Appendix 3: Measuring Social Capital

This study employed three indices measuring social capital, developed and validated in a separate study by Fraser (2021). The original study measured several types of social capital, ranging from 0 (low) to 1 (high), describing the strength of each type of social capital in Japan's 1741 municipalities from 2000 to 2017, based on publicly available data. This framework is based on Kyne & Aldrich's (2020) framework, which measured social capital for every US county using publicly available data. These indices (Kyne & Aldrich 2020; Fraser 2021) synthesize a variety of proxies drawn from other studies of measuring and conceptualizing social capital and community resilience (Tierney 2001, McPherson et al. 2003, Mouw 2006, Murphy 2007, Norris et al. 2008, Morrow 2008, Chamlee-Wright 2010, Cutter et al. 2016). Their framework developed three subindices for (1) bonding (in-group ties), (2) bridging (inter-group) ties, and (3) linking social capital (verticale ties), a common way of delineating social capital (Szreter & Woolcock 2004; Aldrich & Meyer 2015). Together, these measures were used to approximate social capital in each county. In Fraser's (2021) Japanese framework, these measures can be used together to approximate social capital for each municipality. While national context does matter for social capital, scholars have examined and found considerable variation in social capital in communities and countries across the world, adding credence to the idea that we can successfully evaluate it in different country contexts (see for example Putnam 1993; Uekusa 2020; Roque 2020; Alcorta 2020; Fraser, Page-Tan, & Aldrich 2021).

Below, I briefly describe (1) the indicators involved in each index and (2) examples of validation in past studies. For further information, please consult the original articles introducing these indices, including Kyne & Aldrich (2020), Fraser (2021), and Fraser, Page-Tan, & Aldrich (2021).

Building the Indices

These indices relied on several indicators, which each measure different aspects of social capital. Fraser (2021) then averaged these indicators together into bonding, bridging, and linking subindices. I describe each below.

Bonding Social Capital

To represent bonding social capital in the US, this study used several indicators describing how similar members of each municipality are in terms of key salient demographics, including, for example, race and ethnicity (Alesina et al. 1999), income, education (Morrow 2008), gender (Norris et al. 2008), employment (Tierney et al. 2001), age (Cutter et al. 2010), and more.

Because most censuses do not ask about trust, instead, bonding, in-group ties were measured by proxy, measuring how similar members of a community are in terms of 7 commonly measured traits: These traits 7 include similarity in terms of (1) nationality, (2) religion, (3) education, (4) employment levels by gender, (5) employment status, (6) communication capacity, and (7) age. These are ***not*** sheer demographics, but rather several different representations measuring how similar (or, conversely, fractionalized) that community is. The key rationale here is that homophilous communities tend to have strong bonding social ties (Mouw 2006; Pretty 2003), and taking into account *similarity* better captures the strong in-group focus of bonding social capital (McPherson et al. 2003). Homophily has been linked to stronger bonding social ties in numerous studies (Lin, 2001; Dyson, 2006; Mouw 2006; Beaudoin, 2007; Hawkins & Maurer, 2010). By definition, bonding ties are between members of the same social strata (Szreter & Woolcock 2004; Aldrich & Meyer 2015; Mouw 2006; McPherson et al. 2003). For example, if

there are higher rates of young people, for example, there can be more ties between them, but if there are fewer residents of that background, the total number of potential in-group, bonding ties ultimately decreases.

In Japan, Fraser (2021) averaged the following 7 rescaled indicators to create a bonding social capital index for each municipality (*shikuchoson*), specified in **Table 1:**

1. *Similarity by nationality (*Japanese vs. foreign population).
    - The bonding social capital index relies heavily on Alesina and colleagues' (1999) method of assessing divisions in a community using fractionalization measures. Fractionalization measures how fractionalized a community is into different categories (eg. religion, nationality/ethnicity, etc.); Fraser (2021) and Kyne & Aldrich (2020) reverse scale this measure so that 1 = complete homogeneity and 0 = complete heterogeneity.
    - Japan's census does not collect data on race. This is because most Japanese communities are relatively ethnically homophilous, at least compared to other countries like the US. However, Japanese communities still contain more ethnic diversity than is commonly known (Lie 2001). This helps approximate similarity among immigrants including Korean, Chinese, and Indian immigrants, among others.
2. *similarity by religion* (religious minorities vs. Non-religious minorities).
    - Japan's census records the share of residents who identify as Christian or part of an other religious minority (eg. Soka Gakkai); meanwhile, many Japanese identify as Buddhist, Shinto, both, or neither, at various points in their lives. As a result, Fraser (2021) measured religion in terms of Non-minority religions (the latter), Christian, or other minority religions, to capture potential in-group ties within religious identity.
3. *similarity by education levels* (college educated vs. Elementary school graduates).
    - Large inequalities in education levels, especially the most and least educated members of society, may make residents less likely to interact, while smaller inequalities in education provide more opportunity for interaction among residents with similar levels of education (Morrow, 2008; Norris et al., 2008).
4. *similarity in employment rates by gender (*women's vs. men's employment).
    - Differences in gender roles and access to the workplace shape opportunities for cohesion and trust. If levels of employment are similar, men and women have more equal access to make ties among peers at home and at work. Meanwhile, if levels of employment are greatly different by gender, men and women have unequal opportunities to make these ties with others, especially members of their own gender, both at home and at work. This captures a decreased total potential for making in-group social ties (Morrow 2008).
5. *employment equality* (whether the labor force is mostly employed, or not).
    - Employment inequality has been linked to less cohesion and trust (Tierney et al., 2001).
6. *communication capacity* (NHK television broadcast reception contracts per capita).
    - Communities with greater communication infrastructure have a higher potential for building and supporting strong ties between friends and family, while those lacking such infrastructure may have difficulty making these connections electronically

(Morrow, 2008). The Japanese census does not measure telephone connectivity, but it does report NHK broadcast reception, a close proxy for access to phone lines.

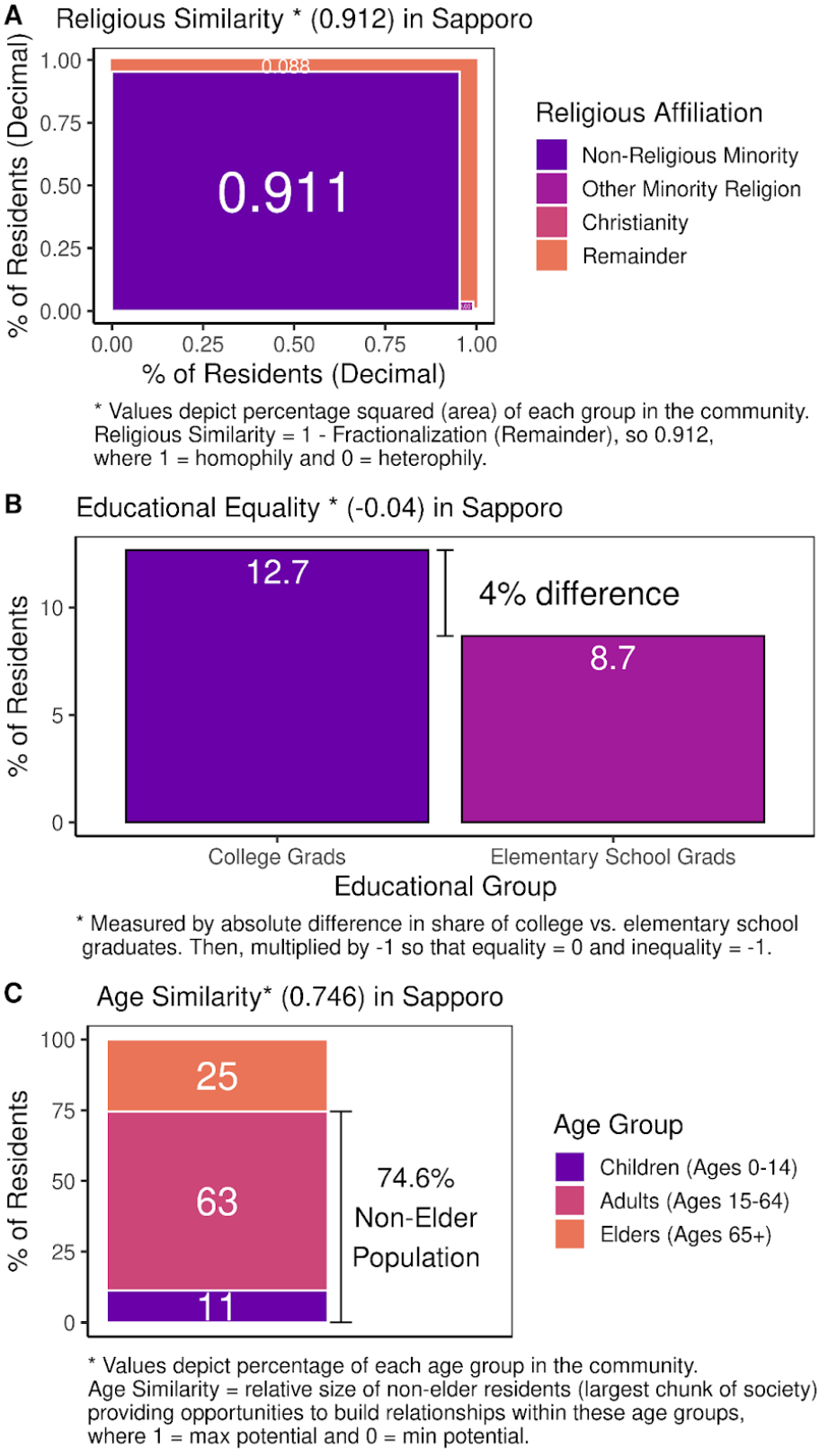
7. *age similarity* (share of residents below age 65).
    - Many aging individuals live in nursing homes, living assistance homes, or have limited mobility, reducing levels of interaction with other community members (Morrow, 2008). Meanwhile, given more residents under age 65, this majority section of the population has more total people in their age groups to interact with. For these reasons, past studies used the percentage of non-elders as a measure of bonding social capital (Kyne & Aldrich 2020; Fraser 2021).

Finally, in **Figure A3.1** below, I visualize three examples of measures used in the bonding social capital index. The first (**Figure A3.1 panel A**) is a visual representation of religious similarity in the city of Sapporo, using Alesina and colleagues' (1999) fractionalization method. This panel visualizes the squared percentages of each religious grouping in the population as a literal square, then calculates fractionalization as the remainder of the total area of the square (0.088) after subtracting the sum of squared percentages (0.912). In a heterophilous society, where these three categories would be evenly sized, the squares would be equally sized, leaving a very large remainder (thus high fractionalization/heterophily). But in a very homophilous society, where most people are not part of a religious minority, like in Sapporo, these three categories are very unevenly sized, leaving a very small remainder. Thus, we calculated religious similarity as 1 minus the remainder (fractionalization), giving us a religious similarity score of 0.912, very close to the max of 1. This same technique is used to measure *similarity by nationality*.

Next, the second (**Figure A3.1 panel B**) is a visual representation of educational equality in the city of Sapporo, using Kyne and Aldrich's (2020) formulation. This panel visualizes the difference in the percentage of the population that is college educated (representing high educational attainment) vs. the percentage of the population that completed elementary school, but not high school. This gap of 4% is then multiplied by -1 to produce an education equality score of -0.04, where educational equality equals 0 while inequality equals -1. The greater the gap, the more unequal levels of education are and the more stratified the population is into groups that have less interaction with each other, reducing bonding social ties. The same general approach of comparing two percentages is used to measure *similarity in employment rates by gender* (but reverse coded), and *employment equality* (but reverse coded).

Finally, the third (**Figure A3.1 panel C**) is a visual representation of age similarity in Sapporo, measured at 0.712, using Kyne and Aldrich's (2020) formulation based off of Morrow's observations about age and social cohesion (2008). This stacked bar chart shows the breakdown of the population by three age groups, including youth, adults, and elders. The share of residents who are non-elders (under age 65) is depicted via a black line, at 71.2%, to show the share of the population who tend to be especially active in social interactions, and who do not face as many barriers to social interaction compared to elders (25% in Sapporo), who face may some challenges due to mobility and institutionalization. Age similarity is measured as a simple percentage or rate. The remaining measures of social capital are all either percentages or population controlled rates, like this measure.

Figure A3.1: Three Measurement Techniques used in Bonding Social Capital Index



Bridging Social Capital

Next, to represent bridging social capital, this study used several indicators of associational membership and civil society participation (Pekkanen et al. 2014; Small 2009; Taniguchi 2016; LeBlanc 1999). This is because associations are reported to frequently build ties across different racial, ethnic, income, and age groups (Putnam 2000). These inter-group ties help *bridge* divides and reduce inter-ethnic conflict (Varshney 2001), share information about evacuation (Fraser, Morikawa, & Aldrich 2021), and recover from crisis (Aldrich 2012).

In the US, Kyne & Aldrich (2020) and Fraser, Page-Tan, & Aldrich (2021) averaged rates of several different types of community organizations to create a bridging social capital index for each county and county subdivision, using different types of associations (religious, civic, advocacy, charitable, unions, fraternal), based on the work of Chamlee-Wright (2010), Norris et al. (2008), and Cutter et al. (2016). In the Japanese indices, Fraser (2021) used 8 indicators, including associational measures, supplemented by civil society participation to replace US indicators not available in Japan. Libraries and community centers, for example, are key places in communities that foster social capital and connectedness across different group lines (Klinenberg 2018). Similarly, voter turnout is a common approximation of civic engagement, a by-product of bridging ties that help build a sense of shared stake in one's community among residents from different backgrounds. Voter turnout has been used to measure bridging social ties in several studies (Fraser 2019; Aldrich 2021).

1. *Volunteer participation rate*
2. *Unions per capita*
3. *Nonprofit organizations per capita*
4. *Religious organizations per capita*
5. *Rate of community centers per capita*
6. *Rate of libraries per capita*.
7. *Voter turnout in prefectural elections (as measures of civic engagement)*
8. *Voter turnout in lower house elections (as measures of civic engagement)*

Linking Social Capital

Finally, to represent linking social capital, Fraser (2021) used several indicators of political linkages and representation to signify vertical ties to government officials and authorities, matching the approach of Kyne & Aldrich (2020), Fraser, Page-Tan, & Aldrich (2021), and past literature (Tierney 2001; Murphy 2007; Morrow 2008). For Japan, Fraser (2021) used 6 measures of linking ties. These approximated linkages between residents and local, prefectural, and central government, as well as political linkages through support for the party in power.

The logic here is that in communities with more government employees, policy, assembly members, etc. per capita, residents literally have more decision-makers available to connect with, petition, and build relationships and experiences with (Murphy 2007; Morrow 2008). Further, support for the ruling party has been used in several past studies (Fraser 2021b; Fraser 2019; Aldrich 2019) to measure linking ties.

Particularly in Japan, parties frequently form clientelist relationships with constituencies, providing communities with valuable construction and infrastructure jobs and new economic development projects to reward them for their support, cater to their constituents' needs, and ensure their votes in future elections (Fukui & Fukai 1996; Aldrich 2008; Tsai 2007; Catalinac et al. 2020). Communities which supported the party in power in the most recent election therefore often

have greater pull on those officials, able to make their needs heard to local, prefectural, and central government bodies (Aldrich 2019; Fraser et al. 2021).

1. *Local government employees per capita*
2. *Prefectural government employees per capita*
3. *Prefectural assembly members per capita*
4. *Prefectural police per capita*
5. *% of vote for ruling party in Lower House elections*
6. *% of vote for ruling party in prefectural elections*

Past Indices

In Japan, the author is unaware of other past indices available for every municipality; previous measurements of social capital have often been by single proxy (Aldrich 2011; Ramseyer 2015; Fraser 2019) or in-depth surveys of specific neighborhoods (Hikichi et al. 2020, for example). While the US has several alternative social capital datasets (United States Joint Economic Committee's Social Capital Index 2018; Rupasinga et al. 2006), the Fraser (2021) indices are the first main measure of social capital closely engaged with the literature that are available in Japan.

There are two major types of value added by the Kyne & Aldrich framework. First, it captures bonding social capital especially well in terms of the propensity of homophilous communities to form strong in-group ties, which are effective at helping members of the same racial, ethnic, religious, age, income, or gender groups, but not as effective at extending help and resources across different social lines. (Alternative measures, like overall trust, are really too general to capture this in-group nature; additionally, trust measures are not available for Japanese municipalities.) The second major value added is that by sourcing from publicly available data sources, these indices can be easily redesigned at lower-levels of analysis, like the city level (as done by Fraser (2021) in Japan and Fraser, Page-Tan, & Aldrich (2021) in the US).

Validation in past studies

Both sets of indices were validated in their original studies by Kyne & Aldrich (2020) and Fraser (2021), where the authors showed that index components had strong conceptual and internal validity, correlating in expected ways with each other and with original indicators. The studies also validated these indices by showing that they appropriately correlated with known correlates, including disaster recovery outcomes.

Further, these indices have been repeatedly applied to multiple disaster scenarios, consistently demonstrating the associations expected by the literature, even in spite of different national contexts. These outcomes are listed in Table A3.1 below:

Table A3.1: Expected Associations with Indices Found Consistently in 10 Studies

#	Outcomes associated with these Indices, as expected	Source(s)
1	Presidential disaster declarations, disaster-related fatalities, and disaster damage in the US	Kyne & Aldrich 2020
2	Post-disaster death rates, outmigration rates, and public works spending in Japan after the 2011 triple disaster	Fraser 2021

3	Long-term migration and financial recovery among Tohoku and Miyagi communities affected by the 2011 triple disaster	Fraser, Small, & Aldrich 2021
4	Preemptive evacuation and long-term evacuation after the 2018 Eastern Iburi Earthquake in Hokkaido, Japan	Fraser, Morikawa, & Aldrich 2021
5	Building back better through climate change adaptation after Hurricane Sandy in 2012 and the 2011 triple disaster in Japan	Fraser, Cunningham, & Nasongo 2021
6	Reduction in greenhouse emissions in Japanese municipalities between 2005-2017	Fraser et al. 2020
7	Excess death rates during the COVID-19 pandemic among US counties	Fraser, Aldrich, & Page-Tan 2021
8	COVID test positivity rates during the COVID-19 pandemic among US census tracts and zipcodes	Fraser, Page-Tan, & Aldrich 2021
9	COVID-19 case rates and death rates during the pandemic among Japanese prefectures	Fraser & Aldrich 2021
10	Improvements in Health in US Counties	Panagopoulos et al. 2021

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