HOUSING AFFORDABILITY AND INEQUALITY: A CONSUMPTION-ADJUSTED APPROACH

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ABSTRACT

We introduce a new measure of housing affordability that adjusts for normative variation in housing consumption. The new measure is computed using extensive micro-data from Israel for the 1998–2015 period. Findings suggest sharp declines in Israel quality- and consumption-adjusted affordability. Further, the new consumption-adjusted measure suggests more pronounced affordability burdens among minority and underprivileged groups. The new measure also gives rise to elevated Gini measures of housing affordability inequality. We also find that recent trending up in house prices and income in Israel is associated with more pressing consumption-adjusted affordability challenges among those already in housing distress, particularly in outlying, peripheral areas.

Key Words: Housing affordability, housing consumption, inequality, price-to-income

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1. INTRODUCTION

Issues of housing affordability long have been on the agendas of policymakers and governments worldwide. In recent years, however, those concerns have turned particularly acute, in the wake of deterioration in availability of affordable units and related popular protest in many western cities.[1] Appropriate policy response, however, is predicated on accurate measurement of affordability burdens. Indeed, longstanding popular measures of affordability may be biased owing to failure to account for variability among households in housing preferences and consumption. In this paper, we address those concerns in development and assessment of a new normative consumption- and quality-adjusted measure of housing affordability. We employ the new measure to assess the incidence of affordability burdens as well as to compute a new Gini measure of affordability inequality. Finally, we evaluate how economy-wide trends in house prices and incomes affect the affordability burdens of severely affordability constrained households.

In the literature, housing affordability is typically represented by the relationship between housing costs and some ability-to-pay criterion (e.g., Robinson *et al.*, 2006). Among the most prevalent method for assessing affordability is the house price-to-income ratio (e.g., Gan and Hill, 2009; Weicher, 1977; Bogdon and Can, 1997; Thalmann, 1999; Quigley and Raphael, 2004; Belsky *et al*., 2005; Stone, 2006; and Kim and Cho, 2010).[2] However, the individual household price-to-income measure may be biased owing to varying individual preferences for consumption of housing services. For example, households may choose to reduce their consumption of housing services and hence be viewed as less affordability burdened. Conversely, households may consume excessive housing services and hence appear to be highly affordability burdened (see also Thalmann [1999]).

In this study, we propose a new normative measure that corrects for the above-described consumption bias in the assessment of housing affordability. Our proposed measure is normative

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[1] See, for example, *The New York Times*, Foreclosure Protesters in Spain's Cities Now Go Door to Door (by Suzanne Daley, July 15, 2011); *The Economist*, Income Inequality in America (April 23, 2012); *The Guardian*, Social Unrest on the Rise in Europe, Says ILO Report (by Phillip Inman, April 30, 2012); and *The Economist*, Why Homes Even in the Unfashionable Parts of LA Cost So Much (August 23, 2014).

[2] Other working definitions include mortgage debt-to-housing price (see, for example, Hendershott, 1980; Jones, 1989; Gyourko and Linneman, 1993; Mayer and Engelhardt, 1996; Gyourko and Tracy, 1999; and Norris and Shiels, 2007); mortgage loan repayment-to-income (see, for example, Jones, 1989 and Brounen *et al*., 2006); and ongoing housing cost-to-income (see, for example, Smets, 1999; Ong, 2000; Brounen *et al*., 2006; and Haffner and Heylen, 2011). Further, some studies adopt the residual income approach, where the cost of basic goods net of housing is examined in association with income (e.g., Whitehead, 1991; Stone, 2006; Kutty, 2005; and Chen *et al*., 2010).

in the sense that it is endogenously derived, varies over time and space, and represents current consumption typical of similarly situated households. To compute the new measure, we employ extensive micro-data on Israeli households over the 1998–2015 period to identify the typical housing consumption bundle of households stratified by demographic and locational characteristics. We then match each household in our sample to the average housing consumption bundle of similar households. We also estimate housing hedonic price indices for each city in Israel for the timeframe of the analysis using the universe of housing transactions. Given computed information on normative household housing consumption, the pricing thereof via hedonic price equations, and housing net income, we compute a quality- and consumption-adjusted measure of housing affordability. We compare results of the new consumption-adjusted affordability measure to standard unadjusted measures.[3] Both measures give rise to substantial evidenced decline in housing affordability in Israel over recent decades. Further, failure to correct for housing consumption variability results in understatement of affordability burdens among a large number of sample stratifications. We also compute a Gini measure of inequality in housing affordability; the consumption-adjusted measure shows a substantially larger housing Gini coefficient.

We further evaluate systematic variability in our new affordability measure across household demographic and locational traits. A few prior studies, including Skaburskis (1997, 2004), Charlier *et al.* (2001), and Lin *et al.* (2014), have used micro-data to examine the association between housing affordability and household attributes in Canada, Taiwan, and The Netherlands, respectively. Malpezzi (1999) and Ben-Shahar and Warszawski (2011) estimate the relationship between macro measures of housing affordability and market indicators in the United States and Israel, respectively.[4] Results of our analysis show that consumption-adjusted affordability burdens in Israel are elevated among low educational attainment, minority, and immigrant households. Further, those associations vary across the new consumption-adjusted and traditional measures. Finally, we assess how trending up in house prices and incomes in Israel over the course of recent decades has affected affordability among disadvantaged populations, notably including those living

[3] Notably, unlike most studies in this area that assess the state of housing affordability based on macro-data (such as *average* and/or *median* price and income figures), we employ a micro-level approach that allows us, among other things, to standardize and explore individual housing consumption and affordability.

[4] Studies also explore the correlation between housing consumption and socio-demographic variables in various markets around the world. These include, for example, Mayo (1981), Awan *et al.* (1982), Mankiw and Weil (1989), Goodman (1990), Engelhardt and Poterba (1991), Pitkin and Myers (1994), Green and Hendershott (1996), Ohtake and Shintani (1996), Myers and Vidaurri (1996), Fortin and Leclerc (2000), Reed (2002), and Li (2014).

in areas peripheral to the primary coastal agglomeration of economic activity. Findings show the incidence of those economy-wide trends to be substantially more adverse among highly affordability-burdened households. Further, the trending up in those indices in Israel in recent years has been even more harmful to highly affordability-burdened households residing in outlying, peripheral areas.

The primary contributions of our paper are as follows. First, we introduce a new method for estimating housing affordability that addresses potential bias in traditional measures by adjusting for normative housing consumption. We use that measure to compute estimates of consumption-adjusted affordability as well as Gini-based indices of affordability inequality. The new consumption-adjusted measure suggests more marked deterioration in Israel housing affordability and related affordability inequality. We identify variance in normative affordability across household socio-demographic and locational traits and show more severe affordability burdens among Israel minority and disadvantaged groups. Finally, we show an adverse incidence of recent trending up in Israel economy-wide house price and income trends as regards the consumption-adjusted affordability burdens of less privileged groups, especially those living on the outlying, peripheral areas. In marked contrast, those same macro trends are associated with improved relative affordability among the least burdened segment of households, especially those living in Israel's superstar Tel Aviv location. That evidence may prove useful to policymakers in designing programs aimed at mitigating housing distress.

The paper is organized as follows. The next section describes the sample, variable definitions, and related summary statistics. Section 3 details our approach to estimating consumption- and quality-adjusted housing affordability. Section 4 examines housing affordability inequality under the consumption-adjusted, as compared to the standard approach. Section 5 identifies individual characteristics associated with elevated affordability burdens. Section 6 studies the incidence of recent economy-wide income and house price trends on housing affordability among disadvantaged groups. Finally, Section 7 provides a summary and concluding remarks.

2. THE SAMPLE

Data for this study include a raw sample of about 235,000 observations on individual household socio-economic, demographic, locational, and dwelling unit characteristics provided by the Household Income and Expenditure Surveys conducted by the Israel Central Bureau of

Statistics. We compile the data for the years 1998–2015.[5] Each annual, independent cross-sectional sample is comprised of 8,742 to 15,171 observations and is representative of all households in Israel (see Central Bureau of Statistics, 1998–2015). Table 1 displays the number of cross-sectional observations for each year of the sample period. Table 2 provides a description and summary statistics of household socio-economic, demographic, locational, and dwelling unit characteristics.

As indicated in Table 2, the typical household owns its home (67 percent) and consists of 2.07 adults and 0.79 children. On average, household heads are 52 years old and have about 13 years of education. About 4 percent of household heads in our sample are Arab, while 96 percent are either Jewish or other nationalities.[6] About 43 percent of households are female-headed.[7] The majority of household heads (62 percent) are married; about 11 percent are single, 11 percent are divorced, 14 percent are widowed, and the remainder are either living separately from their spouses, or the marital status is unknown. Household heads' country/continent of origin is Israel (44 percent), Europe or America (15 percent), or Asia or Africa (17 percent), and the former Soviet Union (23 percent). The continent/country of origin of the fathers of native Israeli household heads is Israel or unknown (30 percent), Europe or America (26 percent), Asia or Africa (40 percent), or the former Soviet Union (4 percent).[8] Finally, the average score on the household location index is 4.31, where the index ranges from 1 (most peripheral location) to 5 (most central location).[9]

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[5] Following 2012 there had been a change in the way income variable is calculated in the Household Income and Expenditure Surveys, however at a separated Household expenditure survey the income calculation stayed consistent along the years. Thus, and following the recommendation of the Israeli Central Bureau of Statistics, we use only the separated Household Expenditure Survey for 2012-2015.

[6] Non-Jewish nationalities are under-represented in the Household Income and Expenditure Surveys conducted by the Israel Central Bureau of Statistics. In particular, the surveys only include Arabs living in mixed-population areas (i.e., where Jews and Arabs coexist) and thus exclude the majority of the Arab population in Israel, who live in segregated municipalities. Hence, our outcomes below regarding the below-standard housing affordability of Arab households is likely to be under-assessed, since the socio-economic status of Arab households who live in segregated communities is generally worse than those living in integrated cities.

[7] Household head gender is generally identified as the gender of the person who is the main income provider in the household. See Israel Central Bureau of Statistics (2013) for further details.

[8] It should be noted that during the 1990s Israel absorbed a total of about 1 million immigrants (almost 20% of the 1990 population), the majority of whom arrived from states of the former USSR.

[9] The periphery index calculated by the Israel Central Bureau of Statistics is based on a combination of two equally weighted components: an accessibility index (a population-weighted average of distances between a given municipality and all other municipalities in Israel) and a measure of proximity to the Tel Aviv district (see Central Bureau of Statistics, 2008).

Our study further employs the universe of all housing transactions in Israel for the period 1998–2015—a total of over one million observations—as recorded by the Israel Tax Authority. We use this dataset to estimate hedonic price indices and to compute the house price for each household in the Household Income and Expenditure Surveys. Further, that dataset allows us to estimate the price of the normative housing bundle of each household in the dataset. Table 3 provides a description and summary statistics of the dwelling unit characteristics in the housing transaction dataset. As indicated in Table 3, the typical dwelling unit is a 3.6-room condominium apartment located on the second or third floor of a 21-year-old structure. The average unit price is about 216,000 dollars, with a standard deviation of about 130,000 dollars.[10]

3. THE CONSUMPTION-ADJUSTED HOUSING AFFORDABILITY MEASURE

Below we introduce a new quality- and consumption-adjusted measure of housing affordability. That measure adjusts for variability in housing consumption across households. We compute the new measure as follows:

Step one: We stratify the sample of households from the Israel Income and Expenditure Surveys over the period 1998–2015 (Israel Central Bureau of Statistics) by year and by demographic and locational characteristics. Specifically, we generate mutually exclusive clusters of households, each denoted by *A, C, L,* and *Y* (henceforth *ACLY*), where *A* is the number of adults in a household, *A*=(1,2,…,5 and over); *C* is the number of children in a household, *C*=(1,2,…,8 and over); *L* is the score on the periphery index of the city in which the household resides, *L*=(1,2,…,5, where 1 is the most peripheral and 5 is the least peripheral); and *Y* is the year in which the household is observed, *Y*=(1998,1999,…,2015). Thus, for example, $i \in (A = 1, C = 2, L = 3, Y = 2012)$ implies that household *i* in the sample belongs to the cluster whose characteristics include one adult with two children, living in city location with a periphery index of 3 and observed in 2012.[11] Note that the periphery index indicates distance from Tel Aviv, Israel's primary commercial and cultural

[10] In fact, the Income and Expenditure Survey does not indicate the type of dwelling unit (whether it is a condominium, detached unit, etc.). However, as more than 90% of the housing transactions in Israel involve condominiums (see Israel Central Bureau of Statistics, 2015), we assume that housing units in the survey are condominiums and thus restrict the Tax Authority transaction dataset (from which a price is matched to the household dwelling in the survey) to include condominium transactions only. Also, we convert all shekel (NIS) prices to US dollar, where 1 US dollar = 4 NIS.

[11] Household clustering by number of adults and number of children is consistent with, among others, previous studies on the correlation between household housing consumption and both the number of adults and number of children. See, for example, Mayo (1981), Bratt *et al.* (2006), Li (2014), Awan *et al.* (1982), Goodman (1990), Swan (1995), and Reed (2002).

center. The Tel Aviv area has witnessed ongoing elevated rates of house price increase and comprises Israel's superstar city.

We require that each cluster include no less than 20 observations per year-city couplet; otherwise, the cluster is removed from the sample. Table 4 shows the matrix of clusters according to the number of children (*C*) and the number of adults (*A*) and the share of each cluster in the sample. It follows that the number of different clusters (by number of children and adults) for which we observe no less than 20 observations per year and per city is equal to 21, where clusters with 2 adults comprise almost 54 percent of total households in the sample, followed by 1 adult (24 percent) and 3 adults (14 percent). Also, more than 61 percent of the households are classified in clusters without children, followed by clusters with 1 child (15 percent) and 2 children (13 percent). Over time and space, the cluster of 2 adults with no children comprises the largest share (27 percent), followed by clusters of 1 adult with no children (21 percent) and 2 adults with 2 children (10 percent), respectively.

Step two: The Income and Expenditure Surveys specify the size of unit consumed by each household in total number of rooms. For each cluster *ACLY*, we thus compute

(1)

$$NR^{CA}_{i\in ACLY} = \sum_i NR_{i\in ACLY}/N_{ACLY}\ ,$$

where $NR_{i\in ACLY}$ denotes the total number of rooms consumed by household *i* in cluster *ACLY*, and N_{ACLY} denotes the total number of households in that cluster. Hence, $NR^{CA}_{i\in ACLY}$ is the average number of rooms consumed across all households in cluster *ACLY*. We refer to $NR^{CA}_{i\in ACLY}$ as the (endogenously derived) consumption-adjusted (CA) housing bundle of households in *ACLY*.[12]

Step three: Employing all housing transactions in Israel for the period 1998–2015 (Israel Tax Authority dataset), we estimate a hedonic price equation of the form

(2)

$$\ln(P_{jl}) = \gamma_{1l} + \gamma_{2l}NR_{jl} + \vec{\gamma}_{3l}CHARACTERISTICS_{jl} + \vec{\gamma}_{4l}TFE_{jl} + \varepsilon_{1jl} \text{ for all } l$$

[12] In an attempt to produce a consumption-adjusted housing affordability measure along the lines of our suggested procedure, one could have alternatively proposed an estimation equation of the type $NR_{it} = \beta_1 + \beta_2 \times A_{it} + \beta_3 \times C_{it} + \beta_4 \times L_{it} + \varepsilon_{it}$, where *i* and *t* refer to households and time periods (years), respectively; $\beta_1 - \beta_4$ are estimated parameters; ε is a disturbance term; and all other variables are as described above. Note, however, that this equation potentially suffers from endogeneity, as the causality between a household's choice of *C* and *L* and the choice of *NR* may be bi-directional. Our clustering procedure thus avoids this potential endogeneity problem in the regression estimation.

where the indices *j* and *l* represent transactions and cities, respectively; *P* denotes the housing transaction price; *NR* is the number of rooms in the unit; and *CHARACTERISTICS* is a vector of other housing unit characteristics, including, *Age*, the age of the structure in which the unit is located; *Floor*, the floor on which the unit is located in the building; and *DumNew*, a dummy variable that equals one for units whose age is up to 1 year and zero otherwise. Also, *TFE* is a vector of time (year) fixed-effects; ln(·) is the log operator; $\gamma_1 - \gamma_2$ and $\vec{\gamma}_3 - \vec{\gamma}_4$ are estimated parameters and vectors of parameters, respectively; and ε_1 is a random disturbance term. Equation (2) is separately estimated for every city *l* (altogether 52 equations—one for each city).[13]

Step four: Following the estimation of equation (2), we compute

(3)

$$\hat{P}^{CA}_{i\in ACLY} = EXP\left[\hat{\gamma}_{1l} + \hat{\gamma}_{2l} NR^{CA}_{i\in ACLY} + \hat{\vec{\gamma}}_{3l}\overline{CHARACTERISTICS}_{il} + \hat{\vec{\gamma}}_{4l} TFE_{i\in ACLY}\right] \text{ for all } i \text{ and } l,$$

where the indices *i* and *l* represent households and cities, respectively; $NR^{CA}_{i\in ACLY}$ on the right-hand side of (3) is the adjusted total room consumption of household *i*, $i \in ACLY$ (from equation [1]); $\overline{CHARACTERISTICS}$ is a vector of other housing unit characteristics (including *Age* and *Floor*) at their sample average across all assets in city *l* (where *i* is located);[14] and $\hat{\gamma}_1 - \hat{\gamma}_2$ and $\hat{\vec{\gamma}}_3 - \hat{\vec{\gamma}}_4$ are the estimated coefficients and vector of coefficients, respectively, from equation (2). That is, based on the estimated coefficients from equation (2) and a household's adjusted room consumption in the respective cluster, in equation (3) we compute for each household *i* in every *ACLY* (from steps one and two above) a hedonic price, $\hat{P}^{CA}_{i\in ACLY}$, that corresponds to its consumption-adjusted housing bundle, $NR^{CA}_{i\in ACLY}$.

Step five: Given household *i*'s net income, $Income_i$, we compute the ratio $P^{CA}_i / Income_i$, which we refer to as consumption-adjusted housing affordability of household *i* (i.e., *i*'s consumption-adjusted housing price-to-net income ratio).

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[13] The number of observations per city ranges from 223 to 55,576. Also, the average R^2 of the 62 estimations of equation (2) is equal to 0.84, with a maximum of 0.92 and a minimum of 0.71. Finally, note that of the total of 76 cities in Israel, we include the 62 cities represented by the clusters generated in step one above.

[14] Note that, while *DumNew* in (2) refines the estimation of the correlation between the structure's age and the housing unit price, it does not appear in (3) because the average structure's age across all assets in city *l* is greater than one year for all *l* (thus *DumNew*=0).

In addition to the consumption-adjusted housing affordability measure, our dataset allows estimation of the traditional price-to-net income ratio as follows:

(4)

$$\hat{P}_{i\in ACLY} = EXP\left[\hat{\gamma}_{1l} + \hat{\gamma}_{2l}NR_{i\in ACLY} + \hat{\bar{\gamma}}_{3l}\overline{CHARACTERISTICS}_{il} + \hat{\bar{\gamma}}_{4l}TFE_{i\in ACLY}\right] \text{ for all } i \text{ and } l,$$

where $NR_{i\in ACLY}$ on the right-hand side of (4) is the *actual* number of rooms consumed by household *i* in cluster *ACLY* and $\hat{P}_{i\in ACLY}$ is the price of *i*'s actual housing consumption. Given household *i*'s net income, $Income_i$, the expression $\hat{P}_{i\in ACLY}/Income_i$ is therefore *i*'s housing affordability measure (the traditional, non-consumption-adjusted, housing price-to-net income ratio).[15]

4. CONSUMPTION-ADJUSTED HOUSING AFFORDABILITY AND INEQUALITY

In this section, we assess trends in housing affordability and related affordability inequality as derived under the consumption-adjusted measure as compared to the traditional approach.[16] Figure 1 plots the annual average consumption-adjusted affordability measure across all households over the period 1998–2015. Consumption-adjusted affordability is denominated in months of household net income. That measure increases by roughly one-third over the 1998-2015 sample period. Further, over the 2007-2015 period, the number of months required by the typical household to afford a consumption-adjusted home increased by 60 percent in the wake of a 110 percent increase in quality-adjusted house prices.[17]

Figure 2 presents $NR_{i\in ACLY}/NR^{CA}_{i\in ACLY}$ (i.e., the ratio of the household actual housing consumption bundle—measured in total number of rooms—to its associated consumption-adjusted housing bundle) and $\hat{P}_{i\in ACLY}/\hat{P}^{CA}_{i\in ACLY}$ (i.e., the ratio of the estimated price of the household's housing unit to the price of its associated estimated consumption-adjusted housing unit) by income

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[15] We use $\overline{CHARACTERISTICS}$ on the right-hand side of (4) rather than actual household's asset characteristics as the latter is not available in the dataset.

[16] The outcomes from the estimation of equation (2)—used in deriving the results that follow—are not reported and can be obtained from the authors on request.

[17] As presented below, outcomes on inequality in housing affordability derived under the consumption-adjusted approach substantially differ from those attained under traditional measures. As expected, however, *average* values of the consumption-adjusted and traditional affordability measures are close to one another, which immediately follows from the way that the consumption-adjusted measure is derived based on equations (1) and (3).

deciles for 2015. As shown, $NR_{i\in ACLY}/NR^{CA}_{i\in ACLY}$ and $\hat{P}_{i\in ACLY}/\hat{P}^{CA}_{i\in ACLY}$ exhibit a similar pattern. The housing consumption and house price ratios are less than 1 for lower income deciles, implying that those households live in relatively inexpensive housing units and that their actual consumption of housing services is less than their consumption-adjusted housing bundle. At the same time, the housing consumption and house price ratios exceed 1 for higher income deciles. Moreover, the chart provides evidence of the asymmetry in housing consumption relative to the household standard for upper and lower deciles. While lower income decile households consume about 10 percent less than their demographically-adjusted standard bundle, households in the upper deciles consume upwards to 20 percent in excess of their demographically-adjusted bundle.

We stratify the sample among households who consume housing services in excess of/less than their respective consumption-adjusted bundle. That analysis yields additional insights into the state of housing affordability in Israel. Figure 3 illustrates the annual average consumption-adjusted and traditional affordability measures for households stratified by actual housing consumption greater/less than their corresponding consumption-adjusted bundle for the 1998–2015 period. In other words, the sample is divided into those households who exhibit $NR_{i\in ACLY} \geq NR^{CA}_{i\in ACLY}$ and those households who exhibit $NR_{i\in ACLY} < NR^{CA}_{i\in ACLY}$, respectively. Results indicate that while the average housing price-to-net income ratio of the above-consumption-adjusted group is *greater* than that of the below-consumption-adjusted group under the *traditional* measure, that same affordability burden (average housing price-to-net income) of the above-consumption-adjusted group is *less* than that of the below-consumption-adjusted group when assessed under the consumption-adjusted approach. Moreover, inequality between the above- and below-consumption-adjusted groups is considerably more pronounced under the consumption-adjusted measure. In particular, while the average between-group difference is equal to about 19 months of net income under the traditional approach, the difference increases markedly to about 34 months of net income under the consumption-adjusted approach.

Figure 4 presents the consumption-adjusted and traditional housing affordability measures for 2015 stratified by housing consumption above and below the consumption-adjusted standard for the three largest cities in Israel—Jerusalem, Tel Aviv, and Haifa. As is evident, the results for the above consumption-adjusted group are robust to this sample selection. Specifically, while the average affordability burden (housing price-to-net income ratio) of the above-consumption group exceeds that of the below-consumption group for the traditional measure, this finding largely reverses when using the consumption-adjusted measure. Specifically, while the average housing price-to-net income ratio of the above-consumption group exceeds that of the below-consumption

group by 38 to 106 months of net income under the traditional measure, average housing price-to-net income of the below-consumption group exceeds that of the above-consumption group by (-9) to 64 months of net income under the consumption-adjusted measure.[18] In other words, in comparison to the traditional affordability measure, our new consumption-adjusted measure indicates substantially greater inequality in housing affordability as prevails in Israel's three largest cities in 2015. The new consumption-adjusted approach hence provides new insights regarding the state of inequality in housing affordability in Israeli cities.

We further assess the robustness of affordability findings to stratification of sampled households by various demographic traits. Those traits include tenure mode as well as nationality, gender, and college/no college education of household head. Figures 5a-5d present average consumption-adjusted versus traditional affordability burdens for the sample stratified by tenure mode (owners versus renters), nationality (Jews versus Arabs), gender (male- versus female-headed households), and education (college versus no-college headed households), respectively. In all cases, while affordability burdens for more privileged groups (e.g., owner, Jewish, male, and college household head) under the consumption-adjusted measure are less than or equal to those under the traditional measure, the traditional measure considerably underestimates the affordability burdens of the less privileged groups (i.e., renter, Arab, female, and no-college headed households). In other words, adjustment for systematic variation across households in housing consumption choices results in substantially greater inequality in housing affordability among stratifications of the sampled population.

Finally, we use the consumption-adjusted and traditional measures to compute Gini indices of inequality in housing affordability. As is broadly appreciated, the Gini measure of inequality (see, for example, Alderson and Nielsen, 2002; Frank, 2009; Leigh, 2007) is commonly used to estimate income inequality. Further, it has been employed to measure inequality in other economic dimensions.[19] For income, the Gini measure computes, for each income level, the difference between the share of total income earned by individuals at this income level or below it and the share of those individuals in the population. For a population with non-negative income values, it ranges from 0, which implies perfect equality, to 1, which implies that all the populations' income

[18] As once can see, Tel Aviv is somewhat exceptional as the gap between the two groups, while considerably shrinks (from 99 to 9 months of net income), does not reverse in signs.

[19] See extension of the Gini coefficient approach for measuring, for example, inequality in education and human capital (Földvári and Leeuwen, 2011), fossil resource consumption (Papathanasopoulou and Jackson, 2009), ecological entitlements (Ruitebeek, 1996), and child achievements (Sastry and Pebley, 2010).

is earned by a fraction of the population. Ben-Shahar and Warszawski (2016) extend the Gini measure to capture housing affordability inequality. As the Gini is designed for normal goods, while housing affordability instead measures affordability distress, Ben-Shahar and Warszawski compute housing affordability inequality by applying the Gini on the inverse value of housing affordability (effectively, income-to-price rather than price-to-income). We use a similar approach to compute affordability inequality under consumption-adjusted and traditional measures. In so doing, each household is assigned $Income_i/P_i^{CA}$ (the inverse of the consumption-adjusted affordability measure) and $Income_i/\hat{P}_{i\in ACLY}$ (the inverse of the traditional affordability measure) to compute the Gini index. For comparison, we also compute an income Gini coefficient.

Figure 6 presents the income and housing affordability Gini coefficients over the 1998–2015 period. As is evident, upon adjustment for consumption bias, Gini-based inequality in housing affordability is substantially greater than evidenced under the traditional affordability measure. Moreover, while inequality in housing affordability under the traditional measure is substantially less than income inequality throughout, that result is reversed when comparing the consumption-adjusted Gini to the income Gini. Upon adjusting for variability in normative housing consumption, inequality in housing affordability substantially exceeds income inequality.

5. AFFORDABILITY BURDENS ACROSS DEMOGRAPHIC TRAITS

In this section, we examine the association between housing affordability and household demographic characteristics. Consider the following estimated equation:

(5)

$$\ln(HA_{it}) = \alpha_1 + \alpha_2 Female_i + \alpha_3 Arab_i + \alpha_4 Age_i + \alpha_5 Education_i + \vec{\alpha}_6 STATUS_i + \vec{\alpha}_7 CONTINENT_i + \vec{\alpha}_8 TFE_i + \varepsilon_{2it},$$

where HA_{it}=($P_{it}^{CA}/Income_{it}$; $P_{it}/Income_{ti}$) denotes the consumption-adjusted and traditional measures of household *i*'s housing affordability at time *t*, respectively. Also, the independent variables in equation (5) include a series of household demographic traits that associate with housing affordability (see description of all variables in Table 2). Among controls, *Female* is a dummy variable indicating the gender of the household head (equals 1 for female and 0 for male); *Arab* is a dummy variable indicating the head-of-household nationality (equals 1 for Arab and 0 for Jewish or other); *Age* is the head-of-household age; *Education* is the head-of-household years of education; *STATUS* is a vector of categorical variables indicating the head-of-household marital status (*divorced*, *widowed*, *single*, and *living separately*, where married is the base category);

CONTINENT is a vector of categorical variables indicating the head-of-household's continent of origin if not born in Israel (including Asia or Africa; Europe or America; and Former USSR) and household head father's continent of origin among those born in Israel (including Asia or Africa; Europe or America; and former USSR), where the base category is household head born in Israel and father born in Israel; and *TFE* is a vector of time (annual) fixed-effects. Finally, ln(·) is the log operator, $\alpha_1 - \alpha_5$ and $\vec{\alpha}_6 - \vec{\alpha}_8$ are the estimated coefficients and vectors of coefficients, respectively, associated with equation (5), and ε_2 is a random disturbance term.

Columns 1 and 2 in Table 5 present OLS estimates of equation (5) for the consumption-adjusted and traditional approaches, respectively. Results provide evidence of systematic variation in housing affordability across demographic traits. Notably, those variations differ markedly between the consumption-adjusted and standard measures. Among salient results, note that an increment by one year in educational attainment associates with housing affordability gains (decrease in the housing price-to-net income ratio) of 4.5 and 3.3 percent under the consumption-adjusted and traditional approaches, respectively (coefficients are significant at the 1 percent level). Among other findings, Israeli Arab household status (compared to the base category of Jewish or other households) is associated with sharply depressed levels of housing affordability; indeed, Arab households in Israel are associated with 27 and 14 percent increases in the housing price-to-net income ratio under the consumption-adjusted and traditional measures, respectively (coefficients and difference between them are significant at the 1 percent level). Household affordability is similarly depressed among female-headed households (compared to the male category). As shown, female household heads are associated with a 6 percent increase in the housing price-to-net income ratio under both measures (significant at the 1 percent level).[20] Also, compared to head-of-households born in Israel whose father was also born in Israel, those born in the former Soviet Union associate with a 14 percent and 11 percent increase in the housing price-to-net income ratio under the consumption-adjusted and traditional measures, respectively (coefficients and difference between them are significant at the 1% level). Finally, note as well that those born in Israel whose father was born in Europe or America associate with improved affordability; 18 percent and 11 percent decline in the housing price-to-net income ratio under the consumption-adjusted and traditional measures, respectively. In sum, regression findings suggest significantly higher

[20] Our outcome on the gender effect in housing affordability relates to evidence on the association between gender and housing consumption (e.g., Mayo, 1981; Birch, 1985; Laux and Cook, 1994; and Saegert and Clark, 2006).

consumption-adjusted affordability burdens (relative to the traditional measure) among lower education, minority, and former Soviet Union immigrant households.

6. How Trends in House Prices and Income Affect Households with Severe Affordability Burdens

In this section, we assess the affordability incidence of economy-wide trends in house prices and income. The analysis focuses on households with severe affordability burdens and is undertaken using our new consumption-adjusted affordability measure. Moreover, we examine whether the incidence of economy-wide trends varies systematically between those who live in Israel's superstar city (Tel Aviv) compared with those who live in outlying, peripheral areas.

Consider the following estimated equation:

(6)

$$\ln(RHA_{it}) = \beta_1 + \beta_2 \ln(HPI_t) + \beta_3 \ln(Avg\_Inc_t) + \vec{\beta}_4 DEMOGRAPHY_i + \vec{\beta}_5 LFE_i + \varepsilon_{3it},$$

where the indices *i* and *t* represent households and time periods (years), respectively, and the dependent variable, $RHA_{it} = (P^{CA}/Income)_{i,t} - \overline{(P^{CA}/Income)}_t$, where $\overline{(P^{CA}/Income)}_t$ is the average of $(P^{CA}/Income)_{i,t}$ across all sample households in year *t*; thus, RHA_i is the relative-to the-mean individual housing affordability. We first estimate equation (6) only for those households who exhibit relative unaffordability, namely, whose $(P^{CA}/Income)_{i,t} > \overline{(P^{CA}/Income)}_t$ (i.e., whose consumption-adjusted housing price-to-net income ratio is greater than the average ratio for that year). The independent variables in equation (6) include *HPI*, the quality-adjusted housing price index for Israel; *Avg_Inc*, the mean income of households in Israel; *DEMOGRAPHY*, a vector of household demographic variables included on the right-hand side of equation (5) above (including *Female*, *Arab*, *Age*, *Education*, *STATUS*, and *CONTINENT*); and *LFE*, a vector of city fixed-effects. Also, ln(·) is the log operator, $\beta_1 - \beta_3$ and $\vec{\beta}_4 - \vec{\beta}_5$ are the estimated coefficients and vectors of coefficients, respectively, associated with equation (6), and ε_3 is a random disturbance term.

Note that the dependent variable in (6), RHA_{it}. measures the extent to which the household's affordability burden exceeds the mean affordability burden. That is, by specifically focusing on the sub-sample whose $(P^{CA}/Income)_{i,t}$ is greater than $\overline{(P^{CA}/Income)}_t$ it follows that the larger is the RHA_{it} term, the greater is the affordability burden experienced by household *i* relative to the sample average affordability burden at time *t*.

As *HPI* and *Avg_Inc* are highly correlated (Pearson correlation equals 0.77), we separately estimate (6) for each of these factors. Columns 1 and 2 in Table 6 present OLS estimates of the association between severe affordability burdens and economy-wide trends in *HPI* and *Avg_Inc*, respectively, controlling for demographic and location characteristics. Estimation results indicate that a 1 percent increase in average housing prices (*HPI*) and average income (*Avg_Inc*) is associated with a 0.57 percent and 0.39 percent increase in the relative consumption-adjusted house price-to-net income ratio of those less privileged households [i.e., households who maintain$(P^{CA}/Income)_{i,t} > (\overline{P^{CA}/Income})_t$]. Those coefficients are significant at the 1% level. In other words, as expected, housing affordability deteriorates for the severely burdened group as average prices rise. Further, affordability burdens among less privileged households increase as economy-wide incomes trend up. The latter is likely due to: (*a*) the skewing of the increase in income to the more privileged group [i.e., those for whom $(P^{CA}/Income)_{i,t} < (\overline{P^{CA}/Income})_t$]; and (*b*) the associated increase in average housing prices, where income increase is insufficient to compensate for the increase in housing prices.

In columns 3 and 4 of Table 6, we repeat the estimation of equation (6) for the sub-sample of households whose $(P^{CA}/Income)_{i,t} < (\overline{P^{CA}/Income})_t$ (i.e., those households whose consumption-adjusted house price-to-net income ratio is below the sample average affordability burden for that year). Note, however, that we compute $RA_{it} = (\overline{P^{CA}/Income})_t - (P^{CA}/Income)_{i,t}$ in order to maintain positive values on the left-hand side of (6). As shown in columns 3 and 4, a 1 percent increase in average housing prices (*HPI*) and average income (*Avg_Inc*) is associated with a 0.71 percent and 0.62 percent *decrease* in the relative-to-the-mean consumption-adjusted house price to net income ratio among those more privileged households [i.e., households who maintain$(P^{CA}/Income)_{i,t} < (\overline{P^{CA}/Income})_t$]. Those coefficients are significant at the 1% level. In other words, economy-wide trending up in house prices in Israel serves to improve the relative affordability burden of those already less affordability burdened households.[21] A similar result is obtained as regards the trending up in economy-wide average income. It follows from columns 1-4 that the economy-wide trending up in *HPI* and *Avg_Inc*

[21] `Note that RHA_{it} measures affordability of household *i* relative to average affordability across all households at time *t*. Our results thus show that economy-wide trending up of house prices (likely to be accompanied with economy-wide changes in income) serve to improve (diminish) relative—to the mean—affordability of those already less (more) affordability burdened.

evidenced in Israel is associated with increased inequality in housing affordability among the more and less affordability burdened groups.

In columns 5-8 of table 6, we repeat the estimations of columns 1-4 for the sub-samples of households who are in even more (columns 5 and 6) or less (columns 7 and 8) affordability burdened. Specifically, we stratify the sample by those households whose consumption-adjusted house price-to-net income ratio is in the highest and lowest affordability burden quantiles (i.e, fifth and first quantiles, respectively). As shown in columns 5-8, results are robust to this specification.

Finally, we focus on those households with the highest and lowest affordability burdens (i.e., households in the fifth and first quantiles of the consumption-adjusted house price-to-net income ratio) by geography, so as to assess the incidence of economy-wide trends in house price and income among those living in Israel's superstar city (Tel Aviv) versus those living in outlying, peripheral areas.[22] As suggested above, Tel Aviv is home to many of Israel's leading cultural and corporate entities; the city has sustained elevated rates of house price increase over the course of recent decades. Columns 1 and 2 (3 and 4) in Table 7 present the outcomes from estimating equation (6) controlling for *HPI* (*Avg_Inc*) for the most affordability burdened subset of households in the periphery and Tel Aviv, respectively. Outcomes are consistent with those presented in Table 6. In particular, the affordability incidence of economy-wide increases in house prices and incomes is more adverse among those highly affordability burdened households living in the periphery relative to those residing in Tel Aviv. In other words, a 1 percent increase in *HPI* (*Avg_Inc*) is associated with an 0.57 percent and 0.32 percent (0.20 percent and 0.12 percent) increases in the relative consumption-adjusted house price-to-net income ratios of the periphery and superstar city groups, respectively (estimates are significant at the 1% level and are different in the periphery relative to the superstar city for the *HPI* coefficient at the 1% level). Columns 5-8 in table 7 present that equivalent estimation outcomes for those households who are least affordability burdened (i.e. households in the lowest price-to-net income quantile) in the periphery (columns 5 and 7) and Tel Aviv (columns 6 and 8). Again, outcomes are consistent with those presented in table 6. Specifically, economy-wide trending up in house prices and incomes is associated with improvements in relative affordability burdens among the less burdened households. Further, affordability gains are even more pronounced for the Tel Aviv sub-sample, as compared to those

[22] Recall from above that the periphery index ranges from 1 (most peripheral) to 5 (most central). In fact, only a small share (about 5%) of the household resides in localities whose periphery index equals 1 or 2. We therefore compare here between households living in Tel Aviv and those whose periphery index is equal to either 3 or 4.

households residing in outlying, peripheral areas (coefficients for Tel Aviv are greater than those of the periphery and significantly different for the *Avg_Inc* variable at the 5% level).

7. SUMMARY AND CONCLUSIONS

Recent years have shown increased concern and policy attention to pressing issues of housing affordability. While policymakers have offered a myriad of policy responses, the efficacy of such approaches is predicated on accurate measurement of household affordability burdens. Indeed, longstanding popular measures of affordability may be biased owing to failure to account for variability among households in preferences for and consumption of housing. In this paper, we address those concerns in development and assessment of a new normative consumption- and quality-adjusted measure of housing affordability. We employ the new measure to assess the incidence of affordability burdens as well as to compute a new Gini measure of affordability inequality. Finally, we evaluate how economy-wide trends in house prices and incomes affect the affordability burdens of relatively more and less affordability constrained households and in outlying, peripheral versus superstar Tel Aviv areas.

The analysis employs extensive micro-data from Israel for the 1998–2015 period. Research findings suggest sharp declines in Israel quality- and consumption-adjusted affordability. Further, affordability burdens are pronounced among minority and underprivileged groups. The new consumption-adjusted measure gives rise to elevated Gini measures of inequality in housing affordability. Results further indicate that recent economy-wide trending up in house prices and income in Israel is associated with more pressing affordability challenges among those already in housing distress, particularly in outlying, peripheral areas. Those same macro trends are associated with improved relative affordability among least burdened households, especially those living in Tel Aviv. Evidence provided in this study may prove useful to policymakers in improved measurement and design of programs aimed at mitigating affordability distress.

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Table 1: Number of Cross-Sectional Annual Observations for the Period 1998–2015

Year	Source	Number of Observations (households in survey)	
		Raw sample	Clean sample
1998		13,499	10,448
1999		13,515	10,383
2000		13,485	10,246
2001		13,689	10,345
2002		14,201	10,495
2003		14,418	10,208
2004		14,636	10,300
2005		14,545	9,823
2006		14,582	9,855
2007		14,147	9,465
2008		14,167	10,000
2009		15,114	10,755
2010		15,171	10,465
2011		14,996	10,455
2012		8,742	4,327
2013		9,507	4,737
2014		8,465	4,039
2015		8,550	4,172
Total		235,429	160,518

Notes: Observations indicated in Table 1 come from the Household Income and Expenditure Surveys conducted by the Israel Central Bureau of Statistics. Original total number of households in the sample is 235,429. Missing observations and observations of either households living in cities with insufficient number of housing transactions or clusters with insufficient number of households, led to a final sample of 160,518 households.

Table 2: List of Variables from Income and Expenditure Surveys, Definitions, and Summary Statistics

Variable	Definition	Mean	Std. Dev.	Min	Max
Adults	Number of adults in household	2.07	0.87	1	5
Children	Number of children (under 18) in household	0.79	1.20	0	7
Periphery	Score on the peripheral index (ranges from 1 [most peripheral] to 5 [most central])	4.31	1.19	1	5
Income	Household monthly net income (in dollars)	2,441.9	1,722.8	187.5	10,061
NR	Actual number of rooms consumed by a household	3.47	1.10	1	7
NR^{CA}	Standardized number of rooms	3.47	0.51	2.50	4.84
$\hat{P}$	Estimated price of the actual dwelling unit consumed by a household (in dollars)	194,319	114,730	7,142	1,067,356
$\hat{P}^{CA}$	Estimated price of the standardized dwelling unit of a household (in dollars)	195,864	104,785	17,271	748,704
Tenure	Dummy variable that equals 1 if household is a homeowner and 0 otherwise	0.67	0.47	0	1
Education	Number of Years of education (truncated at 22)	12.92	4.23	0	22
Arabs	Household head with an Arab nationality	0.04	0.19	0	1
Female	Household head is female	0.43	0.50	0	1
Age	Household head age	51.96	17.65	15	108
Married	Household family status: Married	0.621	0.485	0	1
Single	Household family status: Single	0.107	0.309	0	1
Divorced	Household family status: Divorced	0.109	0.311	0	1
Widowed	Household family status: Widowed	0.136	0.343	0	1
Separate	Household family status: Living separately	0.015	0.121	0	1

Variable	Definition	Mean	Std. Dev.	Min	Max
Israel/Israel	Household head born in Israel and father is either born in Israel or unknown	0.134	0.341	0	1

Table 2 (continued): List of Variables from Income and Expenditure Surveys, Definitions, and Summary Statistics

Variable	Definition	Mean	Std. Dev.	Min	Max
Israel/ Asia_Africa	Household head is born in Israel and father's continent of origin is Asia or Africa	0.175	0.380	0	1
Israel/ Euro_America	Household head born in Israel and father's continent of origin is Europe or America	0.117	0.322	0	1
Israel/USSR	Household head born in Israel and father's origin is USSR	0.016	0.126	0	1
Asia_Africa	Household head continent of origin is Asia or Africa	0.173	0.379	0	1
Euro_America	Household head continent of origin is Europe or America	0.151	0.358	0	1
USSR	Household head origin is USSR	0.233	0.423	0	1

Table 3: List of Variables in the Housing Transactions Recorded by the Israel Tax Authority, Description, and Summary Statistics

Variable	Description	Avg.	Std.	Min	Max
P	Transaction closing price (in dollars)	216,469	130,185	17,106	1,800,000
Room	Total number of rooms	3.57	0.86	2	5
Age	The age of the structure (in years) at the time of the transaction	20.83	18.15	0	100
Story	The story on which the asset is located in the structure	2.83	3.01	0	40
DumNew	Dummy variable that equals 1 if *Age* is no more than 1 year; 0 otherwise	0.20	0.40	0	1

Notes: After the omission of transactions in localities with low number of observations (either in the transaction data or in the Household Income and Expenditure data), and the omission of erroneous data, about 670,000 transactions in 62 cities participate in the sample. Closing prices are originally expressed in new Israeli shekels (NIS), however, for ease of presentation were inverted to US dollars using a 1:4 exchange rate (1$=4NIS).

Table 4: Household Clusters According to Number of Children and Number of Adults and Their Share in the Sample

	1 Adult	**2 Adults**	**3 Adults**	**4 Adults**	**5 Adults**	**Total**
No Children	21.4%	27.0%	8.5%	3.6%	0.9%	61.3%
1 Child	1.6%	7.7%	3.3%	2.1%	0.4%	15.2%
2 Children	1.0%	9.7%	2.0%	0.8%		13.5%
3 Children	0.1%	6.0%	0.6%	0.0%		6.8%
4 Children		2.2%	0.1%			2.3%
5 Children or more		0.9%				0.9%
Total	24.1%	53.6%	14.4%	6.6%	1.4%	100.0%

Notes: Cells representing clusters of households with insufficient number of observations are left blank (as we condition the inclusion of a cluster in a given year by including no less than 30 households in the sample). Households in these clusters are omitted from the sample. As a result, the attained cluster distribution, while resembling that of the general population, exhibits a slight bias toward the larger clusters. The maximum bias is attained for the 2-person households whose share in the population (sample) equals 25% (28.6%).

Table 5: Outcomes Obtained from the Estimation of Equations (5)

Variable	Consumption-Adjusted	Traditional	Difference in Coefficient
Constant	5.499***	5.086***	
	(0.181)	(0.178)	
Arab	0.273***	0.141***	***
	(0.013)	(0.013)	
Female	0.056***	0.067***	
	(0.003)	(0.003)	
Education	-0.045***	-0.033***	***
	0.000	0.000	
Age	0.002***	0.003***	***
	0.000	0.000	
Single	0.443***	0.336***	***
	(0.005)	(0.005)	
Divorced	0.371***	0.342***	
	(0.005)	(0.005)	
Widowed	0.334***	0.337***	
	(0.005)	(0.005)	
Separated	0.373***	0.371***	
	(0.012)	(0.012)	
Israel/Asia_Africa	-0.060***	-0.052***	
	(0.006)	(0.005)	
Israel/Euro_America	-0.179***	-0.106***	***
	(0.006)	(0.006)	
hIsrael/USSR	-0.138***	-0.068***	***
	(0.012)	(0.012)	
Asia_Africa	0.007	0.041***	***
	(0.006)	(0.006)	
Euro_America	-0.066***	-0.038***	***
	(0.006)	(0.006)	
USSR	0.141***	0.011**	***
	(0.006)	(0.006)	
LFE (city fixed effects)	included	included	
TFE (time fixed effect)	included	included	
N	155,121	155,121	
R^2	40	36.1	

Notes: Estimators of the categorical time- and city-indicating vector *TFE* and *LFE*, respectively, are not reported in Table 5 and are available by request. Standard errors in parentheses. Two and three asterisks represent significance at the 5%, and 1% levels, respectively.

Table 6: Outcomes Obtained from the Estimation of Equations (6)

Variable	**Column 1**	**Column 2**	**Column 3**	**Column 4**	**Column 5**	**Column 6**	**Column 7**	**Column 8**
Constant	1.244***	0.806***	-0.910***	-2.642***	1.994***	1.244***	0.763***	-0.517***
	(0.169)	(0.308)	(0.069)	(0.125)	(0.106)	(0.196)	(0.077)	(0.039)
HPI_t	0.569***		0.710***		0.567***		0.645***	
	(0.031)		(0.012)		(0.019)		(0.003)	
Avg_Inc_t		0.388***		0.621***		0.423***		0.532***
		(0.035)		(0.014)		(0.022)		(0.004)
$DEMOGRAPH$	included	included	included	included	included	included	included	included
LFE	included	included	included	included	included	included	included	included
N	50,419	50,419	104,702	104,702	29,886	29,886	31,609	31,609
R^2	0.101	0.097	0.170	0.160	0.120	0.107	0.602	0.367
Geography	National	National	National	National	National	National	National	National
Sample	$\frac{P^{CA}}{Income} > (\frac{P^{CA}}{Income})_t$	$\frac{P^{CA}}{Income} > (\frac{P^{CA}}{Income})_t$	$\frac{P^{CA}}{Income} < (\frac{P^{CA}}{Income})_t$	$\frac{P^{CA}}{Income} < (\frac{P^{CA}}{Income})_t$	Least Afford. Quantile	Least Afford. Quantile	Most Afford. Quantile	Most Afford. Quantile

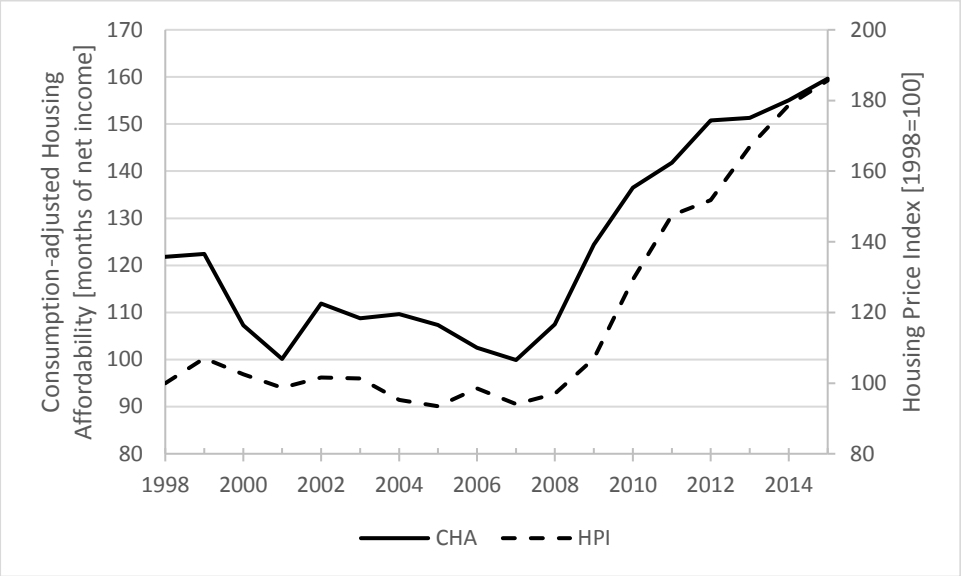
Notes: Standard errors in parentheses. Three asterisks represent significance at the 1% level.

Table 7: Outcomes Obtained from the Estimation of Equations (6) – Tel Aviv versus Periphery

Variable	**Column 1**	**Column 2**	**Column 3**	**Column 4**	**Column 5**	**Column 6**	**Column 7**	**Column 8**
Constant	0.910***	3.755***	2.136***	3.238	0.829***	-0.0003	-0.695***	-1.892***
	(0.242)	(0.222)	(0.436)	(0.260)	(0.025)	(0.117)	(0.061)	(0.224)
HPI_t	0.572***	0.320***			0.665***	0.706***		
	(0.044)	(0.041)			(0.005)	(0.021)		
Avg_Inc_t			0.198***	0.124***			0.568***	0.635***
			(0.049)	(0.047)			(0.007)	(0.025)
DEMOGRAPHY	included	included	included	included	included	included	included	included
LFE	included	included	included	included	included	included	included	included
N	10,675	3,289	10,675	3,289	10,967	3,289	10,967	3,289
R^2	0.143	0.051	0.131	0.036	0.682	0.286	0.440	0.286
Geography	Periph.	Tel Aviv	Periph.	Tel Aviv	Periph.	Tel Aviv	Periph.	Tel Aviv
Sample	Least Afford. Quantile	Least Afford. Quantile	Least Afford. Quantile	Least Afford. Quantile	Most Afford. Quantile	Most Afford. Quantile	Most Afford. Quantile	Most Afford. Quantile

Notes: Standard errors in parentheses. Three asterisks represent significance at the 1% level.

Figure 1: Average value of Consumption-adjusted Housing Affordability, 1998–2015



Notes: the HPI values for each year represent the January housing price index of that year, as published by the Israeli Central Bureau of Statistics. We set 1998 to be the 100-point base.

Exhibit 2: $NR_{i\in ACLY}/NR^{CA}_{i\in ACLY}$ and $\hat{P}_{i\in ACLY}/\hat{P}^{CA}_{i\in ACLY}$ by Income deciles, 2015

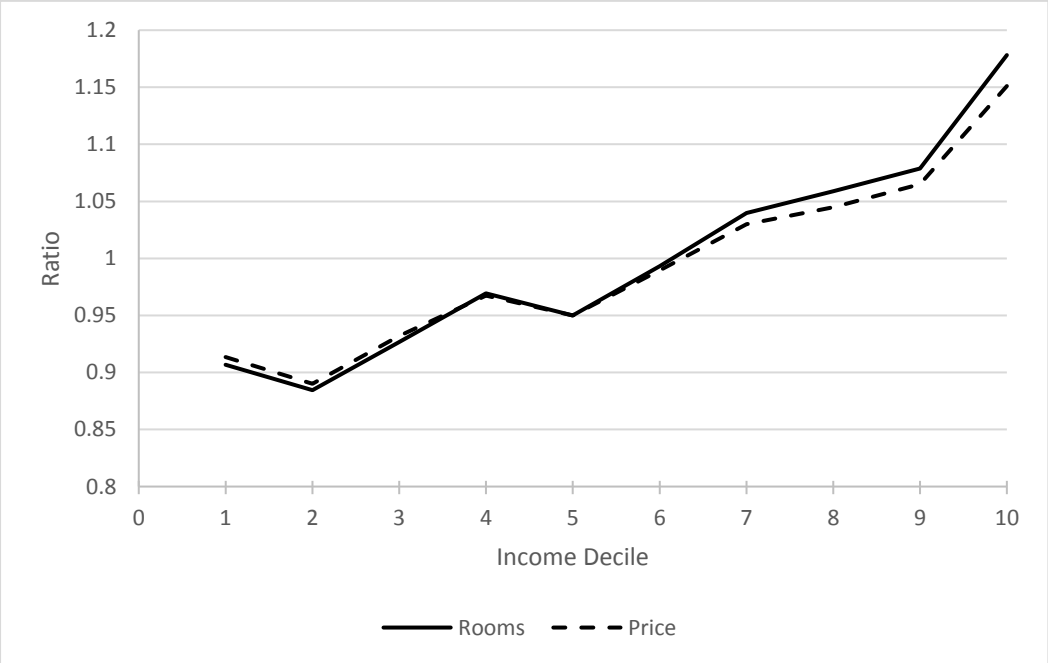


Figure 3: Annual Average Consumption-Adjusted and Traditional Affordability Measures Stratified by Below- and Above-Consumption-Adjusted Housing, 1998–2015

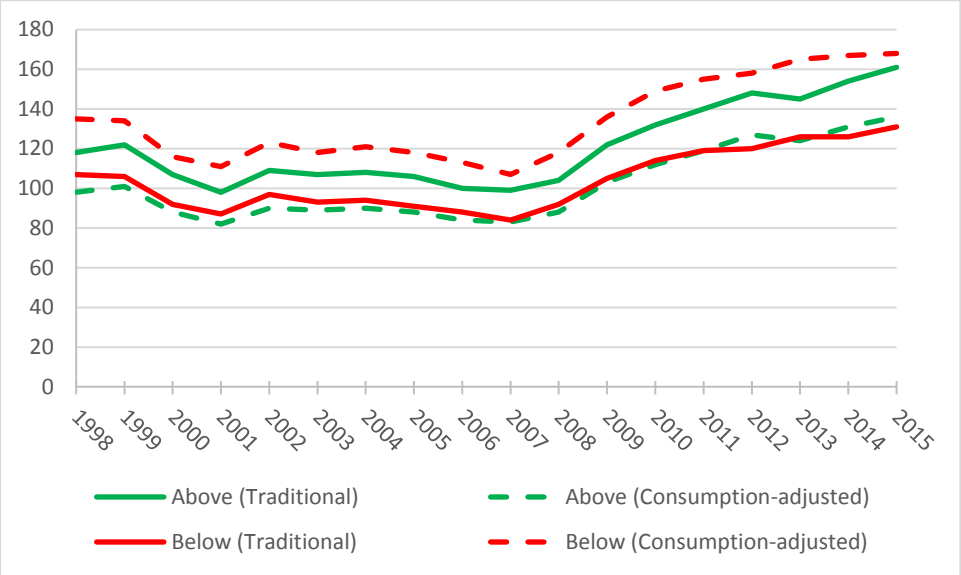


Figure 4: Average Consumption-Adjusted and Traditional Affordability Measures Stratified by Below- and Above-Consumption-Adjusted Housing in Three Largest Cities, 2015

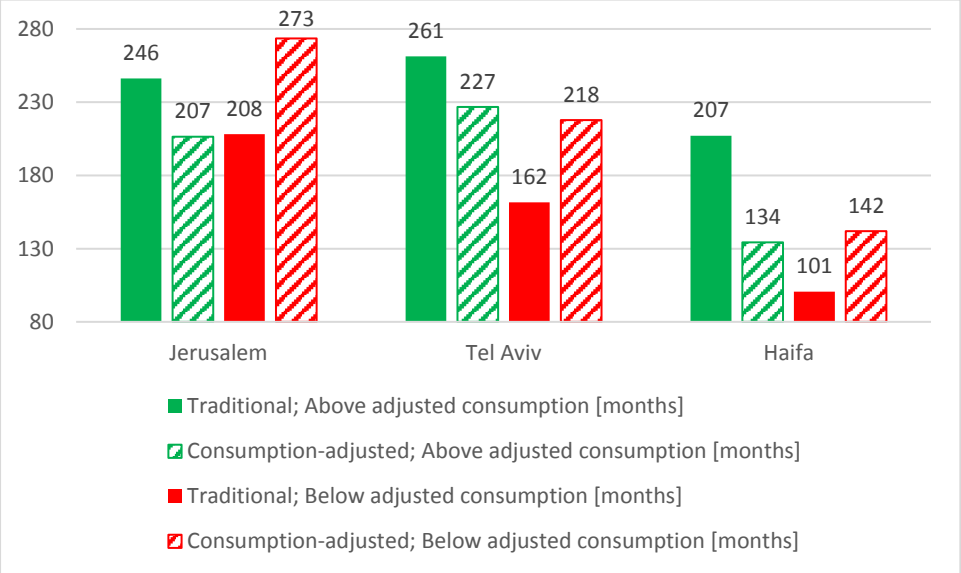
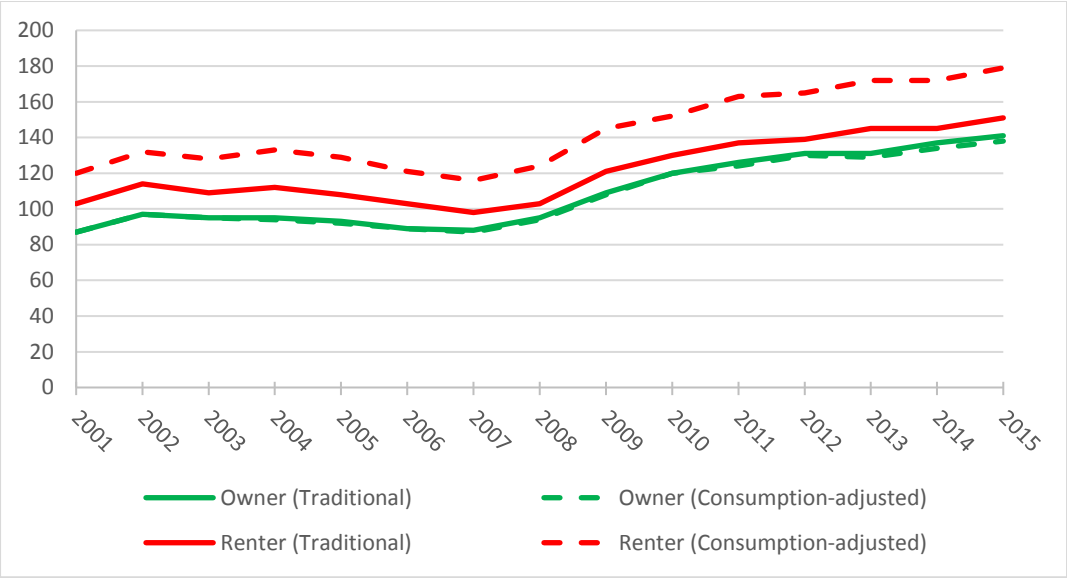
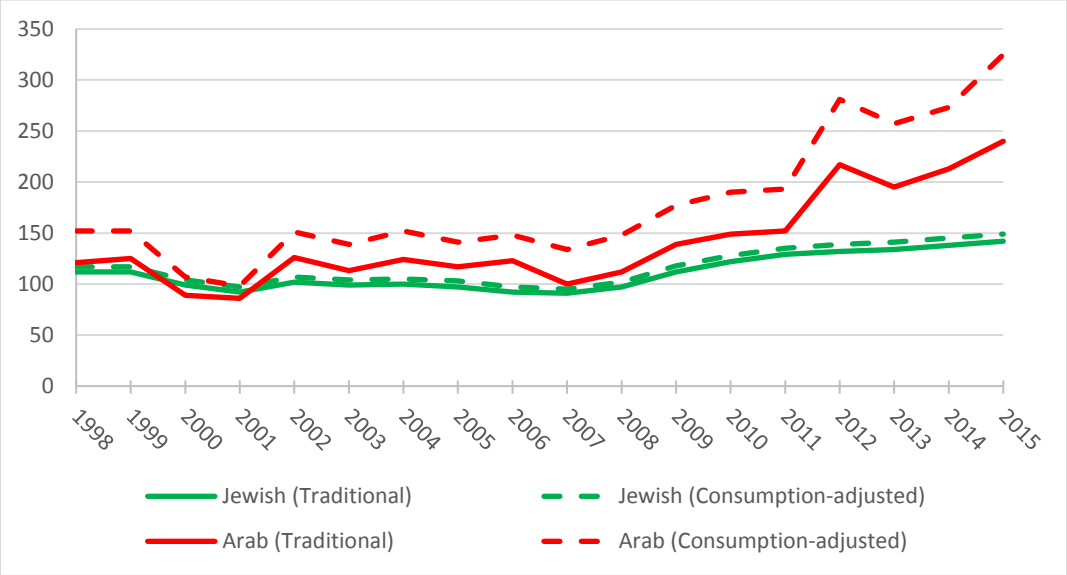


Figure 5a-5d: Average Standardized and Traditional Affordability Measures Stratified by Nationality, Gender, Tenure Mode, and Education, 1998–2015

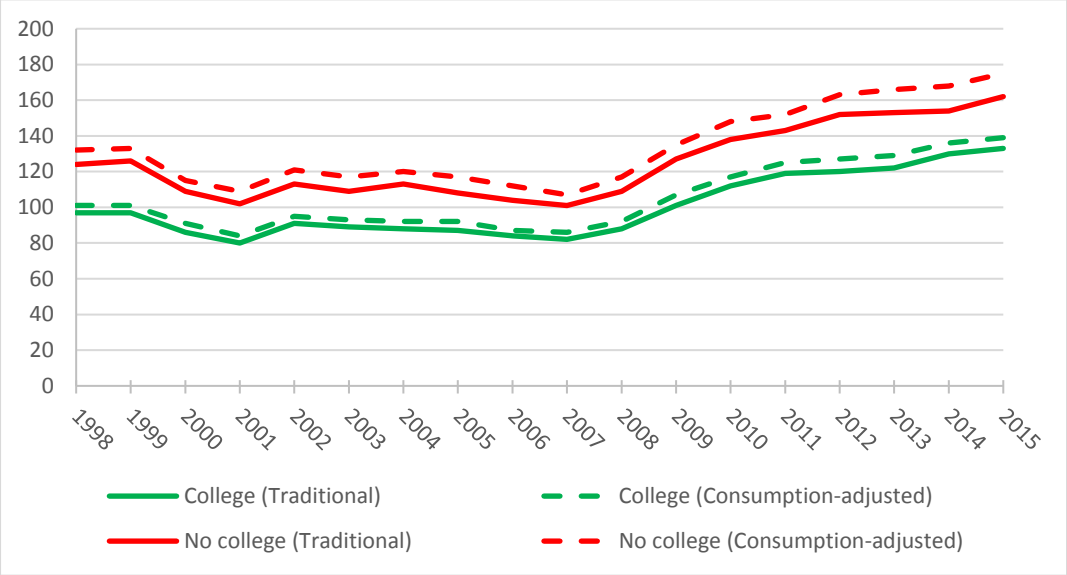
5a: Tenure Mode



5b: Nationality



5c: Education



5d: Gender

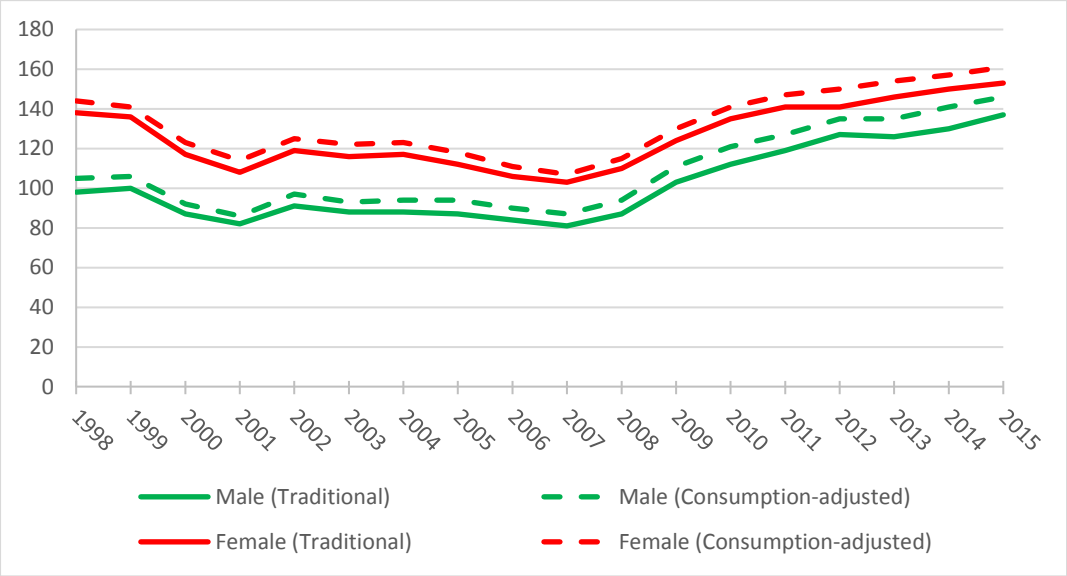


Figure 6: Income and Housing Affordability Gini Coefficients of Inequality, 1998–2015