Housing Inequality in Developing Asia and the United States: Will Common Problems Mean Common Solutions?

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Abstract

We analyze housing inequality, an important and common issue in both developing and developed countries. To do so, we use two different samples: one from the 2012–2017 Demographic and Health Survey data for 10 developing countries in Asia and one from the 2017 American Housing Survey for the United States. Our findings suggest that while cities generally have more advantages for housing adequacy because of their population size, not all cities manifest these advantages. In the United States, residents in central cities have lower access to adequate housing than suburban residents. In addition to urban-rural or urban-suburban housing inequality, another dimension of housing inequality is associated with household economic status. We find a significant concentration of inadequate housing among households with lower wealth and income both in Asian developing countries and the United States. Finally, our results suggest spatial heterogeneity in household-level housing inequality. Areas with a larger population, higher economic inequality among residents, and lower housing affordability tend to experience greater housing inequality among households with different levels of wealth and income. After presenting these empirical findings, we discuss various policy measures that attempt to mitigate housing inequality.

1. Introduction

Much attention has been paid to rising economic inequalities in many developed countries and their metropolitan areas (Piketty, 2014; Wetzstein, 2017). Although income and wealth have been the focus of such inequality research, the distribution of adequate housing and associated living conditions has received much less attention. That distribution, however, is another important dimension that determines the actual level of household-level inequality. As housing adequacy has a significant effect on household wellbeing (Ineichen, 2003; Krieger and Higgins, 2002), housing inequality reinforces health and socioeconomic inequalities at the household level. Inequalities at the national and metropolitan level are associated with lower growth of income and population, higher crime rates (for example, Fajnzylber, Lederman, and Loayza, 2002), and a lower level of happiness (Oishi, Kesebir, and Diener, 2011). At the same time, the distribution of adequate housing influences how households sort into metropolitan areas and neighborhoods and contributes to spatial inequality that manifest in economic segregation and the concentration of poverty (Jargowsky and Wheeler, 2017).

Existing research tends to separate housing inequality into two dimensions: household-level and spatial inequality. Studies mainly done in the United States and other western contexts have looked into unequal homeownership opportunities among racial and ethnic minorities (for example, Borjas, 2002; Krivo and Kaufman, 2004). Others have studied neighborhood-level residential segregation to address spatial inequality in the degree of housing consumption (for example, Charles, 2003; Charles, 2006; Iceland and Weinberg, 2002). What is seemingly obvious but less known is the extent to which household economic inequality plays a role in household-level inequality in access to adequate housing. Another under-researched question is whether spatial attributes such as population size and local housing markets matter for housing adequacy gaps between rural and urban areas and across metropolitan areas. Furthermore, there is scant evidence on metropolitan heterogeneity in the extent of housing inequality by household economic status, as most existing research focuses on inequality at the household or smaller geographic level.

This article aims to provide systematic evidence of two dimensions of housing inequality in Asian developing countries and the United States. We begin by investigating the spatial heterogeneity in housing adequacy by population size, focusing on urban-rural and urban-suburban gaps and heterogeneities across metropolitan areas. Then, we move to the estimation of housing inequality by household economic status, such as wealth and income. Lastly, we look at how metropolitan-level spatial attributes, such as population size, economic inequality, and local housing markets, are associated with household-level housing inequality. Given the large difference in economic status and urban development between developing Asia and the United States, the main purpose of our article is not directly comparing their housing adequacy. We instead attempt to report whether different types of metropolitan areas—in terms of household income, urban growth, and geographic factors—have experienced similar or different patterns of housing inequality and to discuss how policy measures have coped with these issues.

In doing so, we use two different samples, one from the 2012–2017 Demographic and Health Survey (DHS) data for 10 Asian developing countries and one from the 2017 American Housing Survey (AHS) for the United States. To account for housing adequacy for our DHS sample, we use

the information on four-dimensional criteria including the durability of the building, crowding, access to improved water, and access to sanitation. For the AHS sample, we rely on housing quality information provided by AHS. We argue that this inconsistency in housing adequacy measures is not critical for our research because our main interest lies in the level of housing inequality within a given country or metropolitan area. For the same reason, all our analyses are done separately for the DHS and AHS samples. As we have uniform data and more household-level information, we can perform more in-depth analyses for our DHS sample, whereas our analysis for the AHS sample is mostly descriptive. For the comparison of housing inequality by household wealth among 10 Asian developing countries, we plot the concentration curve and calculate the concentration index (Kakwani, Wagstaff, and van Doorslaer, 1997; O'Donnell et al., 2008). We also use the DHS sample for our regression analysis at both the household- and metropolitan area-level that attempts to investigate the association between spatial attributes and housing inequality.

Our analyses using the DHS sample report serious housing inequality problems in Asian developing countries. We first observe the significantly lower share of adequate housing in rural areas than cities. Our analysis results also confirm a significantly higher probability that wealthier households reside in adequate housing. Then, we find that areas with a larger population, higher wealth inequality, and lower housing affordability experience more serious housing inequality by household wealth. Our regression results show that, although large and small cities in developing Asia offer more adequate housing than rural areas, many urban households with a lower wealth level do not enjoy this benefit. Both the standard deviation of household wealth and price-to-income ratio (PIR) have negative associations with overall housing adequacy, and they contribute to a wider gap in housing adequacy between households with different wealth levels. Metropolitan area-level regressions confirm that the concentration indices in cities and areas with higher wealth inequality are significantly higher than those in other areas.

Although the differences in economic status and the degree of development across U.S. metropolitan areas are less substantial compared to the urban-rural differences in developing countries, residents in some cities like Boston and New York show lower access to adequate housing than suburban residents. Unlike Asian developing countries, where economic deprivation in rural areas is found to be a main driver for the urban-rural housing inequality, spatial inequality in the United States appears to be mainly related with other factors, such as income inequality and housing market circumstances within a given metropolitan area. Along with spatial inequality, the concentration of inadequate housing among lower-income households also exists in the United States. With respect to the spatial heterogeneity in such household-level housing inequality, U.S. results show a consistent pattern with our evidence from Asian developing countries. The concentration of housing inadequacy among lower-income households is much higher in metropolitan areas than in non-metropolitan areas. Such concentration is also more significant in U.S. metropolitan areas with higher income inequality and higher PIRs.

We contribute to the inequality research by presenting housing inequality as an important dimension of household inequality. By bridging household-level housing inequality with spatial inequality at the metropolitan level, we try to understand why lower-income residents have limited access to adequate housing in some areas with a relatively higher share of adequate housing.

Our analysis also fills a knowledge gap for developing countries that have more serious housing adequacy problems than those in developed countries. Despite the importance of housing inequality for sustainable urbanization, there is surprisingly little systematic evidence on related issues in Asian developing countries that have been rapidly urbanizing in the past three decades. Finally, we discuss housing inequality issues across different contexts in developing and developed countries, which is rare in the existing literature.

The article is structured as follows: we first provide a scholarly background on the importance of housing inequality and potential reasons for it, along with a brief spatial background of developing Asia and U.S. metropolitan areas. Next, we present the main data sources and methods we used for our analyses. In the following section, we present our findings on spatial inequality, housing inequality by household economic status, and spatial heterogeneity in household-level housing inequality separately for Asian developing countries and the United States. We also discuss how these inequality patterns are comparable between developing Asia and the United States and how various policies have attempted to mitigate them. Finally, we conclude with implications of our findings and directions for future research.

2. Background

2.1. Importance of Housing Adequacy and Housing Inequality

According to the United Nations General Assembly (1948), the right to housing is recognized as an important element, along with health care and other social services to achieve an adequate standard of living.[1] Despite broad recognition of the importance of the right to adequate housing as a basic human right (United Nations, 1966), there is no internationally agreed-upon definition of adequate housing. The United Nations (1991) recognizes that adequacy is determined by various social, economic, cultural, climatic, ecological, and other factors. The general guidelines provided by the UN Habitat (2009) cover not only the physical and territorial dimensions but also cultural adequacy, accessibility for disadvantaged groups, and legal security of tenure. Independent of the definition, housing adequacy is closely associated with household housing consumption, which encompasses broader ranges of housing quality and quantity from the physical condition to housing tenure and investment.

While the definition of adequate housing itself has not received much scholarly attention, as housing adequacy is country-specific and highly contextualized, more research has been done on the link between housing adequacy and various societal outcomes. Existing research suggests that adequate housing is an important determinant of human well-being and other core development outcomes, such as educational achievements. In particular, many scholars have observed a relationship between poor housing and poor health, both for communicable and non-communicable diseases (see Ineichen, 2003 and Krieger and Higgins, 2002 for a review of relevant literature). Also evident is that poor housing is associated with lower educational achievement. For example, children in the United States who live in a crowded household at any time before the age

[1] In several countries, the right to adequate housing is enshrined in the national constitution. For example, the constitution of Bangladesh suggests a general responsibility of the State for ensuring adequate housing and living conditions for all.

of 19 are less likely to graduate from high school and tend to have lower educational attainment at age 25 (Lopoo and London, 2016).

The unequal distribution of adequate housing also has been a popular research topic; it has been discussed in two dimensions: household-level inequality and spatial inequality. The former refers to the difference in the level of housing adequacy by household economic status or ethnicity, whereas the latter addresses unequal access to adequate housing in relation to household residential locations. Most research on housing inequality in the United States and western contexts tends to separate these two dimensions and deal with homeownership attainment or home equity rather than the physical dimension of housing adequacy. Much research on household-level inequality has focused on homeownership disparities by race and ethnicity (for example, DeSilva and Elmelech, 2012), whereas other scholarly attention has been paid to housing adequacy among lower-income households and specific investigation of subsidized housing and homelessness (Shinn et al., 1998). Research on spatial inequality tends to focus a lot more on residential segregation at the neighborhood level rather than metropolitan inequality (for example, Charles, 2003; Charles, 2006; Iceland and Weinberg, 2002). Although limited, some studies have investigated how slums in developing countries emerge from unequal housing situations (for example, O'Hare, Abbott, and Barke, 1998).

Due to the importance of housing adequacy to household well-being mentioned earlier, housing inequality by household economic status has the potential to create equivalent health and social inequalities. With respect to the spatial dimension, the unequal distribution of adequate housing influences how households sort into metropolitan areas and neighborhoods, and in turn, contributes to socioeconomic inequality across and within metropolitan areas. At the macro level, a higher level of inequality has been linked to lower economic growth (Stiglitz, Sen, and Fitoussi, 2009). Glaeser, Resseger, and Tobio (2009) report that metropolitan-level income inequality is similarly associated with a lower growth of income and population, holding skills constant, in the United States. In addition, there is evidence that higher urban inequality is associated with higher crime rates and lower levels of happiness (Daly, Wilson, and Vasdev, 2001; Luttmer, 2005). At the more micro level, housing inequality between neighborhoods can lead to a concentration of poverty, thereby affecting children's outcomes negatively and exacerbating the degree of economic segregation (Jargowsky and Wheeler, 2017).

2.2. Potential Reasons for Housing Inequality

Housing adequacy refers typically to the quality of the dwelling and its location, including access to services. Both dimensions are two main determinants of housing prices in hedonic housing price regressions. It is, therefore, no surprise that the economic capacity of each household is an important determinant of the level of its housing adequacy, and economic inequality is the precondition of housing inequality. Spatial inequality of adequate housing is a geographic manifestation of household economic inequality as it happens by the sorting of households into metropolitan areas and neighborhoods based on their economic status. At the metropolitan area level, we would also expect that areas with higher income and wealth inequality among residents suffer from unequal distribution of adequate housing. Based on their analysis of the U.S. metropolitan areas, however, Glaeser, Resseger, and Tobio (2009) demonstrate that the extent of

unequal housing consumption is much lower than the level of income inequality. They suggest that the distribution of metropolitan housing prices may have a heterogeneous impact on households with different economic statuses.

Next, the residential sorting mentioned earlier has a dynamic relationship with the distribution of adequate housing. This distribution is influenced by spatial attributes such as urbanity and housing market attributes. Urbanity that can be measured by population size or population density is known to be an important predictor of housing demand and supply. On the one hand, the lack of adequate housing in rural areas has a strong association with scarce housing demand accompanied by lower population density and lower income. On the other hand, as population density rises, housing supply elasticity falls (Green, Malpezzi, and Mayo, 2005). In this regard, metropolitan areas with rapid urban growth are more likely to experience a shortage of adequate housing than rural areas, especially adequate housing for lower-income in-migrants. Depending on the extent of urban growth and supply elasticity, the distribution of affordable housing would also be unequal across and within metropolitan areas; in turn, it would aggravate the unequal access to adequate housing by household economic status in certain places.

Finally, other factors that could influence housing inequality include residential segregation driven by non-economic reasons and governmental actions. In the United States and other western contexts, many scholars have investigated racial and ethnic disparities in the level of household housing consumption (for example, Borjas, 2002; Faber and Ellen, 2016; Gabriel and Rosenthal, 2005; Krivo and Kaufman, 2004). Physical segregation by race and ethnicity has dynamically interacted with such disparities and contributed to spatial inequality of housing consumption in terms of quantity and quality. For example, the decay of housing stock is concentrated in certain U.S. city centers where African-American immigrants took up residence and where their presence increased over time through the process of hypersegregation (Andersen, 2019; Massey and Denton, 1993). Government policies that can affect housing inequality are not finite, ranging from general redistributive policies and financing measures to enhance household-level inequality to housing programs aiming to reduce spatial gaps in adequate housing. We discuss the outcomes of actual policies and cross-country lessons in section 4 in this article.

2.3. Contexts of Asian Developing Countries and the United States

In this study, we focus on housing inequality in cities in Asian developing countries while performing an analogous analysis in the United States and attempting to report similarities and differences in the patterns of housing inequality. Hence, it is useful to understand the differences between the two contexts. The first element to note is the general degree of housing adequacy is much lower in developing countries. Although several national constitutions of Asian countries recognize the right to housing,[2] UN Habitat (2016) estimates that around 560 million people lived in slums in Asia and the Pacific in 2014, which corresponds to about 30 percent of the population. Although the relative number of people living in slums has fallen in the region, the absolute number has risen by about 100 million since 1990 due to overall population growth.

[2] Armenia, Bangladesh, India, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, and Vietnam (Golay and Özden, 2007).

One of the most important factors that contribute to lower housing adequacy in developing countries is fast urbanization accompanied by the high pressure of housing demand. According to United Nations (2018), the average annual growth of urban populations between 1950 and 2018 was about 2.3 to 4.2 percent in developing countries, whereas the urbanization rate was only about 0.5 to 2.4 percent in developed countries. At the same time, housing supply in developing countries has not adequately responded to a fast increase in housing demand. Dasgupta, Lall, and Lozano-Gracia (2014) demonstrate that the economic status of countries is closely related with the elasticity of housing supply to urban growth. Based on the typology of housing investment patterns that they developed, they report that most developing countries belong to the "lagging" category where housing investment lags urbanization by up to 10 years, whereas many wealthy Organisation for Economic Co-operation on Development (OECD) countries fall in the "leading" category where housing investments occur ahead of the increase in housing demand.

There is no clear-cut relation between economic development and household economic inequality. Since Kuznets (1955) first proposed an inverted U-shaped relationship between income inequality and a country's aggregate income level, many studies have attempted to test this relationship. Although older empirical studies (for example, Anand and Kanbur, 1993) find support for Kuznets' curve, more recent evidence shows (for example, Frazer, 2006) that, when using a nonparametric regression approach, Kuznets' evidence wanes. Frazer (2006) also highlights that changes in economic inequality across countries that go through similar economic growth are significantly heterogenous. For example, although France and Italy have experienced significant and sizeable decreases in inequality as they have grown, the inequality has increased significantly in the United States and the United Kingdom.

With respect to spatial inequality and economic development, the similar inverted-U-shaped relationship is evidenced by Lessmann (2014). Although this relationship suggests that spatial inequality may increase at very high levels of economic development, absolute economic deprivation in certain areas is more substantial in developing countries. For example, in rural areas in India, many households still belong to scheduled castes and tribes and suffer from limited access to basic amenities and substandard living standards (Drèze and Sen, 2015; Kumar, 2015; Mohanan and Chakraborty, 2008; Srinivasan and Mohanty, 2004). In China, rising rural-urban income differentials caused by urban-biased policies and institutions are found to be the main driver of increasing overall inequality (Yang, 1999; Zhu and Wan, 2012). In contrast, although most U.S. cities have lower economics status than suburban areas, the majority of urban residents do not experience significant economic deprivation.

3. Data and Methods

3.1. Data

Our analysis focuses on housing inequality in Asian developing countries and the United States. For the analysis of Asian developing countries, we rely on the data from the Demographic and Health Survey (DHS) project, an ongoing collaboration between the United States Agency for International Development and country-specific agencies. One of their main tasks is to conduct household surveys in low- and middle-income countries (Corsi et al., 2012). The DHS data have

been collected based on a comparable sample of nationally representative households in more than 85 countries worldwide since 1984. Respondents selected in the DHS are representative for the entire country or regions of interest.[3] Key advantages of the DHS include the national coverage and high response rates that typically exceed 90 percent. In addition, the DHS questionnaire has been standardized and pre-tested to ensure comparability across populations and over time. Standard data collection procedures and interviewer training in the DHS ensure that its survey data are both reliable and comparable.

This study analyzes the following 10 developing countries in Asia as listed in exhibit 1: Bangladesh, Cambodia, India, Kyrgyzstan, Myanmar, Nepal, Pakistan, Philippines, Tajikistan, and Timor-Leste. We choose these countries as their DHS data are available after 2011 and they have longitude and latitude coordinate information that ensures spatial precision.[4] To explore spatial heterogeneity by population size, we categorize geographic boundaries into the following three types: rural areas, small cities, and large cities. The distinction between rural areas and cities follows the definition suggested by the Asian Development Bank (ADB, 2019). To develop a new database with a common definition of urban spaces across countries and over time, ADB (2019) defines the area by using satellite imagery combined with gridded population data. The benchmark for a city is a population of more than 100,000 in the year 2000.[5] The distinction between smaller cities and large cities is based on the population size. A city with more than 1 million is considered a large city herein. The cut-off of 1 million is often used to describe patterns of urbanization by many studies, including the United Nations (2018).[6]

Exhibit 1 displays the summary statistics for our DHS sample. The number of sample households is heterogeneous by countries and India has the largest sample size. Because the number of sample households is not necessarily proportional to the population size of each country, we apply the weight by population size for all of our analysis. The numbers of rural areas, small cities, and large cities depend on where our DHS sample respondents reside. Although the distribution of rural areas and small and large cities is heterogeneous, we find that the number of rural areas is largest in all countries in our sample. This number suggests the presence of a large rural population despite the rapid urbanization in developing countries.

[3] The DHS respondents are selected using a two-stage sampling process stratified by urban and rural location. In the first stage, primary sampling units (PSUs), also known as clusters, are selected from a frame list with probability proportional to a size measure. In the second stage, a fixed number of households are selected from a list of households in the selected PSUs. A cluster is usually a geographically constructed area or a part of an area called an enumeration area containing a number of households created from the most recent population census (Aliaga and Ren, 2006). The DHS also collects the GPS coordinate information in each cluster. For more details see Perez-Heydrich et al. (2013).

[4] We exclude Afghanistan, Indonesia, and Maldives as they do not have longitude and latitude coordinate data. Also, our sample does not include Kazakhstan, Sri Lanka, Thailand, and Uzbekistan as their last surveys were collected only in the early 2000s or before.

[5] For more information see Asian Development Bank (2019: 59).

[6] The United Nations (2018) reports that in 2018, 1.7 billion people representing 23 percent of the world's population lived in a city with at least 1 million inhabitants. The next common cut-offs are 5 million and 10 million, above which a city is labelled as "megacity" (United Nations, 2018).

Exhibit 1

Sample of Asian Developing Countries and Summary Statistics from the Demographic and Health Survey

Sample Country	(1) Sample Year	(2) Number of DHS Sample Households	(3) Number of Rural Areas	(4) Number of Small Cities	(5) Number of Large Cities	(6) Population Size
Bangladesh	2014	17,300	7	7	2	154,520,167
Cambodia	2014	15,825	19	2	2	15,274,503
India	2015	601,511	619	216	186	1,310,152,403
Kyrgyzstan	2012	8,040	7	3	2	5,607,200
Myanmar	2015	12,500	15	9	3	52,680,726
Nepal	2016	11,040	5	3	1	27,261,131
Pakistan	2017	14,540	8	4	5	207,896,686
Philippines	2017	27,497	17	14	5	105,173,264
Tajikistan	2017	7,843	5	3	2	8,880,268
Timor-Leste	2016	11,502	13	2	0	1,219,288

Note: Population sizes are shown for respective sample years.
Sources: Demographic Health Surveys (DHS), columns (1) and (2); Asian Development Bank (2019), columns (3)-(5); and World Bank (2019), column (6)

One of the most important pieces of information that the DHS data provide for our analysis of Asian developing countries is housing adequacy. DHS survey respondents provided detailed information on four dimensional criteria including: (1) structural quality or durability of dwellings, (2) sufficient living area, (3) access to improved water, and (4) access to improved sanitation.[7] In this study, we define adequate housing units as those that meet all of these four criteria. These criteria coincide with UN Habitat (2018), which defines inadequate housing as one in which the inhabitants suffer one or more of the following household deprivation criteria: lack of access to an improved water source, lack of access to improved sanitation facilities, lack of sufficient living area, lack of housing durability, and lack of security of tenure. One should note that we may apply more modest criteria to define adequate housing than the universal standard as we do not consider the security of tenure due to data unavailability.

Household wealth information is also critical to study the unequal distribution of adequate housing by household economic status. The DHS data provide the wealth index as a measurement of living standards of each household. Derived by the U.S. Agency for International Development, the wealth index is based on principal component analysis from indicators of households' various asset

[7] First, structural quality is measured by roof materials. A house or housing unit is considered to be structurally qualified if its roof is made of finished materials: cement or concrete, ceramic or clay tiles, burnt bricks, cement blocks, wood, roof shingles, metal (zinc, galvanized iron, or aluminum) sheets, asbestos sheets, slates, and so on. Second, a house or housing unit is considered sufficiently spacious if not more than three people share a sleeping room. Third, a house or housing unit is considered to have adequate access to improved water if the main source of drinking water for household members is from piped water, a protected dug well, protected spring water, or bottled water. Lastly, accessibility to improved sanitation is based on whether a house or housing unit owns a flush toilet or ventilated improved pit, and whether a toilet is not shared with more than two other households. Related questions and their response alternatives for each criterion are described in appendix A.

ownership and housing characteristics that are related to wealth status and living standards (Filmer and Pritchett, 2001). The total asset scores are standardized so that they have a standard normal distribution with a mean of zero and a standard deviation of one. The validity of this approach is tested by Montgomery et al. (2000) and Rutstein and Staveteig (2014). The advantage of using wealth over income is that the former, as a stock of income, is suitable as an indicator reflecting the long-term living standards of households. In addition, wealth is less susceptible to temporary economic shocks and seasonal events such as drought, which is important for the analysis of developing countries where agriculture is the main industry. All respondents in our sample are classified into one of the five quintile levels of wealth in respective rural areas and cities. For an economic inequality measure among households, we use a standard deviation of wealth index in each rural area and city.

After the comprehensive analysis of housing inequality in Asian developing countries based on DHS, we attempt to compare it with patterns of housing inequality in the United States. To do so, we rely mainly on the American Housing Survey (AHS) that offers in-depth information of both housing adequacy and household economic status at the metropolitan area level. The AHS classifies each sample unit into three degrees of housing adequacy: "severely inadequate," "moderately inadequate," and "adequate." Units are classified as "severely inadequate" based on conditions of plumbing, heating, electricity, wiring, and upkeep and as "moderately inadequate" based on upkeep and other factors such as toilet, heating, or kitchen issues.[8] The standard of housing adequacy clearly differs between DHS and AHS samples.[9] We claim, however, that this should not be a major concern because our research focus is on the distribution of adequate housing within each sample rather than comparing housing adequacy itself across the sample. To analyze spatial heterogeneity in housing inequality, we follow the AHS 2013 Metropolitan Statistical Areas (MSA) that classify central cities, non-central cities, and non-metropolitan areas.[10] If we compare their

[8] Units are classified as "severely inadequate" if at least one of the following conditions is met: *(1) plumbing* (lacking hot or cold piped water, lacking a full bathroom, or sharing a bathroom with non-household members), *(2) heating* (having been uncomfortably cold last winter for 24 hours or more because the heating equipment broke down, and it broke down at least three times last winter for at least 6 hours each time), *(3) electricity* (having no electricity), *(4) wiring* (having all of the following electric problems: exposed wiring, a room with no working wall outlet, and three blown fuses or tripped circuit breakers in the last 3 months), *(5) upkeep* (having at least five of the following six maintenance problems: (a) water leaks from the outside in the last 12 months, such as from the roof, basement, windows, or doors; (b) leaks from inside structure in the last 12 months, such as pipes or plumbing fixtures; (c) holes in the floors; (d) holes or open cracks (wider than a dime) in the walls or ceilings; (e) more than 8 by 11 inches of peeling paint or broken plaster; or (f) signs of rats in the last 12 months. Units are classified as "moderately inadequate" if at least one of the following conditions is met: *(1) upkeep* (having only three or four of the six problems listed under "severely inadequate—upkeep"), *(2) other* (having any one of the following conditions: (a) on at least three occasions during the last 3 months, all the flush toilets were broken down at the same time for 6 hours or more; (b) having unvented gas, oil, or kerosene heaters as the main heating equipment; (c) lacking a kitchen sink, lacking a working refrigerator, lacking cooking equipment (stove, burners, or microwave oven), or sharing the kitchen with non-household members.

[9] For example, the AHS does not consider sufficient living area whereas the DHS focuses on structural components rather than detailed housing quality such as plumbing, heating, electricity, and upkeep.

[10] Metropolitan areas are composed of whole counties that have significant levels of commuting and contiguous urban areas in common. Non-metropolitan areas include micropolitan statistical areas that are smaller than MSAs and rural areas. Most MSAs have at least one central city. Also, any city with at least 250,000 population or at least 100,000 people working within its corporate limits qualify as a central city. Some smaller cities are identified as central cities based on the commuting requirements and relative size to the MSA's largest city. For more information, see https://www2.census.gov/programs-surveys/ahs/2013/2013%20AHS%20Definitions.pdf.

population size with that of the DHS sample, some central cities fall into the category of smaller cities. As we focus on six major MSAs and their main central cities including Boston, New York, Philadelphia, Seattle, Dallas, and San Francisco, however, the population sizes of these cities are large enough to be comparable with large cities in the DHS sample.[11]

Finally, to account for local housing market circumstances in Asian developing countries, we use the city-level price-to-income ratio (PIR) from Helble, Lee, and Arbo (2020), which provide PIR estimates for 211 cities in 27 countries for the year of 2018.[12] They collect housing prices from Numbeo,[13] which is supposedly the world's largest database on housing prices based on information provided by private contributors and includes housing prices per square meter. The city-level household income data are estimated using household income and expenditure surveys (HIES) from four developing countries in Asia, of which three are included in our sample, namely India, Pakistan, and the Philippines. For countries without HIES, the authors use the World Bank's Povcal data on national monthly household per capita income and expenditure and derive city-level household income data by exploiting the fact that household income is a function of city size. In this article, we assume that the average housing size is 50 m^2 based on United Nations' statistics (2000) and use the average household income and housing prices for the non-city center.[14]

3.2. Methods

We first investigate the extent of housing adequacy by population size and by household wealth quintiles for each country. Then, we explore the relationship between household wealth distribution and housing adequacy. To visualize this relationship and quantify household-level housing inequality for cross-country comparisons, we attempt to plot the concentration curve and calculate the household wealth-based concentration index. The concentration curve plots the cumulative percentage of the outcome variable against the cumulative percentage of the population ranked from poorest to richest (Kakwani, Wagstaff, and van Doorslaer, 1997; O'Donnell et al., 2008). The concentration index corresponds to twice the area between the concentration curve and the perfect equality 45-degree line (Kakwani, Wagstaff, and van Doorslaer, 1997; O'Donnell et al., 2008). The concentration index ranges from -1 to +1. If an outcome variable is equally distributed across wealth levels, then the concentration curve coincides with the 45-degree line and the index becomes 0. If, for example, the concentration index is positive, then it means adequate housing is more concentrated among the rich. The concentration index can be calculated simply by the following formula:

[11] Among the AHS 15 metropolitan areas, we chose these six areas based on the extent of housing inadequacy (high vs. low) and population size. See exhibit 10 for the summary statistics.

[12] We acknowledge that DHS sample years differ from 2018. If PIRs have not changed very rapidly within 1 to 6 years in DHS sample cities, this would not critically affect our regression results. If PIRs have increased significantly in these cities, we may underestimate the role of PIRs.

[13] https://www.numbeo.com/cost-of-living/.

[14] According to the United Nations (2000), the floor area per person in 64 percent of cities in less developed regions ranges from 5 to 14 m2. We believe that the average income is a better measure for cities with high economic inequality. Numbeo inputs are divided into city centers and non-city centers. As city center inputs tend to be extremely high prices concentrated in the most prime area within a city, we believe that average housing prices should be closer to non-city center inputs.

$$CI = \frac{2}{\mu} cov(y_i, r_i)$$

Where y_i is the outcome variable for household i, r_i is the fractional ranking of individuals according to the wealth, and μ is the mean of y_i. The value of this index falls between -1 and +1. In essence, the concentration index (CI) measures the correlation between an outcome variable and the wealth rank. The higher the absolute value of the CI is, the greater the extent of inequality. It is known, however, that the range of the CI becomes smaller when the variable of interest is a binary indicator because the lower and the upper bounds of the CI depend on the mean of the outcome variable (Wagstaff, 2005). Erreygers (2009) suggests alternative normalization of the concentration index, which is defined by $EI=4\mu CI$. In this article, we report the normalized concentration index unless otherwise indicated.

Next, we perform regression analyses to account for the direct relationship between household wealth level and their housing adequacy with a focus on the role of spatial attributes in this relationship. These attributes include population size, economic inequality, and housing affordability. For example, we consider the spatial heterogeneity by population sizes as follows:

$$Y_{ick} = \beta_0 + \sum_{q=2}^{5} \beta_q W_{qic} + \gamma_1 Large_c + \gamma_2 Small_c + \sum_{q=2}^{5} \gamma_{q1} W_{qic} * Large_c + \sum_{q=2}^{5} \gamma_{q2} W_{qic} * Small_c + \alpha_k + u_{ick},$$

where Y_{ick} is the binary variable of adequate housing and it equals 1 if a household i in area c in country k lives in an adequate house; W_{qic} is a q_{th} wealth quintile dummy variable in area c; $Large_c$ and $Small_c$ are large and small city dummy variables, respectively. Lastly, α_k denotes a country fixed effect and u_{ick} is an error term. The coefficients of the interaction terms capture the heterogeneous association between wealth and housing adequacy across areas with different population sizes. We calculate the robust standard errors at the cluster level to enable the dependence of observations within clusters that are much smaller geographic areas than rural areas and cities.[15]

In addition, we use two other specifications. One includes $s.d.(wealth)_c$ in area c, which is a standard deviation of W_{qic}, and the interactions terms of $s.d.(wealth)_c$ and W_{qic}. The other includes PIR_c, a price-to-income ratio in area c, and the interactions terms of PIR_c and W_{qic}. Finally, we regress the area-level concentration index, CI_{ck}, on the above three spatial attributes in area c, including population size ($Large_c$ *and* $Small_c$), economic inequality ($s.d.(wealth)_c$), and housing affordability (PIR_c) as follows:

$$CI_{ck} = \beta_0 + \beta_1 s.d.(wealth)_c + \beta_2 Large_c + \beta_3 Small_c + \beta_4 PIR_c + \alpha_k + u_{ick},$$

where CI_{ck} stands for the concentration index in area c in country k.

[15] In each city or rural area, there are 10 to 50 clusters.

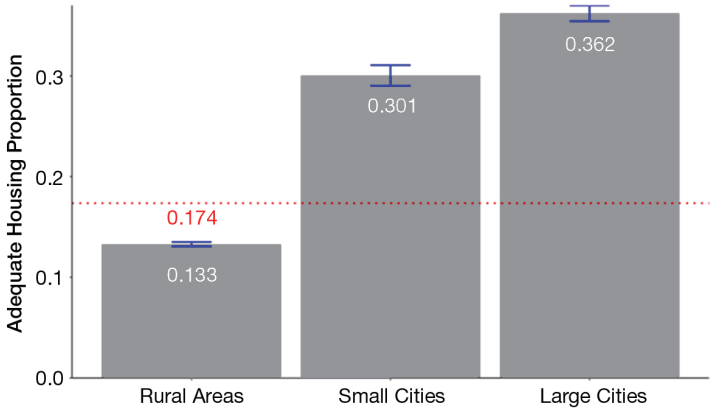
4. Results

4.1. Urban-Rural Housing Inequality in Asian Developing Countries

First, we investigate the extent of housing adequacy in urban and rural areas based on our Demographic and Health Survey sample of 10 developing countries in Asia. Exhibit 2 plots the share of adequate housing by population size with the 95-percent confidence interval. It vividly illustrates that urban areas offer better housing quality than rural areas in developing countries. While 30.1 percent and 36.2 percent of households live in adequate housing in small and large cities, respectively, only 13.3 percent of households reside in adequate housing in rural areas in developing countries. Such unequal access to adequate housing between urban and rural areas could potentially lead to urban-rural inequality in other dimensions, such as household health outcomes, life quality and satisfaction, and economic status (Howden-Chapman, 2004; Keall et al., 2010; Krieger and Higgins, 2002).

Exhibit 2

Heterogeneity in the Share of Adequate Housing by Population Size



Source: Calculations based on Demographic and Health Survey data

Next, to see how physical and economic differences can be related with the urban-rural inequality in housing adequacy, we perform cross-country comparisons. Exhibit 3 confirms that the share of adequate housing in rural areas is significantly lower than that in small and large cities in all countries, although the degree of the urban-rural gap differs between countries. Although it is unsurprising that population density in cities is much higher than that in rural areas, it is notable that the global human footprint index[16] in large cities is almost twice larger than that in rural areas in most Asian developing countries. With respect to global cell production,[17] Kyrgyzstan and the

[16] Global human footprint index is a composite measurement of the human influence index created from nine global data layers covering human population pressure (population density), human land use and infrastructure (built-up areas, nighttime lights, land use or land cover), and human access (coastlines, roads, railroads, navigable rivers). It ranges from 0 (least urban) to 100 (most urban).

[17] Gross cell production measures a regional economic activity level, which is measured in purchasing power parities (PPP) adjusted to U.S. dollars (USD). The conceptual basis of gross cell production is equivalent to that of the gross domestic product (GDP), except that the geographic unit is measured at a 1-degree longitude by 1-degree latitude resolution on a global scale.

Philippines are two countries that show substantial urban-rural differences. These results indicate that heterogeneity in the degree of urban development and productivity-driven economic status could be important drivers of urban-rural housing inequality in Asian developing countries.

Exhibit 3

Cross-Country Comparisons of Urban-Rural Inequality in Housing Adequacy

Country	Area Type	Proportion of Adequate Housing	95% Confidence Interval	Population Density	Global Human Footprint Index	Global Cell Production
Bangladesh	Rural areas	0.008	(0.010, 0.007)	1,350.8	43.4	1,213.0
	Small cities	0.048	(0.058, 0.037)	3,477.2	74.9	1,229.3
	Large cities	0.191	(0.209, 0.174)	27,670.6	79.5	1,101.7
Cambodia	Rural areas	0.100	(0.104, 0.095)	442.4	38.6	1,528.8
	Small cities	0.537	(0.622, 0.452)	2,786.3	68.4	1,569.8
	Large cities	0.595	(0.628, 0.563)	13,776.0	68.9	1,356.9
India	Rural areas	0.129	(0.130, 0.128)	671.7	41.2	2,198.4
	Small cities	0.331	(0.335, 0.326)	1,328.0	68.1	2,521.4
	Large cities	0.364	(0.368, 0.361)	7,748.5	73.4	2,836.7
Kyrgyzstan	Rural areas	0.084	(0.092, 0.077)	109.3	39.7	1,695.9
	Small cities	0.217	(0.242, 0.193)	2,717.2	60.7	1,604.3
	Large cities	0.385	(0.412, 0.357)	5,336.0	64.9	2,444.9
Myanmar	Rural areas	0.125	(0.131, 0.119)	189.3	35.4	-†
	Small cities	0.312	(0.356, 0.269)	448.9	68.7	-†
	Large cities	0.350	(0.382, 0.318)	11,231.2	80.1	-†
Nepal	Rural areas	0.229	(0.237, 0.221)	552.6	36.8	998.0
	Small cities	0.365	(0.414, 0.316)	3,686.3	65.1	905.4
	Large cities	0.441	(0.484, 0.398)	21,032.0	71.2	1,000.2
Pakistan	Rural areas	0.075	(0.081, 0.069)	-	-	-
	Small cities	0.106	(0.130, 0.082)	-	-	-
	Large cities	0.295	(0.309, 0.280)	-	-	-
Philippines	Rural areas	0.441	(0.448, 0.435)	935.3	37.9	2,267.9
	Small cities	0.593	(0.614, 0.571)	4,542.6	64.3	2,288.2
	Large cities	0.632	(0.647, 0.617)	15,663.5	78.0	4,990.5
Tajikistan	Rural areas	0.090	(0.098, 0.082)	283.5	45.2	1,475.3
	Small cities	0.377	(0.412, 0.343)	1,032.6	65.1	1,661.0
	Large cities	0.593	(0.614, 0.572)	6,254.5	76.7	1,554.4
Timor-Leste	Rural areas	0.195	(0.202, 0.187)	165.3	26.4	204.9
	Small cities	0.559	(0.589, 0.529)	4,240.6	57.9	27.4

† The DHS data of global cell production in Myanmar report null in more than 70 percent of all clusters. We suspect that the average of area-level values is not reliable and thus it is not shown here.

Note: Population density, global human footprint index, and global cell production are the averages of area-level values.

Source: Calculations based on Demographic and Health Survey data

4.2. Housing Inequality by Household Wealth in Asian Developing Countries

First, we analyze the general pattern of housing inequality by household economic status in Asian developing countries. Exhibit 4 shows the share of adequate housing across household wealth quintiles at the national level based on our DHS sample.[18] The tendency that wealthier households reside in adequate housing is significantly higher across all countries, indicating the strong inequality in housing adequacy by household wealth. The probability that households in the first wealth quintile reside in adequate housing is close to zero except in Nepal and the Philippines; this raises a serious concern on housing inadequacy for very low-income households in developing Asia. Moreover, only less than 10 percent of households up to the third quintile have access to adequate housing in most countries, suggesting that the housing inadequacy issue is prevalent not only to low-income households but also to middle-class households.

Exhibit 4

Housing Adequacy across Household Wealth Quintiles (1 of 2)

Country	Wealth Quintile	Proportion of Adequate Housing	95% Confidence Interval	Mean Wealth Index
Bangladesh	1st	0	(0.000, 0.000)	-9.853
	2nd	0.001	(0.002, 0.000)	-7.093
	3rd	0.001	(0.002, 0.000)	-3.476
	4th	0.007	(0.010, 0.005)	3.528
	5th	0.193	(0.206, 0.180)	16.296
Cambodia	1st	0.001	(0.003, 0.000)	-10.851
	2nd	0.003	(0.005, 0.001)	-7.082
	3rd	0.021	(0.026, 0.016)	-3.392
	4th	0.131	(0.143, 0.119)	1.9
	5th	0.546	(0.562, 0.531)	14.521
India	1st	0.002	(0.003, 0.002)	-12.953
	2nd	0.021	(0.022, 0.021)	-5.929
	3rd	0.095	(0.097, 0.094)	0.598
	4th	0.277	(0.279, 0.274)	7.229
	5th	0.589	(0.592, 0.586)	15.159
Kyrgyzstan	1st	0.021	(0.028, 0.014)	-5.821
	2nd	0.039	(0.048, 0.029)	-4.271
	3rd	0.036	(0.045, 0.027)	-3.535
	4th	0.109	(0.124, 0.094)	0.036
	5th	0.483	(0.506, 0.460)	11.403

[18] We also look at housing inequality by household wealth with respect to four dimensions of adequate housing in each country. We find a clear pattern that wealthier households enjoy better housing conditions. Results are not shown but available upon request.

Exhibit 4

Housing Adequacy across Household Wealth Quintiles (2 of 2)

Country	Wealth Quintile	Proportion of Adequate Housing	95% Confidence Interval	Mean Wealth Index
Myanmar	1st	0.007	(0.010, 0.003)	-12.201
	2nd	0.038	(0.045, 0.030)	-6.027
	3rd	0.097	(0.109, 0.085)	-0.764
	4th	0.187	(0.202, 0.171)	5.46
	5th	0.489	(0.509, 0.468)	16.121
Nepal	1st	0.155	(0.169, 0.141)	-10.898
	2nd	0.238	(0.255, 0.220)	-5.837
	3rd	0.174	(0.190, 0.158)	-0.579
	4th	0.19	(0.207, 0.174)	6.557
	5th	0.492	(0.515, 0.469)	16.923
Pakistan	1st	0.005	(0.008, 0.002)	-14.109
	2nd	0.052	(0.061, 0.043)	-6.646
	3rd	0.115	(0.129, 0.102)	0.398
	4th	0.173	(0.189, 0.158)	6.391
	5th	0.306	(0.323, 0.288)	13.568
Philippines	1st	0.121	(0.128, 0.114)	-11.864
	2nd	0.317	(0.329, 0.306)	-3.844
	3rd	0.532	(0.545, 0.518)	2.177
	4th	0.736	(0.748, 0.723)	8.378
	5th	0.87	(0.880, 0.859)	16.607
Tajikistan	1st	0.024	(0.032, 0.017)	-10.507
	2nd	0.039	(0.051, 0.028)	-7.426
	3rd	0.047	(0.060, 0.035)	-4.792
	4th	0.09	(0.106, 0.075)	-1.302
	5th	0.649	(0.666, 0.632)	9.822
Timor-Leste	1st	0.006	(0.009, 0.003)	-10.831
	2nd	0.103	(0.115, 0.091)	-6.006
	3rd	0.252	(0.269, 0.234)	-1.243
	4th	0.391	(0.411, 0.370)	5.919
	5th	0.637	(0.659, 0.615)	18.183

Notes: Wealth quintiles are defined as country-level quintiles. Wealth inequality is measured by the country-level standard deviation of wealth index.
Source: Calculations based on Demographic and Health Survey data

Second, we further look into heterogeneity in the degree of household-level housing inequality across developing countries with different economic inequality. Exhibit 5 shows the household wealth-based concentration index of housing adequacy along with the standard deviation of wealth

index based on our DHS sample. Among the five countries with the highest wealth inequality, India, the Philippines, and Timor-Leste also display concentration indices close to or over 0.5, meaning that the degree of concentration of adequate housing among wealthier households is very high. For example, there is a more than 60-percentage-point gap in housing adequacy between households in the lowest and highest wealth quintiles in the Philippines. Exhibit 6 consistently shows that corresponding concentration curves are positive and are all significantly far from zero; those concentration curves confirm that adequate housing is more concentrated among wealthy households.[19] Although exhibits 5 and 6 do not show a clear linear pattern between the concentration index and wealth inequality, our regressions further investigate this later.

Exhibit 5

Household Wealth-Based Concentration Index of Adequate Housing

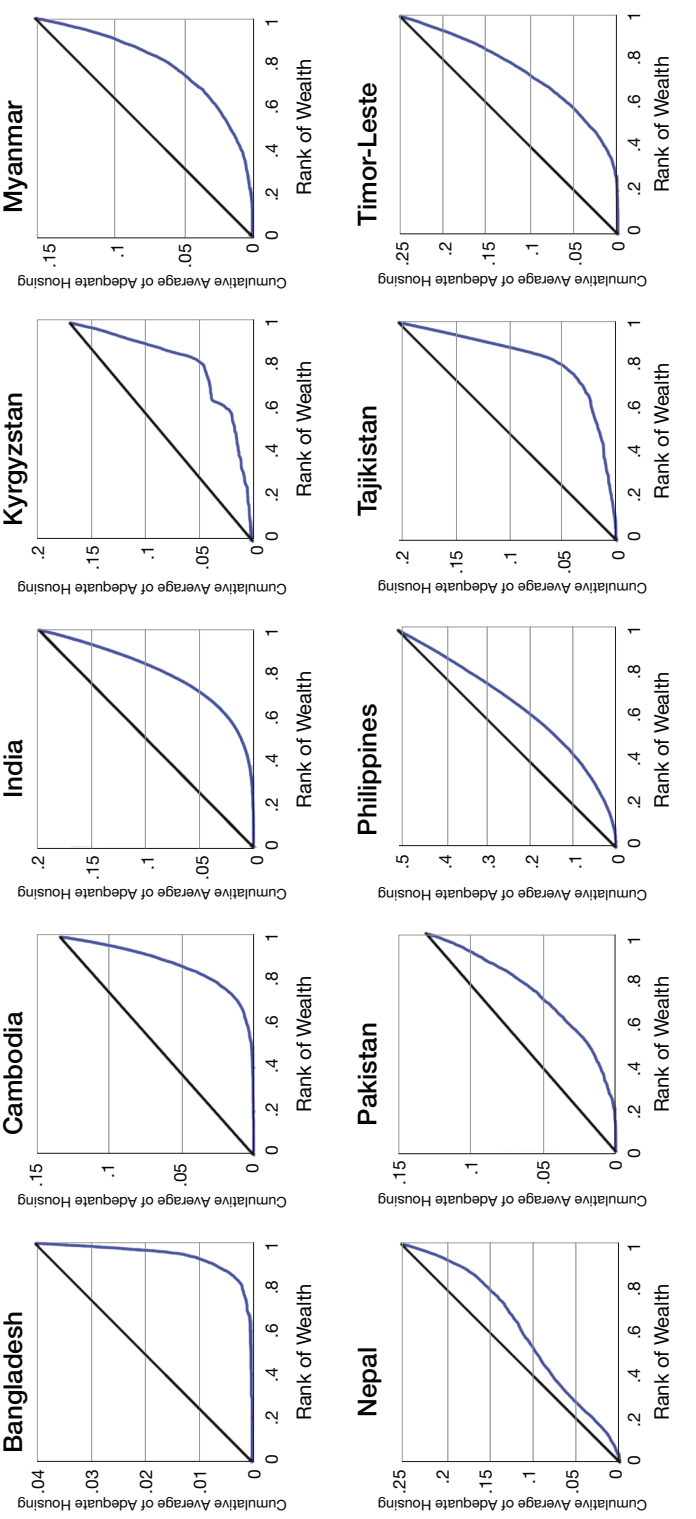
	Concentration Index	Standard Error	Wealth Inequality
Bangladesh	0.142	0.003	9.810
Cambodia	0.400	0.005	9.121
India	0.480	0.001	10.117
Kyrgyzstan	0.415	0.008	7.194
Myanmar	0.369	0.007	10.076
Nepal	0.232	0.009	10.174
Pakistan	0.242	0.007	9.921
Philippines	0.637	0.006	10.024
Tajikistan	0.538	0.009	8.096
Timor-Leste	0.500	0.008	10.255

Note: Wealth inequality is measure by the standard deviation of wealth index at the country level.
Source: Calculations based on Demographic and Health Survey data

[19] Although the panel of Bangladesh in exhibit 6 gives the impression that housing inequality by household wealth is larger than other countries, Bangladesh has the smallest concentration index value among all the 10 countries; this discrepancy is because the absolute difference between rich and poor groups is smaller in Bangladesh than that in other countries.

Exhibit 6

Concentration Curve by Country



Source: Calculations based on Demographic and Health Survey data

4.3. Spatial Heterogeneity in Household-Level Housing Inequality in Asian Developing Countries

We now move to investigate spatial heterogeneity in household housing inequality by household wealth. In the previous section, we observe that households in cities in Asian developing countries are more likely to live in adequate housing, compared with those in rural areas. This finding does not necessarily mean that adequate housing is equally distributed among households with different economic status within cities, however. Asian developing countries have experienced rapid urbanization and economic growth, and many cities in these countries have suffered from issues like housing unaffordability and economic inequality. For example, as a recent report by the Asian Development Bank (ADB, 2019) shows, the price-to-income ratio (PIR) of cities in developing Asia is 15.8 and thus substantially higher compared with the United States.

Exhibit 7 reports the household wealth-based concentration index of adequate housing by population size for our DHS sample of 10 developing countries along with area-level household wealth inequality. We observe that in most countries the values of concentration index in cities are significantly larger than that in rural areas, implying higher household-level housing inequality in cities. Hence, if these households have relatively lower economic status within cities, they are less likely to have access to adequate housing compared with those that have similarly lower economic status within rural areas. Also, this finding does not suggest that richer households in rural areas would have access to adequate housing in urban areas because our concentration index measures the degree of dependence between housing adequacy and the relative wealth rank among respective rural areas, small cities, and large cities. With respect to household wealth inequality, cities do appear to be more unequal than rural areas in Asian developing countries. Therefore, the urban-rural heterogeneity in household-level wealth inequality is less likely to be the main driver of the significant urban-rural gap in housing adequacy presented in the previous section.

Exhibit 7

Household Wealth-Based Concentration Index of Adequate Housing by Population Size (1 of 2)

Country	Area type	Concentration Index	Standard Error	Wealth Inequality (s.d. wealth index)
Bangladesh	Rural areas	0.029	0.002	7.324
	Small cities	0.156	0.011	10.282
	Large cities	0.497	0.017	8.725
Cambodia	Rural areas	0.304	0.005	7.722
	Small cities	0.535	0.088	7.767
	Large cities	0.590	0.033	7.353
India	Rural areas	0.347	0.001	9.272
	Small cities	0.562	0.004	8.764
	Large cities	0.592	0.003	8.345
Kyrgyzstan	Rural areas	0.212	0.008	4.860
	Small cities	0.526	0.024	7.468
	Large cities	0.514	0.029	6.853

Exhibit 7

Household Wealth-Based Concentration Index of Adequate Housing by Population Size (2 of 2)

Country	Area type	Concentration Index	Standard Error	Wealth Inequality (s.d. wealth index)
Myanmar	Rural areas	0.292	0.007	8.877
	Small cities	0.553	0.044	10.845
	Large cities	0.583	0.032	8.439
Nepal	Rural areas	0.161	0.010	9.095
	Small cities	0.479	0.052	7.716
	Large cities	0.580	0.044	6.380
Pakistan	Rural areas	0.140	0.007	9.141
	Small cities	0.120	0.028	7.963
	Large cities	0.254	0.017	6.756
Philippines	Rural areas	0.629	0.007	9.600
	Small cities	0.634	0.021	9.371
	Large cities	0.551	0.015	7.818
Tajikistan	Rural areas	0.216	0.009	5.627
	Small cities	0.806	0.028	7.722
	Large cities	0.765	0.018	8.971
Timor-Leste	Rural areas	0.403	0.008	8.448
	Small cities	0.427	0.033	8.455

s.d. = standard deviation
Note: We measured wealth inequality by calculating the standard deviations of wealth index at the level of each rural area and city and taking their average.
Source: Calculations based on Demographic Health and Survey data

Exhibit 8 reports results of the household-level regressions of housing adequacy with three main spatial attributes—including population size, economic inequality, and housing affordability—as well as their interaction terms with household wealth. It first shows that both large city and small city dummy variables display positive associations with housing adequacy, implying that households in cities are more likely to live in adequate housing than those in rural areas (column 2). When the interaction terms between wealth quintiles and area dummy variables are added, the result shows that all the interaction terms exhibit positive signs with larger coefficients for higher quintiles (column 3). These positive signs indicate that adequate housing is more prevalent among wealthier households in larger cities, compared with rural areas. Alternatively, they suggest that the association between adequate housing and living in cities is stronger for wealthier households.

Exhibit 8 also reports the important role of wealth inequality and housing affordability to housing inequality. We find a significant negative association between the probability of residing in adequate housing and wealth inequality in a given area (column 4). With respect to interaction terms, the result suggests that the negative association is significantly stronger for households belonging to the second and third wealth quintile levels (column 4). Hence, the probability that lower- and middle-income households have access to adequate housing becomes lower if they

reside in areas with higher wealth inequality. On the contrary, the positive association is observed among households belonging to the top wealth quintile level, suggesting that the access to adequate housing increases for wealthier households if the area of their residence becomes more unequal in terms of household wealth. Then, exhibit 8 indicates that the PIR in a given area has a negative association with the probability that residents have the access to adequate housing (column 5). It also reveals that the association with the PIR is negative and more significant for lower wealth quintiles, thus implying that the access to adequate housing is affected more negatively by housing unaffordability for lower-income households.

Exhibit 8

Household-Level Regression of Housing Adequacy (1 of 2)

	(1)	(2)	(3)	(4)	(5)
Wealth 2nd quintile	0.0551***	0.0548***	0.0330***	0.134***	0.148***
	(0.00185)	(0.00191)	(0.00136)	(0.0127)	(0.0232)
Wealth 3rd quintile	0.118***	0.117***	0.0707***	0.217***	0.299***
	(0.00263)	(0.00250)	(0.00183)	(0.0177)	(0.0278)
Wealth 4th quintile	0.208***	0.206***	0.135***	0.245***	0.424***
	(0.00341)	(0.00317)	(0.00239)	(0.0231)	(0.0307)
Wealth 5th quintile	0.379***	0.377***	0.302***	0.245***	0.574***
	(0.00414)	(0.00379)	(0.00366)	(0.0284)	(0.0285)
Large city		0.233***	0.0771***		
		(0.00590)	(0.00519)		
Small city		0.199***	0.0698***		
		(0.00682)	(0.00602)		
wealth q2*Large city			0.0755***		
			(0.00675)		
wealth q3*Large city			0.169***		
			(0.00888)		
wealth q4*Large city			0.255***		
			(0.0104)		
wealth q5*Large city			0.277***		
			(0.0105)		
sd(wealth)				-0.0412***	
				(0.00152)	
wealth q2*sd(wealth)				-0.0102***	
				(0.00155)	
wealth q3*sd(wealth)				-0.0129***	
				(0.00215)	
wealth q4*sd(wealth)				-0.00489*	
				(0.00286)	
wealth q5*sd(wealth)				0.0174***	
				(0.00354)	

Exhibit 8

Household-Level Regression of Housing Adequacy (2 of 2)

	(1)	(2)	(3)	(4)	(5)
PIR					-0.00879***
					(0.00110)
wealth q2*PIR					-0.00243
					(0.00165)
wealth q3*PIR					-0.00389*
					(0.00205)
wealth q4*PIR					-0.00231
					(0.00250)
wealth q5*PIR					0.000956
					(0.00201)
Observations	724,924	724,924	724,924	724,924	35,895
r2	0.136	0.200	0.212	0.151	0.227
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Wealth quintiles* small city	No	No	Yes	No	No

PIR = price-to-income ratio.
** p < 0.1, ** p < 0.05, *** p < 0.01*
Notes: Standard errors are in parentheses and cluster-robust to heteroscedasticity.
Including the city-level PIR reduces the number of observations dramatically as we have the PIR only for selected small and large cities.
Source: Calculations based on Demographic and Health Survey data

Lastly, exhibit 9 reports the results of the area-level regressions of household wealth-based concentration index, in which all independent variables are measured in the level of rural areas and cities. We first observe a significant positive unconditional correlation between the size of concentration index and wealth inequality (column 1). Even when adding country fixed effects (column 2), the significance of wealth inequality does not change. Hence, the result confirms that areas with higher wealth inequality have a higher concentration of adequate housing among wealthier households. Column 3 indicates that housing inequality by household wealth is more significant in cities than in rural areas, which is again consistent with the previous finding that population size is a strong predictor of the degree of concentration of adequate housing among wealthier households. When we additionally control for PIR, we still observe a significant, positive association between the size of concentration index and wealth inequality (column 4) whereas the added role of PIR appears to be negative but insignificant. Across all specifications presented in exhibit 5, therefore, wealth inequality between households is the most significant predictor of housing inequality in Asian developing countries.

Exhibit 9

Area-Level Regressions of Household Wealth-Based Concentration Index

	(1)	(2)	(3)	(4)
sd(wealth)	0.0176***	0.0136***	0.0161***	0.0421***
	(0.00449)	(0.00477)	(0.00460)	(0.0120)
Large city			0.167***	-0.00671
			(0.0151)	(0.0405)
Small city			0.146***	
			(0.0145)	
PIR				-0.000842
				(0.00249)
Cambodia		0.170***	0.228***	-
		(0.0593)	(0.0517)	-
India		0.170***	0.197***	0.247**
		(0.0493)	(0.0413)	(0.101)
Kyrgyzstan		0.115	0.147*	0.369**
		(0.0879)	(0.0777)	(0.172)
Myanmar		0.182***	0.200***	0.366***
		(0.0580)	(0.0519)	(0.0929)
Nepal		0.123	0.141*	0.398***
		(0.0897)	(0.0731)	(0.103)
Pakistan		0.0776	0.0737	0.0959
		(0.0609)	(0.0558)	(0.108)
Philippines		0.390***	0.394***	0.263***
		(0.0552)	(0.0513)	(0.0985)
Tajikistan		0.223**	0.237***	-
		(0.0944)	(0.0807)	-
Timor-Leste		0.241***	0.305***	0.163*
		(0.0569)	(0.0511)	(0.0936)
Observations	1162	1162	1162	84
r2	0.0139	0.0640	0.200	0.208

PIR = price-to-income ratio.
** p < 0.1, ** p < 0.05, *** p < 0.01*
Notes: Standard errors are in parentheses and cluster-robust to heteroscedasticity.
In column 4, as the PIR is not available in rural areas, small city is dropped to avoid multi-collinearity.
Including the PIR reduces the number of observations dramatically as we have the PIR only for selected cities. We have no PIR data for Cambodia.
Source: Calculations based on the Demographic and Health Survey data

4.4. Housing Inequality in the United States

So far, we have suggested that cities in developing countries have a higher level of housing adequacy than rural areas whereas these cities suffer from higher housing inequality by household wealth. In this section, we attempt to see whether the United States experiences similar patterns of housing inequality based on our AHS sample. We first look into spatial inequality in housing adequacy, which was significant in Asian developing countries. Exhibit 10 shows that U.S. central cities do not have a strong advantage for housing adequacy. Their share of adequate housing is only slightly higher than non-metropolitan areas and lower than non-central cities. This is inconsistent

with our previous finding on the positive relationship between population size and the level of housing adequacy, based on our DHS sample.

Exhibit 10 continues to suggest that, although the share of adequate housing is much higher compared to that from our DHS sample, more than 10 percent of households reside in inadequate housing in some U.S. metropolitan areas such as New York and Boston. Results also report a significant heterogeneity in housing adequacy across U.S. metropolitan areas. For example, residents in Boston have an 8-percent higher probability of residing in inadequate housing than those in Seattle. Housing adequacy and population size in selected cities in our AHS sample do not seem to have a distinct, linear pattern. What is distinct among cities with a lower level of housing adequacy is higher poverty rates. For example, the median household income is higher, but poverty rates are also higher in Boston than in Dallas, and Boston shows a larger population residing in inadequate housing than Dallas. This finding implies that income inequality and other factors may be more related to the distribution of adequate housing.

Exhibit 10

Spatial Inequality in Housing Adequacy in the United States

	All Metropolitan Areas		Non-Metropolitan Areas	Central City in Selected Metropolitan Areas					
	Central City	Non-Central City		Boston	New York	Philadelphia	Seattle	Dallas	San Francisco
Share of Adequate Housing (%)	94.33	96.05	93.45	88.25	89.97	90.60	96.40	95.02	94.01
City Population Size				694,583	8,398,748	1,584,138	744,955	1,345,047	883,305
MSA Population Size				4,875,390	19,979,477	6,096,372	3,939,363	7,539,711	4,729,484
Median Household Income ($)	50,000	63,300	42,500	68,500	50,000	38,000	80,000	52,500	95,000
Share of Households below Poverty Level (%)	17.26	10.81	17.29	19.22	19.15	29.52	8.56	13.28	10.91

Notes: Except for population sizes data that are based on 2018 estimates from the U.S. Census Bureau, all information is based on 2017 American Housing Survey (AHS). All geographic definitions follow AHS's 2013 Metropolitan Statistical Areas (MSA) that are delineated by the U.S Office of Management and Budget and are the result of the application of published standards to U.S. Census Bureau data. For more information on these definitions, see footnote 10 in this article. AHS classifies each sample unit into three degrees of housing adequacy: "severely inadequate," "moderately inadequate," and "adequate." For more information on how these degrees are defined, see footnote 8 in this article. A unit is deemed "adequate" if it does not meet the definitions of "severely inadequate" or "moderately inadequate." Households below the poverty level are those below the national poverty threshold established by family size, number, and characteristics.

Source: 2017 American Housing Survey and U.S. Census Bureau

We further investigate spatial heterogeneity in housing adequacy by comparing central cities and non-central cities within each metropolitan area. Although non-central cities are located within metropolitan areas, they are mostly suburban areas as their population size is smaller than 250,000, or they do not function as an employment location. Exhibit 10 indicates that residents have better access to adequate housing in non-central cities than in central cities in all selected metropolitan areas in our AHS sample. Lower household income in central cities could be, of course, one important factor that explains this urban-suburban inequality of housing adequacy.[20] We also find that housing affordability problems in central cities are far more serious than non-central cities within the same metropolitan area. Central cities in all selected metropolitan areas in our AHS sample display a higher PIR, higher median burden of rent payment, and higher share of cost-burdened renter households than non-central cities. The New York metropolitan area exhibits a particularly high urban-suburban gap in housing affordability for both homeowners and renters, and it also experiences substantially unequal access to adequate housing between urban and suburban locations.

Next, we look into housing inequality by household economic status in U.S. metropolitan areas. We are not able to estimate the concentration index due to data limitation, so we use the extent of concentration of inadequate housing among households that have an annual income less than $30,000. Exhibit 11 reports that among all inadequate housing in the United States, more than 13.61 percent of housing units are occupied by these lower-income households. When restricting the sample to housing units in the U.S. metropolitan areas, however, the unequal distribution by income becomes much more serious—more than 45 percent of inadequate housing concentrates among lower-income households. Most of the selected metropolitan areas show a similarly high level of unequal distribution of inadequate housing across different income groups, and Philadelphia is the one experiencing the highest level of household-level housing inequality. This finding is consistent with the previous finding from the DHS sample that cities tend to suffer more from housing inequality by household economic status than rural areas.

Finally, we observe a significant heterogeneity in the household-level housing inequality between U.S. metropolitan areas. Exhibit 11 shows that metropolitan areas with a larger population size, such as New York, Philadelphia, and Dallas, have a higher concentration of inadequate housing among lower-income households. In the last section, we have identified a similar, positive association between population size and housing inequality based on our DHS sample. Economic inequality and housing market performance appear to be other important potential factors that are related with housing inequality by household economic status. For example, New York and Boston are two metropolitan areas with the highest top-to-bottom income ratio based on our AHS sample and more than 33 percent of inadequate housing concentrates among lower-income households in these areas. These two areas also show significantly higher levels of housing unaffordability for both owners and renters. Although San Francisco also experiences a relatively higher income gap and serious housing affordability issue, its household-level housing inequality is lower than those of New York and Boston potentially because the general quality of housing stock and general household economic status in San Francisco are higher.

[20] One should note, however, that inequalities in economic status and the degree of development between urban and suburban areas and across metropolitan areas in the United States are not as significant as in developing countries.

Exhibit 11

Housing Inequality by Household Income in U.S. Metropolitan Areas

	United States	U.S. Metropolitan Areas		Boston		New York		Philadelphia		Seattle		Dallas		San Francisco	
		Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City
Share of Adequate Housing (%)	95.07	94.33	96.05	88.25	95.78	89.97	96.40	90.60	96.41	96.40	97.51	95.02	96.63	94.01	96.38
City Population Size				694,583		8,398,748		1,584,138		744,955		1,345,047		883,305	
Concentration of Inadequate Housing among Households with Income below $30,000 (%)	13.61	45.78		33.07		37.34		42.3		30.45		41.04		21.78	
MSA Top-to-Bottom Income Ratio	25.3			30.6		39.3		21.07		21.63		24.82		30.5	
Median Household Income ($)	55,100	50,000	63,300	68,500	81,850	50,000	80,000	38,000	78,000	80,000	79,130	52,500	70,000	95,000	100,000
Median Price-to-Income Ratio (PIR)	3	3	3	4.4	4.0	6.7	3.6	2.8	2.5	4.5	3.9	2.4	2.4	6.9	6.1
Median Burden of Rent Payment (%)	22	25	22	26	24	31	26	26	22	24	23	24	22	26	25
Share of Cost-Burdened Renter households (%)	37.97	43.14	35.78	41.83		56.23	44.40	47.52	35.13	39.51	37.14	39.63		44.18	

MSA = metropolitan statistical area.

Notes Except for MSA top-to-bottom ratios that are based on 2013 American Community Survey, all information is based on 2017 American Housing Survey. In 2017, the Federal Poverty Level (FPL) is $20,420 for three-person households and $24,600 for four-person households. Medicaid eligibility (138% of FPL) is $28,180 and $33,948 for three- and four-person households, respectively. Top-to-bottom income ratios are measured by the ratio of top 1 percent to bottom 99 percent income in 2013. The median burden of rent payment excludes households with zero or negative income and no cash rent. Cost-burdened renter households are those that spend more than 30 percent of their income on rent payment. Burden of rent payment is monthly total housing costs as percent of household income for renters

Sources: 2017 American Housing Survey and 2013 American Community Survey

4.5. Policy Efforts to Reduce Housing Inequality

Countries around the world have used various policies to resolve the issues of housing inequality. We begin with policy measures to mitigate spatial inequality in housing adequacy. To tackle the urban-rural inequality in developing countries, improving economic deprivation and reducing poverty in rural areas have been, of course, one important policy agenda. There are also serious financial challenges; providing basic infrastructure in rural areas is typically more costly than in denser urban areas. To ensure a progressive expansion of the provision of services, therefore, the public sector should be actively engaged rather than relying on the private sector. In India, the government has launched several programs and schemes over the past decades to improve and ensure access to basic household amenities in rural areas with a special focus on the poor, excluded, and marginalized groups (Sen and Drèze, 1999). Alternatively, developing countries could use some returns on investment in urban areas to expand basic services in rural areas.

In developed countries, policymakers would be more interested in reducing the urban-suburban housing inequality and improving housing adequacy in certain central cities where a lot more population reside compared to rural areas. One potential measure is strict implementation of building codes that could help prevent urban households from residing in inadequate housing. This change may come at a high administrative cost, however, and may be less effective if housing markets are tight. In central cities that are already built up, low-cost adequate housing could be provided through proper upgrading and infill redevelopment strategies. Here, the government could provide not only financial incentives but also planning support, including expediting the approval processes for multi-family developments that have been often lengthy and uncertain in the outcome, as well as relieving requirements that unnecessarily drive up redevelopment costs (Dain, 2019).

Second, policy measures attempt to reduce housing inequality by household economic status by focusing on households that do not have the proper access to adequate housing. Both supply- and demand-side measures have been used to enhance such access. When most low- and middle-income households suffer from housing inadequacy due to acute housing shortage, policy measures to expand housing supply have been used in many countries. Several countries, including South Korea, have opted to publicly provide housing at low cost on a large scale (Kim and Park, 2016). In Singapore, around 80 percent of its resident households reside in public housing that the Housing and Development Board, a government agency, built and managed (Phang and Helble, 2016). These supply-side measures are useful to ensure a certain minimum standard of housing adequacy while providing access to adequate housing for households in need.

On the other hand, if the extent of housing inadequacy is small and only a small number of households need improved access to adequate housing, demand-side deep subsidies have been a more popular method. The housing voucher program in the United States is one of the most prominent examples.[21] Despite many advantages of demand-side subsidies, inelastic supply in many large metropolitan areas may hinder their success in reducing housing inequality. If the problem is more related to physical housing conditions than housing availability or tenure,

[21] In addition to classic vouchers, new demand-side assistances have been discussed. U.S. Senator Kamala D. Harris reintroduced the so-called Rent Relief Act, which would create a new, refundable tax credit for households whose housing costs exceed 30 percent of their income, including rent and utilities (Harris, 2019).

providing targeted demand-side subsidies can be useful to improve housing adequacy. For example, under the National Affordable Housing Program Project in Indonesia, low-income households can apply for governmental support either in cash or building materials.

Finally, to reduce spatial heterogeneity in household-level housing inequality, some policy measures have considered targeting specific areas that experience severe housing inequality. For many large, global cities in developing countries, informal settlements are a major source of housing inequality. Several countries including India, Indonesia, Pakistan, and the Philippines have used slum resettlement programs that relocate informal settlers to sites outside the city with basic infrastructure. Similar to the U.S. policies, such as Moving to Opportunity or homelessness policies that offer rental housing, these programs incentivize household mobility with the provision of adequate housing. The downside is that program participants are often forced to leave their home and relocate to areas far from their employment.

As housing unaffordability is one of the main drivers of housing inequality, policies have also focused on enhancing housing affordability in large cities. Some cities in developing countries have experienced difficulties in providing affordable, adequate housing due to inefficient planning processes (Hussnain et al., 2016) and particularly low floor-area ratios (Shenvi and Slangen, 2018). Therefore, in addition to the various supply- and demand-side policies mentioned earlier, lifting strict zoning restrictions is another policy option for these cities. For example, in the United States, Minneapolis state government implemented "upzoning" every single-family neighborhood at once. Another commonality in most large cities is that affordable housing tends to be located in areas with lower access to important services—such as education and healthcare—which could be considered important elements of housing adequacy in broader terms. An efficient and affordable public transportation system could greatly enhance this access and help lower-income households enjoy housing that is both adequate and affordable.

5. Conclusion

In this article, we provide new evidence on housing adequacy and related inequality in 10 developing Asian countries and explore how these patterns of housing inequality are comparable to those in the United States. Our finding first elucidates spatial inequality in housing adequacy, represented by the urban-rural gap in Asian developing countries and disparities between urban and suburban areas and across metropolitan areas in the United States. Although the significant difference in economic status and the degree of development between urban and rural areas is mainly relevant in Asian developing countries, spatial inequality in the United States appears to be also associated with housing affordability and economic inequality in certain metropolitan areas. Next, households with lower economic status are more likely to face the challenge of housing inadequacy in both developing Asia and the United States. The scale of affected households differs significantly, however. Although even some middle-class households suffer from housing inadequacy in developing countries, the general extent of housing inadequacy is a lot lower, and it concentrates only among very low-income households in the United States. Finally, results from both Asian developing countries and the United States consistently suggest spatial heterogeneity in household-level housing inequality at the metropolitan-area level. Areas

with a larger population, higher economic inequality among resident households, and higher housing unaffordability tend to experience a greater concentration of inadequate housing among households with lower economic status.

Our findings provide important policy implications that are not necessarily limited to Asian developing countries. Developed countries, including the United States, are facing equally serious wealth inequality with aspects like intra-generational divergence and intergenerational transfers compared to developing countries. We suggest that such economic inequality is highly related to housing inequality. In both developing countries and the United States, we find that spatial attributes such as economic inequality and housing unaffordability aggravate the unequal access to adequate housing by household economic status in a given metropolitan area. In fact, although housing adequacy itself may be less of a concern in the United States than in Asian developing countries, we have seen that high poverty rates and acute shortage of affordable housing have risen to homelessness and substandard housing in some U.S. cities like New York. According to the National Low Income Housing Coalition (2020), the United States is facing a shortage of 7 million affordable and available rental homes. Households without access to appropriate low-cost housing pay an unproportionally high share of their income for rent and, in the worst case, become homeless. U.S. policymakers should recognize the unequal nature of access to adequate housing; they should design policies to address the concentration of inadequate housing among the lower end of the central city population and prevent a further spatial concentration of housing wealth.

Some caveats should be mentioned. Due to data limitations, we do not use the same definition of housing adequacy for developing Asia and the United States. Although the DHS definition includes dimensions of crowding and access to water and sanitation, the AHS definition focuses more on the structural quality of the dwelling. We argue that the level of household housing consumption should not be extremely biased toward these different dimensions. If the difference in housing adequacy definitions significantly affects the distribution of adequate housing across households with different economic status and across geographic areas, however, our analysis results on housing inequality in developing Asia and the United States may not be very comparable. Also, because of data shortcomings, our findings do not allow for causal interpretations and remain largely descriptive.

The future research agenda on housing inequality is large. First, as alluded to in the previous paragraph, it would be useful to obtain a more comprehensive picture of housing adequacy. This requires access to more detailed information on housing conditions and household attributes. Little information has been collected through surveys in developing countries, hampering the understanding of their housing adequacy. One solution to overcome the data constraint in developing countries is to use big data collected via nighttime lights, web mapping services, or mobile phone usage. As AHS data provide rich information on housing units but lack household attributes, it will be desirable to expand data collection. Second, as many developing countries are experiencing economic growth and urbanization, it would be interesting to examine how housing inequality and its determinants change over time. For example, as countries develop economically, the rural disadvantage in terms of access to adequate housing is most likely to shrink. Lastly, more

research is needed to identify macroeconomic policies that work best to address housing inequality. For example, it may be interesting to study whether housing inequality is less pronounced in countries with systems of larger income redistribution.

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Appendix A.

We define the four-dimensional housing adequacy criteria from the following questions in the Demographic and Health Survey.

Structural Quality

Structural quality is measured by roof materials. A house is considered to be structurally qualified if it has finished roofing. Relevant question in the DHS is No.143 (hv215): *Main material of the roof of the dwelling (Observation by an interviewer)*

Exhibit A.1

Roof Materials	
Natural	No roof
	Thatch/palm leaf
	Mud
	Sod/mud and grass mixture
	Plastic/polythene sheeting
Rudimentary	Rustic mat
	Palm/bamboo
	Raw wood planks/timber
	Unburnt bricks
	Loosely packed stone
	Wood planks
	Cardboard/makeshift
	Tin
	Plastic sheet
Finished	Metal (zinc/galvanized iron/aluminium)
	Wood
	Calamine/cement fibre
	Asbestos sheets
	Ceramic tiles
	Clay tiles
	Cement/rcc/rbc/concrete
	Roofing shingles
	Tiles
	Slate
	Burnt brick
	Ruberoid

Sufficient Living Area

A house is considered sufficiently spacious if not more than three people share a sleeping room. Relevant question in the DHS is No.117 (hv216): *How many rooms in this household are used for sleeping?*

Access to Improved Water

A house is considered to have adequate access to improved water if the main source of drinking water for household members is from piped water, protected dug well, protected spring water, or bottled water. Relevant question in the DHS is No. 101 (hv201): *What is the main source of drinking water for members of your households?*

Exhibit A.2

Drinking Water Sources	
Piped water	Piped into dwelling
	Piped to yard/plot
	Piped to neighbor
	Public tap/standpipe
Dug Well	Protected well
	Unprotected well
Water from spring	Protected spring
	Unprotected spring
Others	Tube well or borehole
	Rainwater
	Tanker truck
	Cart with small tank
	Surface water (river/dam/lake/pond/stream/canal/ irrigation channel)
	Bottled water
	Others

Access to Improved Sanitation

Accessibility to improved sanitation is based on whether a house owns a flush toilet or ventilated improved pit, and whether a toilet is not shared with more than two other households. Relevant questions in the DHS are No.109 (hv205): *What kind of toilet facility do members of your household usually use?*; No.110 (hv225) : *Do you share this toilet facility with other households?*; and No.111 (hv238): *Including your own household, how many households use this toilet facility?*

Exhibit A.3

Sanitation	
Flush or pour flush toilet	Flush to piped sewer system
	Flush to septic tank
	Flush to pit latrine
	Flush to somewhere else
	Flush, don't know where
Pit latrine	Ventilated improved pit latrine
	Pit latrine with slab
	Pit latrine without slab/open pit
Others	Composting toilet
	Bucket toilet
	Hanging toilet/hanging latrine
	No facility/bush/field
	Public facility
	Others

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