing) loss may help households restore their housing wellbeing sooner. Long-term plans to guarantee income security would require restitution of jobs and employment.

The loss of life of an earning member takes a toll on the emotional and housing well-being of the household. Again, insurance policies for the loss of life due to disaster may speed up the recovery process.

An important aspect of the post-disaster reconstruction process is that people's satisfaction with their housing and location should be addressed, and to achieve that, it would be necessary to (i) improve their ability to own housing (as opposed to renting); (ii) improve access to affordable earthquake insurance; (iii) reduce vulnerability to inundation, radioactive contamination, and other forms of natural and man-made disaster through remodelling and/or seismic retrofitting older houses.

Alongside these, the continuous stream of financial assistance has a significant positive impact on housing wellbeing in the absence of other forms of assistance. Findings from this research pave the way for future research and contribute to the bigger debate favouring the design of a comprehensive mechanism of compensation and restitution for disaster-affected people through which all their affected functionings can be reinstalled to at least the same level as before disaster.

Chapter 5
Chennai – the city and its slums

Chennai is a metropolitan city in Tamil Nadu (India) located on the coast of the Bay of Bengal. Spread on more than 426 sq km, the city is crossed by two main rivers – the Cooum River and Adyar River – which flow to the Bay of Bengal. A 4km long Buckingham Canal, which runs parallel to the coast, connects these two rivers (Hochart, 2014).

According to the 2011 census, Chennai is the fourth largest metropolitan city in India, with a population of 8.9 million living in the city and its extensive suburbs. At least 26 percent of Chennai's population lives in slums (Harriss-White, Olsen, Vera-Sanso, & Suresh, 2013). In comparison to non-slum areas, slums have higher concentration of people who are constrained by deprivations such as low caste, low education, informal work, irregular income, limited economic resources, unenforceable rights, and poor health (Harriss-White, Olsen, Vera-Sanso, & Suresh, 2013). Slums in Chennai have existed since the 1940s when migrants began moving to unused public and private land that was low-lying and flood prone (Harriss-White, Olsen, Vera-Sanso, & Suresh, 2013).

Harriss-White, Olsen, Vera-Sanso, & Suresh (2013) identify certain characteristics of slum households in Chennai. Their study found that while the majority of households worked in informal sectors, diverse livelihood combinations were not common. A total of 80 percent of households had no asset, and three-quarters had no savings. Self-employed households had higher income than waged workers and older workers' incomes were lower than younger workers'. Small households tended to be poorer than larger households, which provided the opportunity for income from multiple workers. Slum dwellers' resilience to loss of income of due to disasters is better for self-employed people than salaried workers.

5.1 History of disasters and losses

Several natural and man-made disasters have affected Chennai. The city was affected by a severe drought in 2003-04, which caused a severe drop in groundwater level and affected the city's piped water supply. In 2004, a tsunami hit the coastal areas of Tamil Nadu, including Nagapattinam, Chennai, Cuddalore, and Velankanni, which killed nearly 8,000 people and affected

more than a million. In 2015, Chennai was among the most affected regions by the heavy rains that led to severe floods across Tamil Nadu. More than 6 million people were affected, and 1.5 million houses were damaged. Several cyclonic storms have also affected the city, such as Cyclone Vardah in 2016 and Cyclone Gaja in 2018, which have had a significant negative impact on infrastructural systems and households (Jain, Singh, & Malladi, 2021).

For one of the most recent disasters, the 2015 floods, Patankar (2019) conducted a survey to understand the extent of losses suffered by affected families. They recorded five types of damage: house structure; household assets; appliances; vehicles; and work tools. In their study on the extent of damage and recovery process after the floods in 2015, Joerin, Steinberger, Krishnamurthy, & Scolobig (2018) found that while it took a long time to recover physical assets (housing and infrastructure) in most affected areas, socio-economic losses (such as income, employment, physical and mental health, nutrition, education and culture) took even longer to be restored.

The impact on consumption expenditure after floods varied among households depending on their financial constraints. Patnaik, Sane, & Shah (2019) argue that after the flood, the consumption expenditure of households in Chennai increased by 32% (largest percentage increase was on health, power and fuel) but for financially constrained low-income households, consumption expenditure increased only by a smaller amount. Much of this surge in consumption expenditure was financed through savings and postponement of purchasing durable goods. Low-income households had less of savings to draw on, implying that low-income households have higher inability to cope with disasters.

In a study of coping strategies of households affected by flooding in India, Patnaik & Narayanan (2010) evaluated the effectiveness of money transfer, relief from various public agencies, sale of livestock and borrowings in meeting the shocks to occupation, health, livestock, and damage caused to houses and crops. Their results indicate that none of these measures are sufficient to meet the losses caused by floods. Patankar (2019) found that the compensation paid by public agencies to cover the losses due to floods in Mumbai, Chennai and Puri were inadequate. Households below the poverty line generally resort to borrowings as a coping mechanism, which pushes them into a debt trap and further impoverishment.

Shocks more severely affected waged workers living in slums, whose households had larger dependent-to-worker ratio. The negative aspects of disasters are further extenuated if households are relocated to another area, which reduces opportunities for their work to bounce back and in some cases (such as for fisherfolks) requires complete change in work (Harriss-White, Olsen, Vera-Sanso, & Suresh, 2013).

5.2 Relocation to city's peripheries

Examining land rights and evictions in post-tsunami Sri Lanka, Klein (2007) notes that with increasing land values along the coastline, where the private sector seems to be keen for capital investment, the 2004 tsunami was used as a trigger to evict fishing communities. In India, the State of Tamil Nadu and local government agencies in Chennai have used disasters as an extenuating circumstance to displace people from urban settlements and relocate them to the city's peripheries (Mariaselvan & Samuel, 2017). Peter (2017) terms these acts of state to alienate poor of their resources in the name of 'development' and 'safety' as 'disaster capitalism'. Disasters offer opportunities for the state to offer resettlement plans in conjunction with economic policies (Mariaselvan & Samuel, 2017).

The process of peripheral resettlement of inner slums started in the 1990s with several development projects undertaken for city improvement (Venkat, Subadevan, & Kamath, 2015). Implementation of a mass rapid transit system (MRTS) and integrated stormwater drainage projects required a large tract of land along Buckingham canal resulting in large-scale eviction of slums between 2009 and 2015 (CAG, 2016). Large-scale evictions were also initiated against the encroachment of lakes, ponds and other water bodies, facilitated by a High Court order and legislation to protect water bodies in 2007 (Venkat, Subadevan, & Kamath, 2015).

Natural disasters also provided opportunities to resettle people to peripheral locations. For example, in Chennai, post-2004 Tsunami, coastal communities residing within 200 metres of high tide for many years were relocated in the guise of safety. Households consented to these plans reluctantly as, after the tsunami, they struggled to regain their foothold (Mariaselvan & Samuel, 2017).

In a study of people who were still living in temporary accommodation awaiting relocation four years after the Tsunami, Raju (2013) found that the majority of fisherfolk (affected persons) were unhappy with the proposed site of relocation, given its distance from their current location as well as the sea. They felt a loss of 'belongingness to the sea'. Affected persons feared that their occupation would be adversely affected due to relocation as the micro-environment of resettlement sites was not conducive to fishing-related work (Raju, 2013). Further dissatisfaction concerned resettlement agencies' lack of consultation with the affected people, who were used to making decisions as a community over the type or design of housing and its environment (Raju, 2013).

Another study examining the post-tsunami reconstruction in Nagapattinam in the state of Kerala confirms that the income of the fishing community declined after relocation. In contrast, the income of non-fishing households had returned to pre-disaster levels even after relocation (Jordan, Javernic-Will, & Amadei, 2015). The effect of resettlement on affected persons differed.

A similar pattern of relocation after the disaster was repeated in Chennai after the 2015 floods. As the 2004 tsunami had enabled the removal of coastal fishing villages to build a coastal highway and resettlement of affected people to purpose-built resettlement colonies in Kannagi Nagar and Semmencherry, the floods were used to evict informal settlements along the Adyar and Cooum rivers to pre-existing and vacant housing units in the resettlement colony of Perumbakkam (Jain, Singh, & Malladi, 2021).

Many of the 14,972 families living in 65 settlements on the banks of the Cooum River and 9,687 families living in 28 settlements on the banks of Adyar River who lost their homes were resettled in alternative housing units in Kannagi Nagar and Perumbakkam (Peter, 2017). A third of families living on the banks of the Adyar River were shifted by June 2016 (Peter, 2017).

The other cause of eviction has been the restoration of water areas. Coelho & Raman (2010) demonstrate that in Chennai "beautification, restoration and development serve as metonyms for slum clearance". State-led forced eviction of households living along riverbeds, lakes and in informal settlements in Chennai have affected more than 21,000 households since 2000. Another 31,912 households are in the process of eviction (D.G. & Peter, 2016).

5.3 Resettlement colonies

The relocation site of Perumbakkam consists of 188 high-rise blocks of apartments (Ground + 7) constructed by Tamil Nadu Slum Clearance Board (TNSCB). The site has 23,864 tenements, of which 14,388 were occupied by June 2016 (Peter, 2017).

The housing settlement in Kannagi Nagar, located in Thoraipakkam along Old Mahabalipuram Road, was built by TNSCB since 2000. The site houses 15,656 families (about 100,000 people) on a 40-hectare land parcel. The first relocation to Kannagi Nagar was in 2000 when 3,000 houses were constructed under a flood alleviation programme. An additional 6,500 houses were added under the Tenth Finance Commission grant from the central government to the state of Tamil Nadu. Between 2002 and 2003, 1,620 tenements were constructed through special problem grant from the Eleventh Finance Commission.

To house relocations under the infrastructure development plan of the Chennai Metropolitan Area, 3,618 tenements were added in 2004-05. In 2005 an additional 1,271 tenements were built to accommodate fishermen and slum dwellers affected by tsunami (Hochart, 2014).

The typical structure of buildings in Kannagi Nagar is Ground + 1 floor built in 2000 with shared toilets, Ground + 2 floors built in 2004, and Ground + 3 floors built in 2005 with separate room, kitchen and bathroom. The size of tenements ranges from 195 sq ft to 310 sq ft (D.G. & Peter, 2016).

Ezhil Nagar is an annexe of Kannagi Nagar, with 8,048 tenements in 43 building blocks (D.G. & Peter, 2016). Buildings are designed as four-storey

structures, each comprising 96 to 176 tenements per block (Chitra, Ravi, & Kumar, 2015). The size of each tenement is about 390 sq ft with a hall, bedroom, kitchen and attached bathroom with toilet (Chitra, Ravi, & Kumar, 2015).

The tenements in resettled colonies have been allocated based on the 'Hire Purchase Scheme' of TNSCB, which requires residents in Kannagi Nagar to pay a monthly rent of 150 to 250 rupees for 20 years before they attain full ownership (D.G. & Peter, 2016). The monthly payment in Ezhil Nagar is 300 rupees. In Perumbakkam, families resettled after the 2015 floods pay 750 rupees per month for their tenement (Peter, 2017).

5.4 Household satisfaction with resettlement colonies

Households resettled in purpose-built resettlement colonies in Kannagi Nagar, Perumbakkam and Ezhil Nagar have expressed their dissatisfaction on many counts. In fact, researchers such as D.G. & Peter (2016) have termed these resettlement colonies as 'ghettos', where Chennai's poor are being forcibly settled. Though TNSCB has resettled almost 95 percent of affected households in permanent housing, they have resisted relocation (HLRN, 2018). A comparison by Hochart (2014) of the physical condition of tenements in Kannagi Nagar to the tenements at locations from where households were relocated, found that the physical structure of tenements at the previous location is better.

Buildings and tenements suffer from poor design and high density. Perumbakkam has two types of design: Type A design covers 32 blocks each containing 192 tenements; Type B design covers 156 blocks with 96 dwellings in each block. Access to upper floors in Type A buildings is through two staircases and two elevators and Type B buildings through one elevator and two staircases, which are inadequate and violate the National Building Code (Peter, 2017). Layout and design of buildings and tenements also lack consideration of livelihood activities of households (Peter, 2017).

Jain, Singh, & Malladi (2021) argue that the Kannagi Nagar and Perumbakkam sites have been developed on the wetland of Pallikaranai marsh, which has exacerbated exposure of resettled households to hazards such as seasonal flooding and increased environmental risks.

From a social and economic conditions perspective, such as job opportunities, access to amenities and impact on household expenditure, Kannagi Nagar has been an unfavourable location (Hochart, 2014). Studies of resettled households in Kannagi Nagar suggest that the resettlement has led to job losses and, due to lack of employment opportunities, many have continued to work in previous locations, almost 25km away (Coelho, Venkat, & Chandrika, 2012). Lack of formal employment around Kannagi Nagar has also led many workers to shift to informal work (Ramya & Peter, 2014).

Moreover, the resettled colony is becoming a ghetto of households from

marginalised social classes such as scheduled caste (SC), scheduled tribe (ST) and most backward classes (MBC) (Coelho, Venkat, & Chandrika, 2012). Among those resettled after the 2015 floods in Perumbakkam, 60 percent of families belong to SC and 40 percent to MBC (Peter, 2017). In Ezhil Nagar, 70 percent of resettled flood-affected families are SCs and 20 percent are MBCs (Peter, 2017). Safety for women and children is a concern that has resulted in many women not going out to work and many children have dropped out of schools (Jayaseelan & Premraj, 2014).

Oft-cited reasons of dissatisfaction in resettlement colonies of Perumbakkam, Kanagi Nagar and Ezhil Nagar are poor connectivity of resettlement locations to the city, lack of adequate housing, lack of personal freedom due to the high density, 'high-rise' typology of buildings, no access infrastructure for people with disabilities, poor access to healthcare facilities, education and inadequate basic services such as water, sanitation, street lights, transport and burial/cremation grounds (HLRN, 2018).

According to a report by HLRN (2018), all households in resettlement colonies have experienced loss of livelihood due to the remote location of these sites and lack of opportunities for employment nearby. The stigma of living in these locations has also affected employment opportunities (HLRN, 2018). The loss of employment due to relocation was anticipated, but it neither stopped relocation nor led to better connection between resettlement sites and employment destinations. A court case was filed in the Madras High Court on behalf of affected households where a local women's organisation petitioned for in-situ rehabilitation of Otteri, Chennai, citing that households had lived and worked in this location for more than 50 years and relocation to Perumbakkam would affect livelihood of families and disrupt their children's education, but the plea was rejected (ToI, 2018).

Residents' experiences differ depending on where they have been relocated from. The previous location of current residents of Ezhil Nagar is within a 2km radius. They have been better off than Kannagi Nagar residents, whose previous location is 20-25km away (Venkat, Subadevan, & Kamath, 2015).

A first sight, ownership of a durable house in resettlement colonies looks attractive compared with insecure tenure in slums. However, households lived in slums for more than 50 years before they were resettled without the requirement of payment towards their housing. Meanwhile, the payments required under 'hire and purchase' schemes in resettled colonies are high and an additional burden considering that almost half of the households have a monthly income of less than 3,000 rupees (Peter, 2017). Failure to meet payments can result in losing tenure and this has forced many households to take high-interest loans. Peter (2017) found that the debt burden is higher among households in resettled colonies.

An unintended consequence of the resettlement has been the disruption of social ties and the creation of artificial communities in resettlement

colonies. While most respondents in the survey reported that political and community networks remained the same over years, the in-depth interviews demonstrated that people reported decreased wellbeing in resettled areas because of issues of safety, regular incidents of conflict and increased alcoholism and drug use (Jain, Singh, & Malladi, 2021). These factors have led to resettlement colonies being perceived as unsafe and unhygienic.

5.5 Research methodology

The multinomial logit model and nested multinomial logit model have been used to model housing choices (see for example Tu & Goldfinch, 1996; Cho, 1997; Gluszak, 2015; Börsch-supan & Pitkin, 1988; Tiwari & Hasegawa, 2004). The multinomial logit model has a limitation in that it assumes independence of irrelevant alternatives (IIA), which is a strong assumption (see Tu & Goldfinch, 1996 for discussion). While the nested multinomial logit model overcomes the problem of IIA, the quantum of calculations is excessive, which makes this technique inefficient.

Given that the purpose of this paper is to examine satisfaction of households with their houses in resettlement colonies, a multinomial logit model is adopted. Households express their satisfaction on a scale of 1 to 5, with 1 as 'very dissatisfied' and 5 as 'very satisfied'.

For j alternatives, the probability function yields the following multinomial logit model:

$P_i(j) = [\exp(\sum_k \gamma_{jk} x_{ik})]/[\sum_{(j=1)}^{J} \exp(\sum_k \gamma_{jk} x_{ik})]$ for all j(= 1,…,J).

In estimating the multinomial logit model, any choice alternative j can be considered as baseline for comparison with other alternatives. In this paper, option 1 and 2 – 'very dissatisfied' and 'moderately dissatisfied' with house is considered as the baseline as only 10 respondents chose the option '1'. Estimated multinomial logit model produces J-1 coefficients for each independent variable. The Jth alternative is the reference with which estimated coefficients are compared.

Estimation of multinomial logit model is conducted using a maximum likelihood estimation procedure.

5.6 Data and variables

A primary survey with sample size of 458 respondents from Kannagi Nagar, Ezhil Nagar and Perumbakkam was conducted in July-August 2021. The random sampling method was used to identify and interview respondents. The sample selection also ensured that residents relocated from various areas of Chennai, at different periods of time, were included to provide comprehensive understanding of how their satisfaction with their homes had evolved.

Table 4: Details of sample

Name of resettlement site	Number of families surveyed
Kannagi Nagar	150
Ezhil Nagar	158
Perumbakkam	150

Table 5 presents mapping of survey questions to functionings. Column 3 in the table indicates how responses were coded for present purposes. The mean and standard deviation of variables are also reported.

The capability approach emphasises the importance of individual differences in determining wellbeing. While it is possible to address person-specific heterogeneity in panel data, it may not be easy to do so if the data is cross-sectional. Anand, et al. (2009) suggest that to allow for this source of heterogeneity in a cross-section data, personality variables may help to make up for the absence of person-specific controls. Five variables have been included to account for person specific heterogeneity of empathy, optimism, and experience with natural and man-made disasters (refer to Table 5).

Table 5: Indicators and descriptive statistics for Chennai

Variable	All respondents		Owners	
Functionings	**Survey questions**	**Indicators**	**Mean**	**Std. Deviation**
Control over one's environment – Be able to improve the physical attributes of the house as per one's likings and needs	Annual income of main earner (Rupees)	Income of household head	7248.95	5169.21
Control over one's environment – Be able to improve the physical attributes of the house as per one's likings and needs	Annual income of other members of household (Rupees)	Income of other members	1990.46	4175.78
Control over one's environment – Be able to improve the physical attributes of the house as per one's likings and needs		Savings as share of income	1.12	3.22
Living comfortably in a home	Area in square feet	Area of house	290.91	108.15
Living comfortably in a home	Number of married couples living in house	Number of couples	0.82	0.52
Living comfortably in a home	Distance in km	Distance from previous location	16.06	12.87
Self-identity in familial identity and status	Location of unit – If Ezhil Nagar = 1; Otherwise = 0 (Perumbakkam is base)	Dummy for Ezhil Nagar	0.35	0.48
Self-identity in familial identity and status	Location of unit – If Kannagi Nagar = 1; Otherwise = 0 (Perumbakkam is base)	Dummy for Kannagi Nagar	0.33	0.47

Disaster resilience and preparedness – Security of physical space	What was the extent of damage due to disaster? Damage to structure and household stuff = 1; Otherwise = 0	Partial or full damage	0.38	0.49
Financial stress	Employment status Employed = 1; Otherwise = 0	Employment Status Present	0.71	0.45
Financial stress	If self-employed = 1; Otherwise = 0	Employment type – Self-employed	0.17	0.37
Financial stress	If employed in skilled job = 1; Otherwise = 0	Employment type – Skilled	0.13	0.34
Financial stress	If employed in unskilled job = 1; Otherwise = 0	Employment type – Unskilled	0.28	0.45
Financial stress	Satisfaction level in current job 1 = very dissatisfied; 2 = Moderately dissatisfied; 3 = Neutral; 4 = Moderately satisfied; 5 = Very satisfied	Satisfaction with current employment If 4 or 5 = 1; Otherwise = 0	0.28	0.45
Psychological wellbeing	How do you rank your health status? 1 = very bad; 2 = bad; 3 = neutral; 4 = good; 5 = very good	Status of health If 4 or 5 = 1; otherwise = 0	0.52	0.50
Psychological wellbeing	How much fear/anxiety do you feel about the following – disaster including flood/tsunami? 1 = Extremely fearful; 2 = Very fearful; 3 = Moderately fearful; 4 = A little fearful; 5 = Not at all fearful.	Fear of disasters including flood/ tsunami If 4 or 5 = 1; Otherwise = 0	0.16	0.37
Psychological wellbeing	How much fear/anxiety do you feel about the following – loss of income/employment? 1= Extremely fearful; 2= Very fearful; 3= Moderately fearful; 4= A little fearful; 5 = Not at all fearful.	Fear of loss of income/ employment If 4 or 5 = 1; Otherwise =0	0.17	0.37
Psychological wellbeing	How much fear/anxiety do you feel about the following – loss of assets/house? 1 = Extremely fearful; 2 = Very fearful; 3 = Moderately fearful; 4 = A little fearful; 5 = Not at all fearful.	Fear of loss of assets/house If 4 or 5 = 1; Otherwise = 0	0.209	0.407
Affiliation – Being able to live with others	Number of members of household	Household size	3.20	1.35

Affiliation – Being able to live towards others	How satisfied are you in the current situation on presence of informal/social support system for children eg childcare facilities, child friendly space? 1 = very dissatisfied; 2 = Moderately dissatisfied; 3 = Neutral; 4 = Moderately satisfied; 5 = Very satisfied	Satisfaction with informal/social support system for children If 4 or 5 = 1; Otherwise = 0	0.18	0.39
Affiliation – Being able to live towards others	How would you rate the overall physical safety of everyone in the current neighbourhood? 1 = very bad; 2 = bad; 3 = neutral; 4 = good; 5 = very good	Physical safety of everyone in neighbourhood If 4 or 5 = 1; Otherwise =0	0.35	0.48
Affiliation – Being able to live towards others	How satisfied are you with the income of other household members before relocation? 1 = very dissatisfied; 2 = Moderately dissatisfied; 3 = Neutral; 4 = Moderately satisfied; 5 = Very satisfied	Satisfaction with income of other household members If 4 or 5 = 1; Otherwise = 0	0.19	0.39
Affiliation – Being able to live towards others Social equity and empowerment for female	How would you rate the overall physical safety of women inside the house? 1 = very bad; 2 = bad; 3 = neutral; 4 = good; 5 = very good	Physical safety of women inside house If 4 or 5 = 1; Otherwise =0	0.53	0.50
Social equity and empowerment for female	How satisfied are you with the personal safety for females on roads, at bus stops, in public transports? 1 = very dissatisfied; 2 = Moderately dissatisfied; 3 = Neutral; 4 = Moderately satisfied; 5 = Very satisfied	Satisfaction with safety of women on road, bus stops and public transport If 4 or 5 = 1; Otherwise = 0	0.22	0.42
Familial wellbeing – Building interpersonal relationship	Have you been as a house-hold Visiting friends and family within city? If Yes = 1; Otherwise = 0	Have you been as a household visiting friends and family within city?	0.69	0.46
Disaster resilience and preparedness - Security of physical space	What level of satisfaction are you with the protection from disaster? 1 = very dissatisfied; 2 = Moderately dissatisfied; 3 = Neutral; 4 = Moderately satisfied; 5 = Very satisfied	Satisfaction with protection from disasters If 4 or 5 = 1; Otherwise = 0	0.24	0.43

Personal trait and experience	Currently, suffering can lead to personal growth 1 = almost never true; 2 = rarely true; 3 = occasionally true; 4 = usually true; 5 = almost always true	Optimism If 4 or 5 = 1; Otherwise = 0	0.55	0.50
Personality trait and experience	Currently, in taking actions, I put priority on others rather than myself. 1 = almost never true; 2 = rarely true; 3 = occasionally true; 4 = usually true; 5 = almost always true	Empathetic 1 If 4 or 5 = 1; Otherwise = 0	0.583	0.494
Personality trait and experience	Currently, I put greater importance on my family, friends and acquaintances than on my job. 1 = almost never true; 2 = rarely true; 3 = occasionally true; 4 = usually true; 5 = almost always true	Empathetic 2 If 4 or 5 = 1; Otherwise = 0	0.546	0.498
Personality trait and experience	What is the type of disaster, encountered by the household? If natural disaster = 1; Otherwise = 0 (Base = those who have not experienced disaster)	Encounter with natural disaster like flood, tsunami, etc.	0.56	0.50
Personality trait and experience	What is the type of disas-ter, encountered by the household? If man-caused disaster = 1; Otherwise = 0 (Base = those who have not experienced disaster)	Encounter with man-caused disaster like fire, crime, forced eviction, etc.	0.32	0.47

5.7 Results: housing wellbeing function for Chennai

A multinomial logistic (MNL) regression is used to predict categorical placement in, or the probability of, category membership on a housing satisfaction (wellbeing) variable based on multiple independent variables. These independent variables are indicators for functionings that contribute to housing satisfaction/wellbeing. The independent variables can be either dichotomous or continuous.

As discussed earlier, respondents report housing satisfaction on a scale of 1 to 5 (1 = least satisfied and 5 = fully satisfied). There were only 10 respondents who responded with '1' as their housing satisfaction choice. In MNL regression, we have combined responses 1 and 2. Hence four categories have been used in MNL regression. The results are presented in Table 6.

Table 6: Multinomial logistic estimate of housing wellbeing function (base Category = 2)

Variable	All respondents		Owners
Indicators	**Coefficient Category = 3**	**Coefficient Category = 4**	**Coefficient Category = 5**
Intercept	1.866 (3.087)	-5.466 (10.052)	-9.335 (11.729)
Encounter with natural disaster like flood, tsunami, etc.	-1.335 (8.845)	-0.957 (1.979)	-3.702 (6.817)
Encounter with man-caused disaster like fire, crime, forced eviction, etc.	-1 (3.765)	-0.912 (1.422)	-2.381 (2.006)
Household size	-0.262 (3.306)	0.12 (0.347)	-0.822 (5.588)
Number of couples	0.504 (2.355)	-0.231 (0.218)	1.304 (1.966)
Dummy for Ezhil Nagar	-1.513 (7.056)	-2.01 (6.666)	-2.369 (4.011)
Dummy for Kannagi Nagar	-0.468 (0.47)	1.45 (2.296)	0.745 (0.174)
Distance from previous location (km)	-0.002 (0.024)	-0.028 (1.122)	-0.147 (6.615)
Partial or full damage	-0.868 (5.369)	-1.47 (6.998)	1.619 (2.34)
Employment Status Present	0.669 (1.503)	1.455 (5.135)	2.314 (7.066)
Status of health	1.229 (7.566)	1.992 (11.063)	0.965 (1.136)
Fear of disasters including flood/tsunami	1.16 (0.901)	1.636 (1.614)	1.239 (0.723)
Have you been as a household visiting friends and family within city?	-0.144 (0.126)	-0.297 (0.317)	0.871 (1.022)
Satisfaction with informal/social support system for children	-1.006 (2.07)	-0.221 (0.08)	0.412 (0.199)
Physical safety of women inside house	0.291 (0.499)	0.851 (2.085)	3.304 (9.645)
Physical safety of everyone in neighbourhood	1.109 (3.782)	1.816 (7.475)	2.375 (7.253)
Area of house	0.005 (7.132)	0.016 (25.633)	0.017 (12.718)
Satisfaction with safety of women on road, bus stops and public transport	0.612 (0.747)	1.278 (2.589)	3.372 (10.326)
Satisfaction with protection from disasters	2.041 (5.015)	2.582 (6.914)	1.163 (0.98)
Savings as share of income	-0.047 (0.622)	-0.038 (0.263)	-0.114 (0.411)
Fear of loss of assets/house	2.612 (8.834)	2.675 (7.525)	2.293 (2.907)

Satisfaction with income of other household members	0.369 (0.218)	1.621 (3.43)	4.193 (10.283)
Total household income	-0.001 (0.002)	-0.022 (0.402)	-0.046 (0.747)
Empathetic 1	-1.265 (2.586)	-1.239 (1.884)	-0.65 (0.241)
Empathetic 2	-0.789 (1.401)	-0.855 (1.101)	-1.099 (1.018)
Optimism	1.958 (6.322)	1.659 (3.332)	4.121 (8.614)
Encounter with natural disaster like flood, tsunami, etc.	-1.335 (8.845)	-0.957 (1.979)	-3.702 (6.817)
Encounter with man-caused disaster like fire, crime, forced eviction, etc.	-1 (3.765)	-0.912 (1.422)	-2.381 (2.006)
Pseudo R-Square			
Cox and Snell	0.599		
Nagelkerke	0.67		
McFadden	0.408		
Note: Figures in brackets are Wald statistics			

Control over one's environment – Be able to improve the physical attributes of the house as per one's likings and needs

The indicator that has been used to measure the functioning 'control over one's environment' associated with housing is the percentage share of savings in income. Households with higher savings have the means to improve their housing attributes and living environment even though the area of the unit cannot be altered. They can enclose open spaces or improve internal attributes of their house to make it better for their living. The coefficient of share of savings in income in MNL is positive for option 5, implying that households with higher savings have higher probability of being satisfied with their housing. Given that higher savings households can exercise control over their living environment, their housing wellbeing is enhanced. Another indicator, total household income, has also been included, but is insignificant.

Living comfortably in a home

Being comfortable in a house is associated with higher housing wellbeing. Three indicators have been used to measure comfort: floor space, number of married couples in the house; and the distance of the current location of the residence from previous location.

A house with larger floor area increases comfort and privacy for its residents. The estimated coefficient for area of house is positive and significant. With the base as '1 and 2 – not satisfied', an increase in area increases housing wellbeing. Since the area of units in resettlement colonies are small and

cannot be altered, an increase in the number of married couples per household decreases housing wellbeing due to reduced privacy. Distance of current location from previous location from which a household has been resettled also reduces housing wellbeing, due to the disruption of employment and social connections. Poor connectivity of resettled colonies, lack of local job opportunities and increased expenditure on transportation to locations of employment, negatively affect satisfaction with housing. As distance of resettlement colonies from previous location increases, households are more likely to express dissatisfaction (choice '1 and 2').

Affiliation – being able to live with others

Large households offer opportunities for diversified sources of income and are associated with higher income (Harriss-White, Olsen, Vera-Sanso, & Suresh, 2013). Being able to live as a large household can therefore bring positive housing wellbeing, particularly for lower-income households. On another note, living in a large household can negatively impact housing wellbeing as it reduces personal space per person (Rehdanz et al, 2013).

Which of these effects will dominate depends on the income opportunities for members of households at a particular location. In the absence of income opportunities, as in resettlement colonies, the burden on earning members increases as the household size increases. The situation is acute in resettlement colonies where housing unit sizes are between 100 and 350 sq m. An increase in household size reduces the probability of the 'satisfied with house' choice, as demonstrated by the negative and significant coefficient of this variable in Table 6.

Affiliation – being able to live towards others

A house provides space for care and living towards other family members. Two sets of indicators have been used as measures of being able to live towards others: being able to care for other members of family; and being able to support them financially. Both are found to enhance satisfaction of living in a house. Three indicators based on survey questions pertaining to 'satisfaction with current situation on the presence of informal/social support system for children'; 'overall physical safety of women inside the house'; and 'physical safety of everyone in the current neighbourhood', are significant in housing wellbeing function estimates.

Satisfaction with support systems for children leads to higher satisfaction with a house and its micro-environment. Safety of women in the house and safety for everyone in the neighbourhood also lead to higher housing wellbeing. Being safe and caring for women and children are important for housing wellbeing *ceteris paribus*.

The second group of indicators measure whether households can support family members financially. Location of house in an area which offers income generation potential, plus household savings, contribute to higher

housing wellbeing. Two indicators have been used. The first, for savings as a percentage of total household income, a higher saving rate is associated with higher satisfaction with housing and its location. This is important in the context of relocated colonies as these have been on the fringes of the city.

The second indicator is satisfaction with income of other household members. Many households, before relocation, had two or more members of the family in the labour force. Often, the male household head is the main earner, while the female adult has supplementary employment. For various reasons (such as fear of child safety if left alone at home or lack of opportunity for work in current location or increased distance to previous workplace) relocation has reduced female adults' opportunity to work (Peter, 2017) with significant adverse impact on supplementary income for the family. The indicator 'satisfaction with income of other household members' captures household's functioning, 'being able to financially support members of household'. Households that are satisfied with income of other members of households, are satisfied with their housing and location, as the positive and significant coefficient for this variable suggests.

Familial wellbeing – building interpersonal relationships

Two indicators reflect familial wellbeing associated with housing: 'household size' and 'ability to visit family and friends in the city'. The indicator household size is a proxy for familial wellbeing (as living in a family is preferable than living alone), but size could have negative effect if it causes congestion in a house. The coefficient in our estimate is negative and significant, which implies that the negative effect due to congestion in a small sized house outweighs any positive impact.

The second indicator used is a response to the question about 'household visits to family and friends in the city'. A positive coefficient would suggest that the location where households reside facilitates that interaction and provides higher wellbeing. Social visits to family and friends could become problematic if these impose financial burden on households or are time-consuming due to distance. Relocation colonies are located on the fringes of Chennai and visits to the city could result in huge time and monetary costs associated with travel. In this case, the coefficient could be negative. The coefficient is positive for housing wellbeing choice '5' relative to the base, but insignificant. For other housing wellbeing choices '3' and '4', the coefficient is negative and insignificant. It may be concluded that this indicator has not had significant impact on housing wellbeing.

Disaster resilience and preparedness – security of physical place

Two indicators have been used to determine disaster resilience and preparedness. Households that had suffered full or partial damage to their homes and contents before being relocated to relocation colonies

with durable housing structures express positive housing wellbeing. This is reflected in the positive coefficient of the first indicator for this functioning, 'Damage to previous house', for housing wellbeing choice '5' relative to the base.

The second indicator relates to household satisfaction with 'protection from disaster' at the current location. Households that are satisfied with disaster protection, due to the durable nature of their housing unit, report higher housing wellbeing. The coefficient for this variable is positive and significant for choices which represent higher housing wellbeing relative to the base.

Self-identity in familial identity and status

Housing is often viewed as a symbol of social status which boosts the identity of the individual and their family. It is expected that owning a house contributes to self-identity. In the case of resettlement, all households that have been relocated will eventually own their allocated units (as the allocations are under the 'hire and purchase' scheme). While ownership is important, the issue of identity for resettled households is associated with the location. D.G. & Peter (2016) highlight the perception that resettlement colonies are viewed as ghettos of poor and crime, which despite ownership, may result in negative identity for households.

The location variable is used as an indicator of identity and status functioning associated with housing. With Perumbakkam as base, Ezhil Nagar and Kannagi Nagar residents are less likely to report higher housing wellbeing, as indicated by negative coefficients of location dummy variables. The coefficient of Kannagi Nagar variable is insignificant.

Social equity and empowerment for females

Ownership of a house may create economic empowerment and autonomy which may further improve a female's satisfaction with life in general and their housing in particular. Women, who have been living in slums prior to relocating to resettlement colonies, have experienced incidents of duress and discrimination within their house and outside at public places (Azcona, Bhatt, & Valero, 2019). If the condition of women improves in resettled colonies, their satisfaction with the housing will be higher.

Two indicators have been used to proxy the functioning of social equity and empowerment for female associated with housing. A house with security of tenure could empower women, which applies to all households in resettlement colonies. Hence, a dummy variable for response to a question on 'physical safety of women in house' is used to proxy social equity and empowerment for females.

Households where women have felt physically safe in their homes have reported higher housing wellbeing. A safe neighbourhood for females also enhances satisfaction with housing. Response to the question 'satisfaction with physical safety for women on roads, bus stops and public transport' is

a proxy for safety in the neighbourhood. The coefficient for this variable in housing wellbeing function is positive and significant. Households who have experienced a safe neighbourhood environment for women report higher housing wellbeing.

Health and psychological wellbeing

Security of a house and neighbourhood contributes positively to the psychological wellbeing of its residents as it ensures safety of life and goods owned by them. Fears and anxieties have negative consequences for health and psychology. When these fears and anxieties are associated with housing, they affect housing wellbeing. A secure house can provide the functioning of psychological wellbeing.

Three indicators have been used to measure the functioning of health and psychological wellbeing with a house. The first is the self-reported 'health status'. Since there is strong correlation between home ownership and health (Aizawa & Helble, 2015), *ceteris paribus*, respondents who report good health are likely be satisfied with their housing. The positive and significant coefficient confirms the positive relation between health status and housing wellbeing.

Respondents who have experienced evacuation due to natural disasters (such as flood or tsunami) and those who experienced loss of house/assets before being relocated to resettlement colonies, are likely to be more satisfied by their housing in resettlement colonies as the security of tenure and durable structure of the house provide psychological comfort against fear of flood/tsunami and associated loss of assets. Two variables that capture this aspect are 'fear of disaster including flood/tsunami' and 'fear of loss of house/assets'. The coefficients for these variables are positive and significant for housing wellbeing choices that represent satisfaction.

Financial security

A house and its location can also be financially advantageous and may result in positive housing wellbeing, particularly when the location is convenient for employment. One indicator used to determine this functioning is the 'satisfaction from employment': households that are satisfied with their employment report higher housing wellbeing. The positive coefficient for housing wellbeing choices that depict satisfaction confirm this. Other variables, such as housing debt, were not significant in the estimated function. This is because households have been provided housing through allocation by the public agencies rather than through market mechanism and hence they do not have the burden of loans.

Person-specific heterogeneity

Housing wellbeing function includes three personality variables that reflect difference in attitude and optimism of respondents.

The first variable is the response to the question 'In taking actions, I put priority on others rather than myself' (empathetic 1). The second variable is the response to question 'In taking action, I put priority on my family, friends and acquaintances, rather than on my job' (empathetic 2). These questions relate to personal attitude of a person. Optimism is measured through the response to a question asked to solicit respondents' views on 'suffering can lead to personal growth'. All three variables require responses on a scale of 1 to 5 (where 1 = almost never true; 2 = rarely true; 3 = occasionally true; 4 = usually true; 5 = almost always true). Three dummy variables are constructed with those reporting positive attitude and optimism (reporting 4 and 5) as 1 and 0, otherwise.

Optimists are likely to report higher satisfaction from housing compared with pessimists. While those with empathy towards their family, friends, acquaintances and others are likely to report lower satisfaction from housing compared to others, if they perceive that housing and neighbourhood environment is not as per their ideals.

In addition, two other variables that account for experiences have also been included. Those who have experienced natural or man-made disasters, in general, report lower housing wellbeing than those who have not. The negative effect is stronger for those who experienced natural disasters than those who were relocated due to other reasons.

5.8 Discussion

Welfare programmes in India are based on a basic needs approach, which aims to provide basic resources to people who are severely deprived so that they have the opportunity to live a full life (Acharya, 2018). These programmes result in top-down planning, which disregards people's values, their choices, the process through which they make choices and the extent to which these choices are participatory (Acharya, 2018). Results presented above provide insights into affected households' valuation of post-disaster reconstruction that has been undertaken in Chennai, which comprised relocation and allocation of durable housing units and associated services. Smith & Frakenberger (2018) argue that "besides disaster preparedness and mitigation, factors such as social capital, human capital, exposure to information, asset holdings, livelihood diversity, safety nets, access to markets and services, women's empowerment, governance, and psycho-social capabilities such as aspirations and confidence to adapt improve resilience".

Sen, in his capability approach, argues that resources are an imperfect indicator of human wellbeing. It is important to examine to what extent the post-disaster reconstruction through relocation of affected households to resettlement colonies in purpose-built housing units has contributed to their wellbeing. For an effective post-disaster reconstruction approach, an understanding of what people value and what they can attain about the level of reconstruction is necessary.

The capability approach emphasises that it is important for people to have choices to enhance their wellbeing aspirations, 'abilities' to facilitate realisation of wellbeing and 'opportunities' to allow access to and use of abilities and choices (Acharya, 2018). A person's capability is the freedom to choose from the set of feasible functionings. Functioning is what an individual chooses to do or to be, in contrast to a 'commodity', which is an instrument enabling them to achieve different functionings (Basu & Lopez-Calva, 2011). The transformation of resources into achieved functionings takes place within the capability space, comprising individual, local (community, traditions, environment etc) and structural (laws and regulations) determinants; risks and vulnerabilities that shape people's choices, abilities and opportunities that facilitates real capabilities (Frediani, 2010).

The functionings that are achieved through the housing and the neighbourhood of resettlement colonies result in housing wellbeing. Households that have been able to secure higher household income and hence savings are able to improve/modify their living environment. Opportunities for higher household income are not equally distributed for all those who have been resettled.

For some households, finding suitable employment in the vicinity has been challenging and they have continued to work in older locations or, in some cases, not work at all. Households that were engaged as fisherfolks or older workers were particularly disadvantaged. Sustainability of income opportunities for other members of households plays an important role in satisfaction with housing and neighbourhood as it allows members to live towards each other and financially support where needed.

A larger household size allows for diversity of employment and hence security of income in the event of disaster for low-income households. Household size is also associated with the functioning of being able to live with others and take care of others. However, housing type, design and size in resettled colonies pose a constraint due to the size of units and 'high-rise' typology of buildings. Besides the size of house, distance of resettlement colonies from original location is important for comfortable living and maintaining interpersonal relationships as social and economic ties of many households remain associated with original locations.

Raju (2013) argues that the built environment must be closely linked to the social aspects of a community. While physical reconstruction is an important component of the post-disaster reconstruction process, it is not the only one as recovery is also a social process (Raju, 2013). Relocations that weaken social and economic associations negatively affect housing wellbeing, as has been the case for many in resettlement colonies.

Support systems for care of children (informal/community based) is important for households as this ensures safety of children and unties adults to be able to take gainful employment. In deep-rooted social systems where trust among

neighbours and support of older members of households persists, care of children is ensured. This, however, becomes challenging when households from diverse backgrounds are resettled at one location.

Availability of support systems for care of children also contributes to the functioning of being able to live towards others. Care of children is an important part of individual's wellbeing.

Social equity and empowerment of females ensures housing wellbeing. The resettlement colonies have faced serious concerns regarding safety of women within and in the neighbourhood. Part of the reason has been distrust among households due to the disruption of old social ties as households from various locations and different social backgrounds were relocated. The other reason is the isolation of resettlement colonies which are stigmatised as concentration of poverty.

Poor health and psychological status of individuals who have faced disaster could negatively affect their satisfaction from housing and its neighbourhood in resettlement colonies. The detrimental effect on psychological health, which could arise from fear of disasters or loss of assets, could be reduced by not only assisting in rebuilding of assets of those who lost them but also by ensuring that these are protected from future damages. Insurance is one possible way. In Chennai, in the aftermath of 2015 floods, households that could afford it indicated their willingness to take insurance or invest in disaster protection measures (Patankar, 2019). However, for low-income households this may not be the case.

Location is also important as it relates to self-identity. One of the key problems with the relocation-based post-disaster reconstruction in Chennai has been that it led to social stratification which disadvantaged the poor and resettlement colonies became ghettos of poor and marginalised people (Peter, 2017). This not only affected self-identity of households but also reduced their opportunities for employment. Kannagi Nagar and Ezhil Nagar are more disadvantaged compared with Perumbakkam, which is located near the IT corridor.

Conclusion and recommendations

This research takes motivation from longstanding problems of inadequacy and bias in contemporary post-disaster compensation and restitution mechanisms – which are guided by the asset-based approach to measuring disaster losses – and argues for a comprehensive measure of wellbeing using the 'capability approach'. Housing as a resource contributes to a number of capabilities necessary for good quality of life for an individual. Referring to the wellbeing that capabilities associated with housing create as housing wellbeing, the research aims to identify the key determinants of households' housing wellbeing that should be the focus of post-disaster compensation/ recovery mechanisms.

Asset-based approaches to measuring disaster intensity and losses have long been criticised for the exclusion of non-asset losses such as psychological wellbeing and social capital, which otherwise are crucial contributors to people's wellbeing and thus require satisfactory reconstruction post-disaster. Asset-based models are also criticised for directing recovery investments toward richer households and regions, and the implicit bias against poor households that otherwise experience larger wellbeing losses.

Among approaches that are used in welfare economics to study wellbeing of people, two of the most prominent approaches are subjective wellbeing (SWB) and the capability approach, though neither is without limitations. Using a combination of SWB and the capability approach, this research identifies crucial determinants of housing wellbeing using the JHPS data in Japan and the date from a primary survey conducted in Chennai, India. This research identifies key determinants of capabilities (such as resources, personal characteristics, and household and societal characteristics) associated with housing wellbeing in these two countries for target households.

The findings emphasise the importance of non-asset dimensions of housing wellbeing and challenge the traditional asset-based approaches to measuring wellbeing and disaster losses. Results add to the discussions on building resilient communities and contribute to the bigger objective of designing a resilient compensation or restitution mechanism that can satisfactorily reinstall or reconstruct the basic capabilities of affected households and consequentially facilitate the self-recovery process in a holistic manner.

The following generalist principles for post-disaster reconstruction (compensation and restitution) emerge from this research:

1. Relocation should not be detrimental for households in securing income opportunities.
2. Housing should respond to the requirements of households. In this context, it is important that the community is involved in the process of designing their living environment (Frediani, 2010).
3. During post-disaster reconstruction, to avoid disrupting social systems which are based on trust and care for each other and particularly for children.
4. Post-disaster reconstruction should make efforts to ensure social equity and empowerment of women, which will not only have a positive impact on the health of women, but would also improve the overall wellbeing of households.
5. Mechanisms for protection of assets/houses and income of low-income households through public insurance or other safety nets should be devised.
6. To resettle households which does not disadvantage them through social stratification or affect their self-identity. This implies that as far as possible reconstruction should be in-situ or, if relocation is necessary, it should not be at a distant location.

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