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Housing Affordability: A New Dataset

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Housing Affordability: A New Dataset

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ABSTRACT: The rapid increase in house prices in the past few years, including during the COVID-19 pandemic, raises concerns about housing affordability. The price-to-income ratio is a widely-used indicator of affordability, but does not take into account important factors such as the cost of financing. The aim of this paper is to construct a measure of housing affordability that takes these factors into account for a large set of countries and long period of time. The resulting dataset covers an unbalanced panel of 40 countries over the period from 1970Q1 to 2021Q4. For each country, the index measures the extent to which a median-income household can qualify for a mortgage loan to purchase an average-priced home. To gauge the performance of the constructed indices, we compare them to other readily-available mesures of affordability and examine the evolution of the indices over time to understand the relevant drivers, including in a regression analysis to assess the extent to which government housing programs could contribute to improving affordability.

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WORKING PAPERS

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Contents

Glossary

GFC	Global Financial Crisis
LTV	Loan-to-value ratio
PIR	Price-to-income ratio
NAR	National Association of Realtors
BIS	Bank for International Settlements
OECD	The Organization for Economic Cooperation and Development
IMF	International Monetary Fund
ECB	European Central Bank
MFI	Monetary financial institution
MMF	Money market fund
HAI	Housing affordability index
AE	Advanced economy
EM	Emerging market
Eurostat	European Statistical Office

Introduction

During the short but deep COVID-19 recession, contrary to expectations and experience in earlier recessions, house prices rose at record levels in many countries. This rise often reflected a combination of demand and supply factors. On the demand side, policy support measures sustained income and allowed financing conditions to remain favorable at a time when many households started looking for more space. On the supply side, constraints on new construction and on mobility kept a tight rein on the number of available properties in the market. While many observers during the pandemic noted that financial risks remained limited thanks to policies put in place in the aftermath of the Global Financial Crisis (GFC), concerns were raised about housing affordability. Even before the pandemic magnified the challenge, affordability was already a policy concern for many countries around the world, as prices quickly resumed their upward march following the correction or pause around the GFC.[1]

One of the challenges in assessing how big a concern housing affordability is stems from the lack of cross-country indicators beyond simple metrics. The price-to-income ratio (PIR) has been used often as a proxy for affordability and is available from international organizations such as the BIS and the OECD, as an index that primarily compares the developments in house prices to developments in income per capita. Its main downside is that it does not take into consideration any mortgage market or housing characteristics. For instance, an increase in mortgage interest rates would worsen affordability by increasing the monthly payments required, even if house prices and household income were held constant. Also, an increase in mortgage rates could decrease house prices, which would reduce the simple price-to-income and complicate the assessment of housing affordability.

Another proxy of housing affordability that could be considered is OECD's housing cost overburden rate, which captures the percentage of households spending over 40% of their income on housing, including costs like rent, mortgage payments, utilities, and maintenance. While this measure is an indicator of the financial burden housing costs place on households for shelter, particularly for those with lower incomes, it takes housing tenure choices as given and does not consider whether a typical family that would prefer to own rather than rent can qualify for a mortgage loan to purchase a typical home, based on prevailing prices and interest rates. Yet another proxy that could be considered is BIS' debt service ratio. This measure, however, does not necessarily capture housing affordability, but rather the burden of debt (including but not limited to housing-related debt) on a household's income. While a handful of countries, including Australia, Canada, New Zealand, the United Kingdom, and the United States, have readily-available indicators of housing affordability that take into consideration mortgage market or housing characteristics, the methodology used in computing these indices varies across countries, which could present a challenge by introducing a measurement error when conducting cross-country analysis.

[1] See, for example, Ahir and Loungani (2019), Ahir et al (2021), Deb et al (2022), and Beraldi and Zhao (2023).

The aim of this paper is to construct a housing affordability index (HAI) that covers a large panel of countries over a long time period and that takes into consideration particular aspects of mortgage and housing markets such as the cost of financing and the typical size of a home within a country. We construct this index for a total of 40 countries for the period between 1970Q1 and 2021Q4. We define affordability as the ability of a median-income household to qualify for a mortgage loan needed to purchase an average-priced home within a country.[2] In constructing the index, we mainly follow the methodology of the National Association of Realtors (NAR), which computes the index for the United States, and extend it to 39 additional countries. In doing so, we collect data on (i) the level of house prices (expressed as price per square meter), (ii) median household income, (iii) mortgage rates, (iv) typical loan-to-value (LTV) ratios, (v) average term-to-maturity of mortgage loans, (vi) average property size, and (vii) average household size.

One of the main challenges with expanding the NAR methodology to other countries is the lack of house price levels reported in national currency, which is necessary to compute the cost of a typical home that a household could afford. Most organizations that maintain cross-country house price datasets, including the BIS and the OECD, report prices as indices standardized to a particular base year. To overcome this challenge, we use data from Bricongne et al. (2019), who collect information on the cost of housing by square meter, and extend their series using the growth rates of house price indices provided by the BIS (as we explain in more detail in the data section).

Another challenge with computing the index is the lack of data on other variables such as mortgage rates, typical LTV ratios, and average term-to-maturity of mortgage loans from a centralized database. In our exercise, we overcome these challenges by (i) drawing data from multiple sources including national statistical offices, (ii) extending and complementing the data series using linear interpolation and back-casting, and (iii) adopting proxies for missing variables.

We perform several exercises to gauge the performance of the cross-country affordability indices we construct. First, for the case of the United States, we compare the NAR index to the one we construct using the data we collect. Second, we analyze the performance of the cross-country indices over time by looking at the summary statistics and the factors driving the dynamics. Finally, to explore the impact of policies on affordability, we also perform regression analysis to examine the link between government spending on housing and affordability.

The rest of the paper is organized as follows. We start with a stocktaking of affordability indices in a few selected countries. Then, we outline the data and the methodology we use to construct the HAI. Next, we document the empirical properties of the HAI over time and across countries as well as its link to government spending on housing. We conclude with a brief summary of the key findings.

[2] We acknowledge that our affordability index, derived from median household income, captures housing affordability for the median household, and not for the broader household income distribution.

Existing Housing Affordability Indices in Selected Countries

A parsimonious measure of housing affordability is the ratio of house price to household income, or the PIR. For example, the OECD publishes this ratio for 47 countries going as far back as 1970Q1.[3] While the PIR provides important information on how well house prices are aligned with household income, it omits important features of a country's housing and mortgage markets. These are relevant because most property purchases involve a loan and mortgage availability, and loan characteristics greatly influence households' housing tenure decisions.

Housing affordability measures that consider aspects of the mortgage market and other housing characteristics are regularly reported only in a handful of countries (for instance, the United States, Australia,[4] Canada,[5] New Zealand,[6] and the United Kingdom[7]). However, the methodology employed in the computation of the indices differs across countries, which poses comparability challenges for conducting cross-country analysis. In this section we highlight some of the main methodological differences in computing these affordability indices.

Conceptually, housing affordability is defined by the ability of a household to make the regular mortgage payments needed to purchase a home while continuing to be able to meet other essential needs and still have an income buffer.[8] This is then a function of household income and house prices, but also mortgage rates, the LTV ratio, and the term-to-maturity of the mortgage loan as the latter factors determine how much a household needs to pay on a monthly basis. Using this information, the affordability index can be obtained as the ratio between household income and a qualifying income that a household would need to earn to qualify for a typical mortgage to purchase a typical house. A higher ratio corresponds to more affordable housing. The index maintained by the NAR in the case of the United States is such an example and we use it as our benchmark.[9]

The most similar index to the one computed by the NAR for the United States is the affordability index for Australia computed by Australia's Housing Industry Association (HIA). The methodologies adopted by the two organizations are fairly similar, the main difference between the two lies in the assumption used to compute the qualifying income: HIA assumes that a mortgage repayment should not exceed 30 percent of households' monthly income, whereas NAR assumes this number to be 25 percent.

[3] Prices—Housing prices—OECD Data.

[4] Australia HIA Housing Affordability.

[5] Real Estate Market: Definitions, Graphs and Data—Bank of Canada.

[6] New Zealand—Housing Affordability Measure.

[7] Housing Purchase Affordability, Great Britain - Office for National Statistics.

[8] Here our focus is on owner-occupiers. Households may also choose to be renters. Then the affordability concept would relate to the relationship of household income to rents. Our analysis still would provide some insight into rental affordability as well, given the close relationship between house prices and rents.

[9] One difference with the NAR methodology is that we use the average house price rather than the median, given data availability across countries.

The Bank of Canada goes a step further and computes the housing affordability index as a ratio, where the numerator is the housing-related costs which comprise not only the mortgage payments but also the utility fees for owning a house, and the denominator is the average disposable household income. Hence, the methodology accounts for a broader set of costs associated with owning a home and considers the household overall average income (net of taxes and transfers) rather than a percentage of it deemed to be minimum in order to obtain a loan.

New Zealand's Ministry of Housing and Urban Development computes three measures of affordability. One is the percentage of households spending more than 30 percent of their income on housing. The second is the percentage of households with below average income after housing costs. A third is an affordability index, closely resembling the one by NAR. The index captures the proportion of first-time homebuyers in a particular area of New Zealand whose income after mortgage payments is above or below the estimated national median equivalized income after housing costs (mortgage payments, fees related to property maintenance, and insurance).

The United Kingdom's Office for National Statistics measures affordability as the ratio between median and lower quartile house prices and annual earnings for full-time workers (rather than household income) over time and geographies. In efforts to refine this measure and reflect on different circumstances that can affect whether housing is affordable or not, alternative measures also consider the overall household income and house price distributions, the upfront costs of purchasing a property, mortgage repayments, and private rental affordability.

To balance the trade-off between needing a limited set of variables and still being able to construct comparable affordability indices for a panel of 40 countries, we follow the NAR methodology. The advantage of using this methodology as the benchmark is that the NAR index is regularly updated, the methodology is explained clearly, and the index accounts for a rich set of information on housing and mortgage markets.

Construction of a New Housing Affordability Index in a Cross-Country Set-up

Data

To construct the cross-country indices, we use data on house price levels (in terms of price per square meter), house price growth rates (calculated from house price indices data), median household income, mortgage rates, average LTV ratios, average size of home (in terms of square meters), and average number of household

members per household for an unbalanced panel of 40 countries for the period 1970Q1–2021Q4.[10] In this section, we discuss the main data sources and the alternatives that we resort to when data is not available from cross-country databases. We also discuss the methodology used in extending the series backwards or forwards in the case of missing observations.

House price data in local currency. We use two data sources to construct a measure of house prices in local currency (in terms of levels, as opposed to an index). First, we draw data from Bricongne et al. (2019), who compute the average cost of housing per square meter (in euros) for an unbalanced panel of 40 OECD countries over the period 1970 to 2017. Since these data are not regularly updated, we extend the coverage as follows. We identify 2015 as a base year and convert the house price per square meter data to local currency using the exchange rate of the local currency vis a vis the euro in 2015.[11] We then draw data on house prices from the BIS (in terms of indices) for all countries in the sample and calculate quarterly nominal growth rates. By applying the growth rates to the base year, we generate the average nominal house prices per square meter. This way, the dataset on house prices spans over the period from 1970Q1 to 2021Q4 for those countries with the maximum number of observations, and at least over the period from 2010Q1 to 2021Q4 for the countries with the minimum number of observations (Poland and Turkey).[12]

Lending rate. We collect residential mortgage rates from various sources.[13] Out of 40 countries in our sample, for 18 countries we draw data from the European Central Bank (ECB),[14] and from Haver Analytics for the rest, except for Iceland as lending rates for house purchases are not available in Haver.[15] In the case of Iceland, we use the general interest rate, from the Central Bank of Iceland, adjusted for inflation.[16] Lastly, since for some countries, data on mortgage rates have a shorter time span than data on house prices, we back-cast mortgage

[10] See Tables A1, A2, A4, and A5 in the Appendix for details on data sources and the length of time horizon by country.

[11] The choice of 2015 is to some extent arbitrary and an alternative base year could be selected. We opt for 2015 because it is a recent, relatively calm year for the world economy during which data for all countries in the sample is available. The indices we compute are robust to the choice of base year.

[12] Both the HPI from the BIS and the Bricongne et al. (2019) data tend to have similar geographical and segment coverage within a country. That said, the constructed series still depends on imputed data and mismeasurement cannot be ruled out.

[13] See Table A4 in the Appendix for detailed sources and definitions of the data.

[14] The lending rate we select refers to the rate charged by credit and other institutions for house purchases of households and non-profit organizations. The rate is the average obtained by weighting different volumes of credit and credit rates. We follow these steps to select this variable: Monthly – Credit and other institutions (MFI except MMFs and central banks) – Lending for house purchase excluding revolving loans and overdrafts, convenience and extended credit card debt – Total calculated by weighting the volumes with a moving average (defined for cost of borrowing purposes) – Annualized agreed rate (AAR) / Narrowly defined effective rate (NDER) – Total – Households and non-profit institutions serving households (S.14 and S.15) – Euro – New business.

[15] The mortgage rate series from Haver vary across countries due to data availability. Apart from the US for which rates are reported for fixed rate mortgages, for all other countries rates are reported for variable mortgage rates with varying reset and maturity terms across countries.

[16] The general interest rate refers to the rate that is generally available to the private borrowers (households and businesses) from credit institutions such as commercial banks (see here). A specific feature of the Icelandic mortgage market is that, typically, mortgage rates are inflation indexed. Hence, we add inflation to the general interest rate to obtain our proxy for the mortgage rate.

rates using data on long-term rates (from the OECD) or policy rates (from BIS or national sources).[17] To back-cast the series for each country individually, we regress the mortgage rate for the period during which data are available on the contemporaneous lending rate (long-term lending rate or the policy rate depending on which one is available) and use the predicted values from this regression for the periods with missing data to generate a proxy for the mortgage rate, which we then use in our analysis.[18]

Loan-to-value (LTV) ratio. LTV ratios are also collected from multiple sources (see Table A1 in Appendix for details). Out of 40 countries in the sample, the data for 30 countries is drawn from the Hypostat report dated 2020.[19] For Greece, Hungary and Norway, this ratio is obtained from Cerutti, Dagher, and Dell'Ariccia (2017). Lastly, we complement the data for the rest of the countries using national sources (Australia, Canada, and Sweden) or reports from international organizations (Finland, Italy, Japan, and Slovenia).

Typical mortgage loan maturity. To a large extent, the sources for mortgage maturity are quite similar to that for the LTV ratios.[20] Data for 31 countries come from the Hypostat report 2020,[21] complimented by Cerutti, Dagher, and Dell'Ariccia (2017) for 4 countries, namely Greece, Hungary, Latvia, and Malta. Of the remaining countries, we use national sources for Australia, Canada, and Romania and information from international organizations for Japan and Italy.

Average property size. The cross-country data on the average size of a home in terms of square meters come from Eurostat for 29 countries, measured as of 2012, which is the latest publication date. For the remaining countries in the sample, average home size is obtained either from official national statistics offices or data referenced in the literature (see Table A1 in the Appendix for details on the data sources for each country).

Average household size. The data on the average number of household members come from Eurostat for 33 countries, United Nations for 6 countries, and from the Population Reference Bureau (PRB) for Russia (see Table A1 in the Appendix). Although data from the UN cover the period between 2013 and 2016, it should not pose a constraint to our analysis as household size tends to be relatively constant over time within a country and does vary considerably across countries covered in our sample.

[17] For the back-casting exercise, our first choice is the long-term lending rates from OECD, followed by policy rates from the BIS or national sources. In a few special cases, lending rate from the IMF's International Financial Statistics (IFS) database and short-term lending rate from OECD are used to address breaks in time series data. We refer the reader to Table A4 in the Appendix for details on each country.

[18] Long-term borrowing rates have a strong predictive power for mortgage rates, with a median R-squared of 0.82 and average of 0.75 in the sample of countries.

[19] Hypostat 2020 | A Review of Europe's Mortgage and Housing Markets.

[20] Table A1 in Appendix contains information on the data sources by country.

Median household income. Data on median household income come mainly from surveys conducted by Eurostat (32 countries).[22] For the remaining 8 countries, data come either from national sources,[23] CEIC, or OECD Income Distribution Database.[24] Since for most economies (apart from Canada, Hong Kong SAR, South Korea, and the United States) median household income is reported in terms of equalized household income, we multiply the income data by the average household size to recover household-level income.[25] In addition, since median household income is in most cases available only at annual frequency, we generate quarterly series by linearly interpolating the annual data. Since time series of median household income does not cover the entire sample period, we extend the data backwards and forwards as needed, using GDP per capita growth rates gathered from the IMF's World Economic Outlook Database. This assumes that the median household income has the same growth rate as the GDP per capita within a country—a caveat that could lead to overestimation of affordability, particularly if income distribution is becoming more skewed and upper deciles end up enjoying larger gains.

Methodology

The housing affordability index is obtained using a formula that combines information on (i) the price of a typical house, (ii) the income of a typical household, (iii) the average mortgage rates, (iv) the typical LTV ratio,[26] and (v) the typical maturity of a mortgage. We follow these steps to compute each building block of the affordability index:[27]

1. We calculate the price of a typical house (*HP*) by multiplying the price per square meter by the average size of a home.
2. We compute a household's monthly payment (*PMT*), for principal and interest of a mortgage loan in the amount of *HP*LTV*, using the formula:

$$PMT = HP * LTV * \frac{IR}{12} * \left[1 - \frac{1}{\left(1 + \frac{IR}{12}\right)^{MA}}\right]^{-1},$$

where *IR* denotes the annualized mortgage rate and *MA* denotes the maturity (in months).[28]

[22] European Union's statistics on income and living conditions (median income by household type, EU-SILC and ECHP surveys).

[23] United States: Census Bureau; Hong Kong SAR, South Korea, and Russia: CEIC; Australia, New Zealand, and Japan: OECD; Canada: National Statistical Agency.

[24] See Table A5 in the Appendix for details on the data sources across countries.

[25] "Equalized" in this context means by person because the size of the household can vary across countries. But it is still the median income. Then we multiply the (equalized) median income by the average size of the household to obtain a median household income that is comparable across countries.

[26] We place emphasis on typical LTVs rather than regulatory LTVs to highlight the long-term structural features of mortgage markets, rather than cyclical fluctuations. Further regulatory LTVs are a relatively new phenomenon in some of the countries in the sample, introduced under the macroprudential frameworks in the aftermath of the GFC.

[27] To simplify the notation, we suppress the subscript *i* when denoting the variables for each country *i* in the sample.

[28] Using the NAR's methodology, the HAI measures housing affordability based on the capacity of households to qualify for a mortgage at a typical LTV ratio. However, we acknowledge that, while a higher LTV can decrease affordability due to the increased costs of servicing larger loans, a lower down payment requirement could potentially enable more households to consider property ownership.

3. We compute the necessary annual income (*QINC*) a household needs to qualify for a mortgage loan, equal to:
   $QINC = PMT * 4 * 12,$
   where we assume that for a household to qualify for a mortgage loan, the monthly mortgage payment should not exceed a quarter of the household's monthly income. This is a commonly used rule of thumb in the mortgage industry, in line with the standard often used in the international debate on housing affordability (housing is considered affordable if households do not spend more than 30% of their gross income on housing costs including insurance and taxes, see OECD).
4. Then, the housing affordability index (HAI) is obtained as:
   $HAI = \left(\frac{MEDINC}{QINC}\right) * 100,$
   where *MEDINC* is the median household income.
   This way, for each country, the index measures the degree to which a typical family can afford the monthly mortgage payments for a home valued at the average market price within a country. A value of 100 for the index indicates that a median-income household has exactly enough income to qualify for a mortgage loan on an average-priced home; an index value above 100 indicates that a household has more than the qualifying income while a value below 100 indicates that a household does not have the sufficient income to qualify for a mortgage on an average-priced house.

Assessing the Performance of the New Housing Affordability Index

Comparison of Housing Affordability Indices in the United States

In this section we compare the NAR index for the United States to the one we compute using our data and the methodology outlined in the previous section. Since we follow the NAR methodology, the first step in validating our approach is to ensure that the two indices for the United States follow similar dynamics. Figure 1 reports the two housing affordability indices for the United States: the line with the triangle markers is the HAI we compute, and the line with the circle markers is the HAI reported by NAR. Overall, the two indices are very similar, with an average of 122.8 and 127.5 over the period 1970q1-2021q4 for our index and NAR's, respectively, and their standard deviation over the same horizon at 27.8 and 30.1, respectively. Also, the correlation between the two indices over the same horizon is 0.96. These statistics indicate that our data and methodology largely reproduce the index reported by NAR.

The fact that the two HAIs have very similar dynamics and are highly correlated gives us comfort in the validity of our exercise. The slight differences are explained by differences in data sources. First, NAR uses data on the median house price; whereas, due to cross-country data constraints, we rely on the average (as opposed to the median) house price per square meter that we construct as described in the data section. Second, although both

NAR and our estimation draws median household income data from the Census, again for comparability purpose, we interpolate the annual data into quarterly series and then forecast and back-cast using the nominal GDP growth rate. We follow this approach because it allows us to apply the same methodology and obtain data on household median income for all the countries in our sample. Lastly, NAR uses the effective mortgage rate from the Federal Housing Finance Board whereas we draw this series from Haver, which in turn collects information from national sources under a category of mortgage rate (as discussed earlier, definitions vary by country).

Housing Affordability Dynamics over Time

In our sample of 40 countries, there are 33 advanced economies (AEs) and 7 emerging markets (EMs). In general, the HAI series for AEs are much longer compared to those of EMs due to limited data on house prices for the latter. Table A2 shows the starting year-quarter of the HAI and its main components for each country in our dataset. For AEs, coverage tends to start in the 1970s, whereas for EMs, it tends to start in the 2000s.

As mentioned earlier, a value of HAI of 100 indicates that a median-income household has exactly enough income to qualify for a mortgage loan on an average-priced home; an index level of above (below) 100 indicates that a household has more (less) than the qualifying income to apply for a mortgage for a house with an average price.

Table 1 shows the summary statistics in terms of the number of observations, median, mean, 25th and 75th percentiles, and standard deviations for both country groups. Since the sample for AEs spans a longer time horizon, we report the statistics over the entire sample period as well as after 2001 for comparability purposes since this is the year when data for EMs become available.

Based on our sample, housing in AEs has been generally more affordable than in EMs. The mean value of the affordability index in AEs is 118 compared to 85 in EMs for the period from 2001q1 to 2021q4. In terms of the variance, AEs exhibit somewhat smaller variance compared to EMs, with the standard deviation equal to 48 and 53 over the same time horizon for the two country groups, respectively. Figure 2 shows the mean, median, and the 25th and 75th cross-country percentiles of the affordability index over time for the countries in our sample.[29]

In the period between the 1970s and mid-1990s, the median value of the index was below 100, which indicates that the median-income household had a hard time obtaining a mortgage for an average-priced house. Even the 75th cross-country percentile of the index was below 100. During the 2000s, affordability improved as the cross-country median of the index exceeded the 100-mark. Affordability collapsed during the GFC but recovered quickly. Since 2010, affordability has continued to improve, and the median remained comfortably above 100 while the 25th cross-country percentile hovered just below.

[29] Note that the country sample size varies over time. The mean is calculated as the average weighted by GDP.

To better understand the drivers of affordability over time, we consider the evolution of each of the time-varying components of HAI, namely, nominal mortgage rates, nominal median household income, and nominal house prices. Figure 3 plots the averages for our sample, weighted by GDP.[30] The trends in the time-varying components of the HAI are consistent with what one would expect to see. Nominal mortgage rates declined over the sample period, in line with the widely-documented secular decline in the natural rate of interest globally as well as financial liberalization patterns, leading to higher competition among lenders and financial deepening. All else equal, this decline in interest rates would contribute to higher levels of HAI and more affordable housing due to lower borrowing costs. At the same time, nominal household income and nominal house prices increased consistently, with the latter experiencing a notable correction during the GFC and a subsequent recovery. These trends, overall, are not too surprising as household income and house prices exhibit an upward time trend.

Next, we look at how changes in each of the time-varying factors in the formula (nominal household income, nominal house prices and nominal mortgage rates) relate to changes in the HAI globally. Figure 4 plots the sum of the average growth rates across countries of each of these factors, weighted by GDP, over the sample period. This is not a decomposition exercise but rather an examination of the changes in the time-varying components of HAI. By construction and holding all other variables constant, an increase in household income should improve affordability while an increase in house prices or interest rates should worsen affordability.

This simple exercise gives the first clues on the factors driving the dynamics of HAI over time. The decline in the HAI during the mid-1970s and early 1980s coincided with an increase in house prices and borrowing rates, which was not offset by the increase in household income. On the flipside, the improvement in affordability following the GFC was concomitant with lower borrowing rates and falling house prices while household income moved little. Finally, during the pandemic, the growth in house prices stands out in relation to the decline in affordability while the other time-varying components actually go in the direction of improved affordability.

For a more formal decomposition exercise, we focus on the case of the United States and use total differentials and plot the contribution from each factor at a given point in time to the change in HAI. The details of the calculations are in Appendix B.

Figure 5 shows that, through the sample period, roughly 40 percent of the changes in affordability are due to changes in household income, about a third due to changes in house prices, and the remainder due to changes in mortgage rates. Nonetheless, we note that the HAI primarily captures the immediate impact of the factors we consider, particularly when it comes to interest rates. A significant drop in mortgage rates would elevate HAI, but that increase does not account for future interest rate adjustments or potential refinancing required to sustain the higher HAI level. In other words, the constructed HAI measure indicates if an average "new buyer" would qualify

[30] The trend and dynamics of the series in real terms look very similar to the nominal ones. We do not report them in the paper, but they are available upon request.

for a typical loan at a certain point in time. This limitation is more prevalent in countries where adjustable-rate mortgages are predominant.

Before moving onto an exploration of the patterns in the cross-section, it is worth noting that this broad-based depiction brushes over differences across countries in the evolution of affordability over time. It is particularly noteworthy that improvements in the HAI are primarily influenced by reduced borrowing costs in countries where house prices are not inflated. Another way of putting this is that lower borrowing costs can go only some way to offset an increase in house prices. Indeed, in several countries with very strong house price growth and signs of stretched valuations, low interest rates have not been enough to counterbalance the affordability strain caused by high property prices. For illustrative purposes, Figure 6 shows the HAI for three AEs: Belgium, Canada, and the United Kingdom. Focusing on the period of low-for-long interest rates that prevailed in the 2010s, there are notable differences. In Belgium, affordability improved as the decline in interest rates offset the moderate increase in house prices. In Canada, affordability worsened as the decline in interest rates was not enough to offset the strong growth in house prices. The United Kingdom exhibited a combination of these forces: affordability worsened from the beginning to the middle of the decade under focus (2010s), and then leveled off. This matches the robust recovery in house prices that followed the post-GFC correction and the much slower pace of house price appreciation following the Brexit vote.

Housing Affordability in the Cross-Section

Across countries, the average HAI varies considerably, reflecting a myriad of country characteristics. When we rank countries by the level of average HAI as shown in Figure 7, Eastern European countries (e.g., the Baltics, the Czech Republic, Poland) top the list with index values touching or exceeding 150.[31] This could reflect traditionally high homeownership rates and a relatively old housing stock, which tends to be of lower quality and cheaper. On the other end of the spectrum, the set of economies is a mixed bunch: Australia, Hong Kong SAR, Russia, and Turkey all have average index values below 50. The reasons for very low affordability levels in these countries are likely different. For instance, in Australia, house prices increased at a fast clip for several decades "driven by demand shifts and amplified by legacy imbalances and a slow supply response" (IMF Staff Report released in February 2018). In Turkey, a lower level of mortgage market development could be the reason. Put more specifically, a typical Turkish household may not be able to afford the mortgage *loan* but still manage to purchase a home through alternative means such as accumulated savings and/or informal borrowing from family and friends.

The narrow focus on mortgage repayment affordability is an important caveat of the methodology we use. Figure 8 demonstrates this in one dimension, namely, outright home ownership versus ownership with a mortgage. In countries with higher GDP per capita – which also tend to have more developed mortgage markets – outright

[31] This is not driven by these countries having a shorter sample period.

home ownership is low but ownership with a mortgage is high. It is in these countries that the HAI constructed here could be more informative.

Other caveats also apply. The index generally can do a decent job in capturing the constraints a typical household faces at a given point in time in order to fulfill an objective of credit-financed home ownership. It cannot, however, broader question of whether homeownership achieved in this manner is sustainable, e.g., if mortgage payments remain affordable over the course of the loan given shocks to interest rates and to household income, or if stretching the household budget in order to afford the mortgage loan squeezes affordability of other essential goods and services. These points are particularly pertinent in the current juncture: the median HAI across countries improved over the last few decades, largely on account of low interest rates. This is because the index is based on the mortgage affordability concept; in other words, it measures how costly owning a home is conditional on being able to access a mortgage at the prevalent market rate. But this trend has started reversing already with the rise in interest rates and will likely get worse as rate resets kick in. Hence, the improvement of the HAI especially in the past decade or so can be ephemeral.

Regression Analysis: Government Programs and Housing Affordability

Regression Specification

A very policy-relevant question is what, beyond the evolution of macro-financial variables, could influence housing affordability. Obviously, monetary, and prudential policies could influence interest rates, credit availability, and house prices, but their primary objective is price and financial stability, respectively, Other, more targeted policy measures could be activated in order to achieve the socially desirable objective of affordable housing while not overburdening monetary and prudential policies.

In this context, we examine the extent to which government spending on programs geared toward housing could play a role in improving housing affordability. For our main variable of interest—government spending on housing—we obtain data from Eurostat, which collects information on general government expenditure by economic function.[32] We consider two types of government spending. The first one is spending on **housing benefits and allowances**. This type of spending may have a more direct effect on housing affordability as it could help reduce the costs associated with funding a house purchase and, thus, make housing more affordable. The second type of government spending that we consider is spending geared toward **housing development**. While this type of expenditure could have an effect on housing affordability, the impact is more indirect as it

[32] Eurostat covers comparable cross-country data on government spending on housing only for a subset of the countries in our sample. This cuts the sample used in the regression analysis to 21 AEs and 4 EMs out of the 40 in the full sample

operates via house prices: higher spending on housing development may help curb house price growth by increasing the supply of housing, which, in turn, may improve housing affordability.[33]

One would expect that it would take some time for such government programs to materialize and influence housing markets and affordability. Therefore, to estimate the effects of government spending programs on housing affordability over time, we use the local projection framework by Jorda (2005) with the following regression specification:

$$HAI_{i,t+h} = \alpha^h + \sum_{\{k=1\}}^{2} \gamma_k^h HAI_{i,t-k} + \sum_{k=1}^{2} \beta_k^h Gov_{i,t-k} + \sum_{\{k=1\}}^{2} \theta_k^h X_{i,t-k} + C_i^h + T_t^h + \epsilon_{i,t}^h$$

where $HAI_{i,t+h}$ denotes the log of housing affordability index for country i in year $t+h \; \forall \; h \in [0,4]$, with h denoting the estimation horizon. $Gov_{i,t-k}$ denotes the log of government expenditure in the form of either housing benefits or housing development as percent of GDP with a lag of k periods. $X_{i,t-k}$ denotes lagged controls. Lastly, C_i^h and T_t^h are country and year fixed effects, respectively. In our baseline specification, we run a parsimonious regression where we only control for real GDP growth and the lagged value of the housing affordability index. The results continue to hold when we consider additional controls guided by the literature on the determinants of house prices and housing affordability, including demographic variables and alternative investment factors, such as population growth, 10-year government bond yield, and growth rate in the stock market index.[34]

Regression Results

Figure 9 plots the regression output. The left hand-side chart in the figure plots the coefficient on government spending on housing benefits over the regression horizon, which is $\beta_1^h \; \forall \; h \in [0,4]$. The chart on the right hand-side plots similarly the coefficient on government spending on housing development. The shaded lines denote the 90th percentile confidence interval.

The results suggest that an increase in government spending on housing benefits is associated with an increase in housing affordability. The effects are significant at a one-year horizon following the increase in government spending on benefits. Thereafter, the effects continue to be positive, but they are not significant.[35]

Spending on housing development also has a positive effect, but the magnitude is smaller, and the impact is not significant. These results may reflect the fact that spending on housing benefits may have a more direct effect in

[33] See Eurostat document for details on government spending by economic function.

[34] See, for example, Higgs and Worthington (2011) on the determinants of housing affordability in Australia; also Capozza et al. (2002) and Igan and Lougani (2012) on the determinants of house prices.

[35] It is worthwhile noting that, although it is possible that affordability influences government spending on housing in the opposite direction (i.e., there may be a reverse causality), this factor is more likely to understate our estimates.

improving housing affordability by lowering borrowing costs directly. On the contrary, government spending on housing development has a less direct impact on affordability as it is likely to operate through increasing housing supply, which in turn may reduce house prices and thereby improve affordability but may end up not having such an impact if the supply response still falls short of demand. As a result, the effects of spending on development are more muted.

The analysis conducted in this section is preliminary, and the results should be interpreted with caution due to at least two reasons. First, the measures for public expenditure on housing benefits and development are crude, and their link to the HAI may be noisy. For instance, government spending may be targeted to particular households (e.g., low-income) or to particular housing segments (e.g., social housing in urban areas), while the HAI aims to capture affordability for an average household to buy a typical property. Second, potential trade-offs may exist between government spending that subsidizes demand (housing benefits) and spending that supports supply (housing development). Housing benefits may inadvertently drive-up house prices in the longer term, negating the improvement in affordability and potentially increasing financial stability risks if they lead to overburdened households struggling to service their debt without the subsidy. In contrast, expenditure on housing development could provide a more sustainable solution, despite its immediate impact on affordability being less pronounced.

Conclusion

This paper introduces a novel dataset on housing affordability for a sample of 40 countries spanning in some cases as early as the 1970s until 2021Q4. To construct the index, we compile information on mortgage rates, typical maturity and LTV ratios, average size of a house, and average number of household members for each of the 40 countries in the sample. Unlike other measures, which proxy affordability as the ratio of house prices and households' income, our measure considers important characteristics of the mortgage and housing markets.

We perform several analyses using the cross-country affordability indexes. Our findings suggest that, since the 1990s, affordability of housing has improved, despite a setback suffered during the GFC. Across the cross-section, housing is more affordable in advanced than in emerging market economies. An important dimension to consider here is the development of mortgage markets and the mode with which households become owner-occupiers, namely with or without a mortgage. Furthermore, our findings indicate that during periods of lower interest rates and favorable economic conditions, affordability improved in all countries. However, it remains uncertain what the future holds in terms of affordability, particularly considering the possibility of a "soft landing"—a scenario where interest rates decline rapidly while incomes do not experience significant decreases. The outcome of this situation will play a crucial role in determining the future state of affordability.

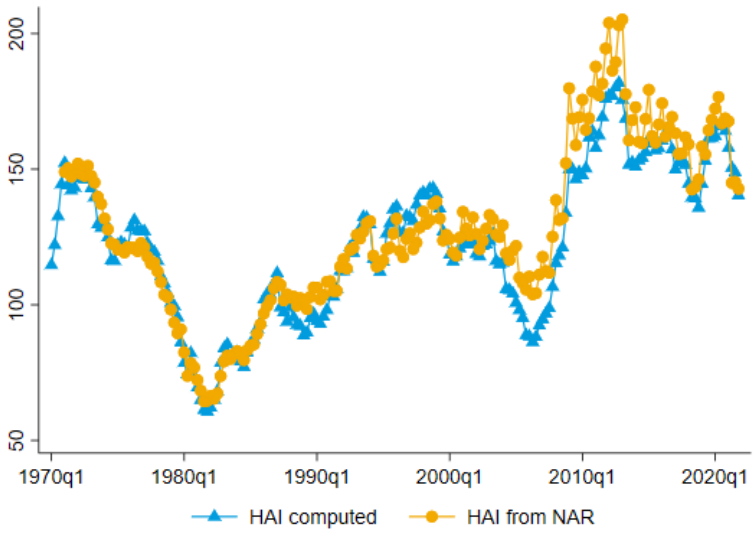
We also perform regression analysis to analyze the extent to which fiscal spending targeted to housing could improve affordability. Our results suggest that government spending on housing could have an impact on housing

affordability, however, only the impact of spending on housing benefits appears to be significant. Government spending on housing development may yield a positive effect, but the impact is insignificant for the sample of countries and for the time-period we consider in our analysis.

The analysis we present should be interpreted largely as illustrative, identifying areas where future research can build on. For instance, more systematic analysis of the cross-country differences in the HAI could shed light on the structural determinants of housing tenure choices. The impact on affordability of different government policies at a more granular level and over different horizons could help policymakers assess the relative costs and benefits, including intertemporal trade-offs in achieving affordability goals. How housing affordability can help understand private consumption and housing investment is another direction that could be explored.

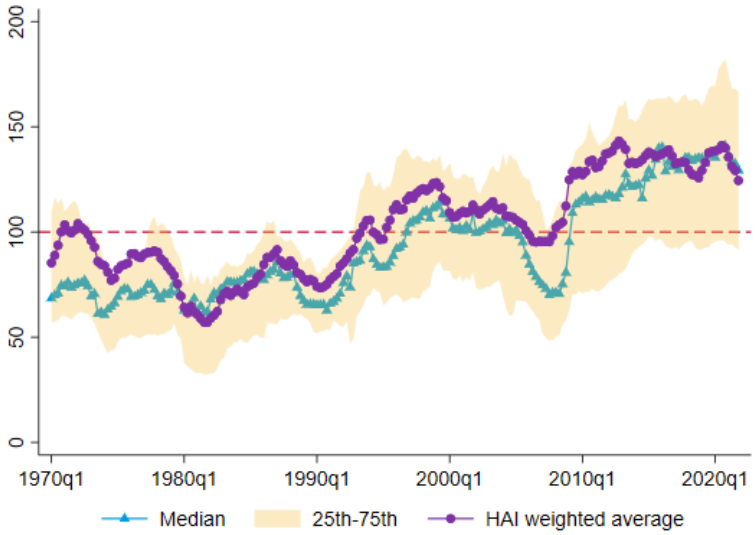
Figures

Figure 1. HAI indices for the United States



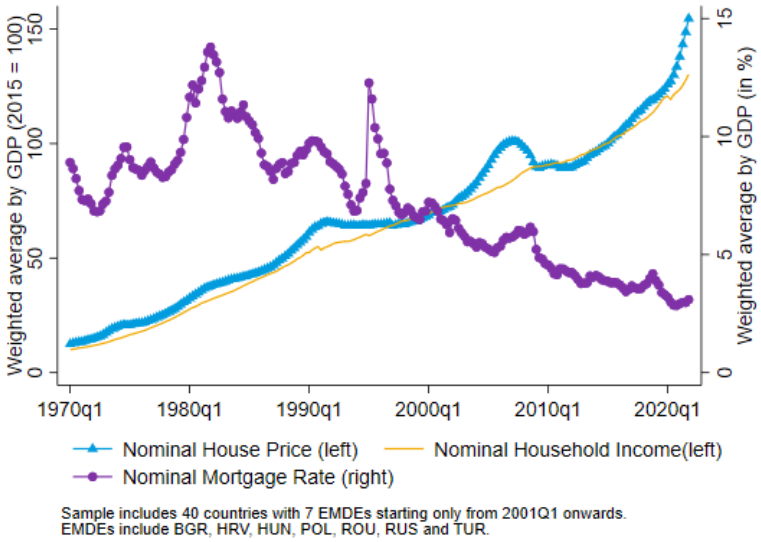
Sources: NAR and IMF staff calculations.

Figure 2. HAI indices for 40 countries over 50 years



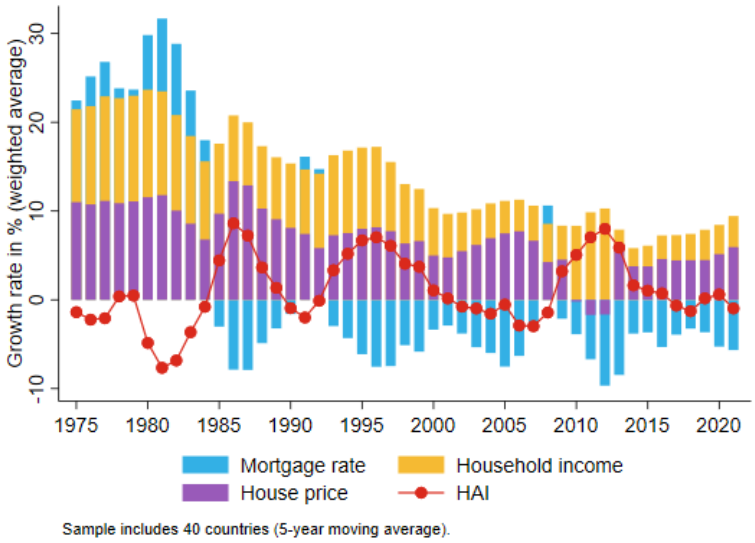
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables used in each country.

Figure 3. Weighted average time series across 40 countries



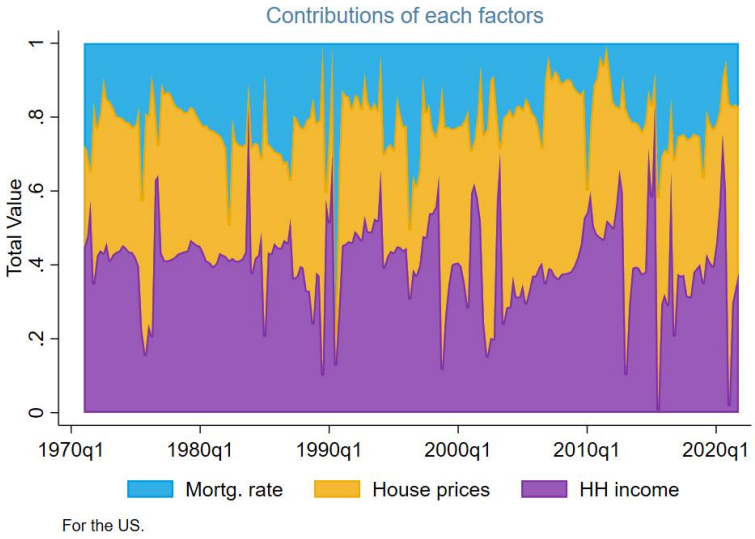
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables used in each country.

Figure 4. Growth rate of HAI and its time-varying components



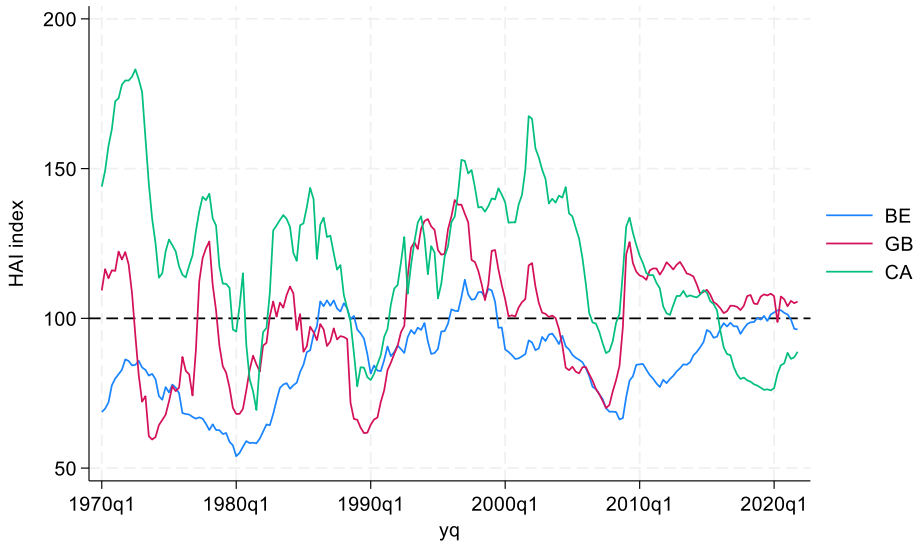
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables used in each country.

Figure 5. Decomposition of changes in HAI



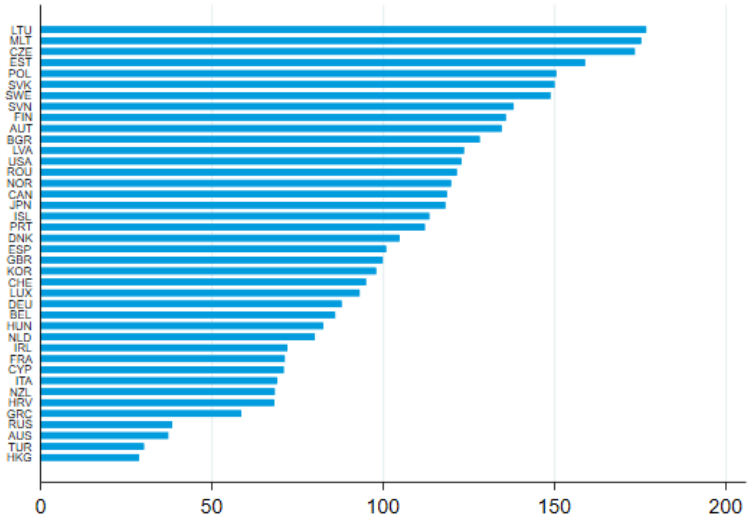
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables.

Figure 6. Evolution of HAI in selected advanced economies



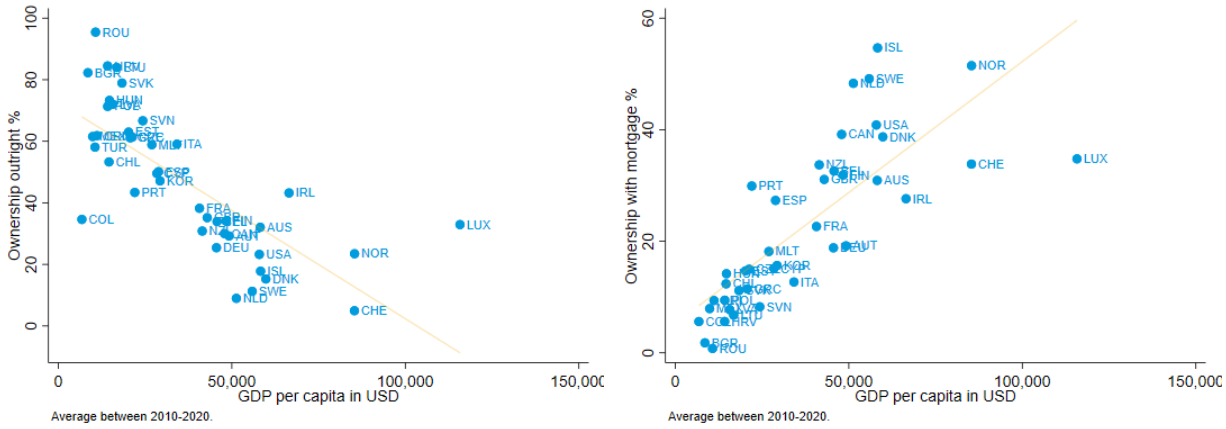
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables used in each country.

Figure 7. Average HAI over the sample period by country



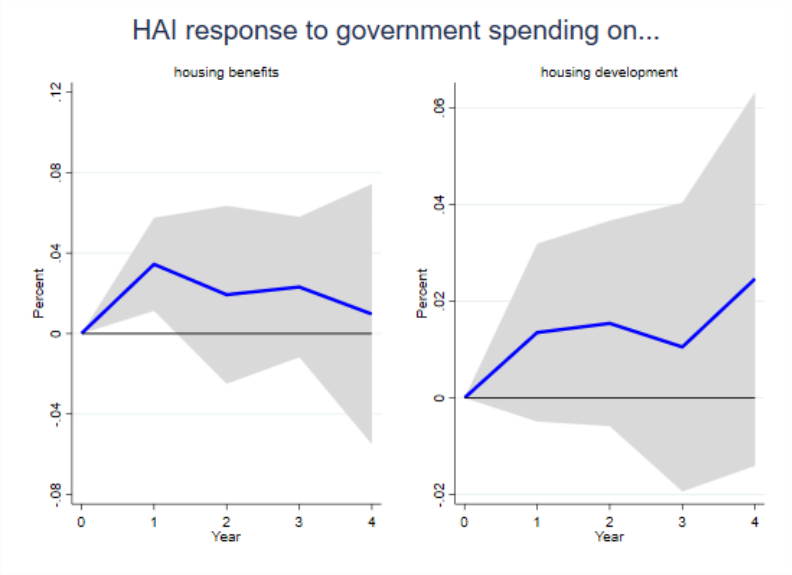
Sources: IMF staff calculations. See Table A1 in the appendix for details on the sources of variables used in each country.

Figure 8. Home ownership with and without a mortgage



Sources: OECD, WEO and IMF staff calculations.

Figure 9. Impulse responses of housing affordability to government spending



Sources: IMF staff calculations.

Tables

Table 1. Summary statistics of HAI

	Number of observations	25th percentile	Median	75th percentile	Mean	Standard deviation
EM	440	40	71	114	85	53
AE (all)	4890	66	94	130	100	46
AE (after 2001)	2572	82	117	153	118	48
Total	5530	64	93	130	99	47

Appendix A. Summary of data sources

Table A1. List of data sources by country

Country	IFS	Mortgage rate	House price per sqm	House price Index	Median household income
Australia	193	Reserve Bank of Australia	Bricongne et al.	BIS	OECD
Austria	122	ECB	Bricongne et al.	BIS	Eurostat
Belgium	124	ECB	Bricongne et al.	BIS	Eurostat
Bulgaria	918	Bulgarian National Bank	Bricongne et al.	BIS	Eurostat
Canada	156	Bank of Canada	Bricongne et al.	BIS	Statistics Canada
Croatia	960	Croatian National Bank	Bricongne et al.	BIS	Eurostat
Cyprus	423	ECB	Bricongne et al.	BIS	Eurostat
Czech Republic	935	Czech National Bank	Bricongne et al.	BIS	Eurostat
Denmark	128	Finance Denmark	Bricongne et al.	BIS	Eurostat
Estonia	939	ECB	Bricongne et al.	BIS	Eurostat
Finland	172	ECB	Bricongne et al.	BIS	Eurostat
France	132	ECB	Bricongne et al.	BIS	Eurostat
Germany	134	ECB	Bricongne et al.	BIS	Eurostat
Greece	174	ECB	Bricongne et al.	BIS	Eurostat
Hong Kong SAR	532	HKMA	Bricongne et al.	BIS	Census and Stat. Dep.
Hungary	944	Magyar Nemzeti Bank	Bricongne et al.	BIS	Eurostat
Iceland	176	Central Bank of Iceland	Bricongne et al.	BIS	Eurostat
Ireland	178	ECB	Bricongne et al.	BIS	Eurostat
Italy	136	ECB	Bricongne et al.	BIS	Eurostat
Japan	158	Bank of Japan	Bricongne et al.	BIS	OECD
Latvia	941	ECB	Bricongne et al.	BIS	Eurostat
Lithuania	946	ECB	Bricongne et al.	BIS	Eurostat
Luxembourg	137	ECB	Bricongne et al.	BIS	Eurostat
Malta	181	ECB	Bricongne et al.	BIS	Eurostat
Netherlands	138	ECB	Bricongne et al.	BIS	Eurostat
New Zealand	196	Reserve Bank of New Zealand	Bricongne et al.	BIS	OECD
Norway	142	Statistics Norway	Bricongne et al.	BIS	Eurostat
Poland	964	National Bank of Poland	Bricongne et al.	BIS	Eurostat
Portugal	182	ECB	Bricongne et al.	BIS	Eurostat
Romania	968	National Bank of Romania	Bricongne et al.	BIS	Eurostat
Russia	922	Central Bank of the Russian Federation	Bricongne et al.	BIS	Fed. State Stat. Ser.
Slovak Republic	936	National Bank of Slovakia	Bricongne et al.	BIS	Eurostat
Slovenia	961	ECB	Bricongne et al.	BIS	Eurostat
South Korea	542	Kookmin Bank	Bricongne et al.	BIS	Statistics Korea
Spain	184	ECB	Bricongne et al.	BIS	Eurostat
Sweden	144	Statistics Sweden	Bricongne et al.	BIS	Eurostat
Switzerland	146	Swiss National Bank	Bricongne et al.	BIS	Eurostat
Turkey	186	Central Bank of the Republic of Turkey	Bricongne et al.	BIS	Eurostat
United Kingdom	112	Bank of England	Bricongne et al.	BIS	Eurostat
United States	111	Federal Home Loan Mortgage Corporation	Bricongne et al.	BIS	Census

Table A1. List of data sources by country (continued)

Country	IFS	House size	Household size	Mortgage maturity	LTV ratio
Australia	193	ABS	UN	RBA	RBA
Austria	122	Eurostat	Eurostat	Hypostat	Hypostat
Belgium	124	Eurostat	Eurostat	Hypostat	Hypostat
Bulgaria	918	Eurostat	Eurostat	Hypostat	Hypostat
Canada	156	NRC	UN	BOC	BOC
Croatia	960	Eurostat	Eurostat	Hypostat	Hypostat
Cyprus	423	Eurostat	Eurostat	Hypostat	Hypostat
Czech Republic	935	Eurostat	Eurostat	Hypostat	Hypostat
Denmark	128	Eurostat	Eurostat	Hypostat	Hypostat
Estonia	939	Eurostat	Eurostat	Hypostat	Hypostat
Finland	172	Eurostat	Eurostat	Hypostat	ECB
France	132	Eurostat	Eurostat	Hypostat	Hypostat
Germany	134	Eurostat	Eurostat	Hypostat	Hypostat
Greece	174	Eurostat	Eurostat	Dell'Ariccia et al. (2017)	Dell'Ariccia et al. (2017)
Hong Kong SAR	532	TH Bureau	UN	Hypostat	Hypostat
Hungary	944	Eurostat	Eurostat	Dell'Ariccia et al. (2017)	Dell'Ariccia et al. (2017)
Iceland	176	Eurostat	Eurostat	Hypostat	Hypostat
Ireland	178	Eurostat	Eurostat	Hypostat	Hypostat
Italy	136	Eurostat	Eurostat	Housing Finance Network	Housing Finance Network
Japan	158	Stat Bureau	UN	ADBI	ADBI
Latvia	941	Eurostat	Eurostat	Dell'Ariccia et al. (2017)	Hypostat
Lithuania	946	Eurostat	Eurostat	Hypostat	Hypostat
Luxembourg	137	Eurostat	Eurostat	Hypostat	Hypostat
Malta	181	Eurostat	Eurostat	Dell'Ariccia et al. (2017)	Hypostat
Netherlands	138	Eurostat	Eurostat	Hypostat	Hypostat
New Zealand	196	Stat NZ	UN	Hypostat	Hypostat
Norway	142	Eurostat	Eurostat	Hypostat	Dell'Ariccia et al. (2017)
Poland	964	Eurostat	Eurostat	Hypostat	Hypostat
Portugal	182	Eurostat	Eurostat	Hypostat	Hypostat
Romania	968	Eurostat	Eurostat	NBR	Hypostat
Russia	922	Eurostat	PRB	Hypostat	Hypostat
Slovak Republic	936	Eurostat	Eurostat	Hypostat	Hypostat
Slovenia	961	Eurostat	Eurostat	Hypostat	ECB
South Korea	542	KOSIS	UN	Hypostat	Hypostat
Spain	184	Eurostat	Eurostat	Hypostat	Hypostat
Sweden	144	Eurostat	Eurostat	Hypostat	FINANSINSPEKTIONEN
Switzerland	146	Eurostat	Eurostat	Hypostat	Hypostat
Turkey	186	Eurostat	Eurostat	Hypostat	Hypostat
United Kingdom	112	EU	Eurostat	Hypostat	Hypostat
United States	111	Eurostat	UN	Hypostat	Hypostat

Table A2. Starting date of the main time-series data

Country	IFS	AE	HAI	House Price	Mortgage Rate	Median Household Income
Australia	193	1	1970q1	1970q1	1970q1	1970q1
Austria	122	1	2000q1	2000q1	1970q1	1970q1
Belgium	124	1	1970q1	1970q1	1970q1	1970q1
Bulgaria	918	0	2005q1	2005q1	1992q1	1970q1
Canada	156	1	1970q1	1970q1	1970q1	1970q1
Croatia	960	0	2002q1	2002q1	1993q1	1992q2
Cyprus	423	1	2002q1	2002q1	1993q1	1970q1
Czech Republic	935	1	2008q1	2008q1	2004q1	1995q2
Denmark	128	1	1970q1	1970q1	1970q1	1970q1
Estonia	939	1	2005q1	2005q1	2005q1	1993q2
Finland	172	1	1970q1	1970q1	1970q1	1970q1
France	132	1	1970q1	1970q1	1970q1	1970q1
Germany	134	1	1970q1	1970q1	1970q1	1970q1
Greece	174	1	2006q1	2006q1	2003q1	1970q1
Hong Kong SAR	532	1	1980q1	1979q4	1980q1	1970q1
Hungary	944	0	2007q1	2007q1	2002q1	1970q1
Iceland	176	1	2000q1	2000q1	1982q4	1970q1
Ireland	178	1	1971q1	1970q1	1971q1	1970q1
Italy	136	1	1970q1	1970q1	1970q1	1970q1
Japan	158	1	1970q1	1970q1	1970q1	1970q1
Latvia	941	1	2006q1	2006q1	1994q1	1992q2
Lithuania	946	1	1998q4	1998q4	1992q4	1995q2
Luxembourg	137	1	2007q1	2007q1	2003q1	1970q1
Malta	181	1	2005q1	2005q1	1995q1	1979q2
Netherlands	138	1	1980q2	1970q1	1970q1	1980q2
New Zealand	196	1	1970q1	1970q1	1970q1	1970q1
Norway	142	1	1970q1	1970q1	1970q1	1970q1
Poland	964	0	2010q1	2010q1	2004q1	1970q1
Portugal	182	1	2008q1	2008q1	2003q1	1970q1
Romania	968	0	2009q1	2009q1	2007q1	1970q1
Russia	922	0	2001q1	2001q1	1995q1	1990q2
Slovak Republic	936	1	2006q1	2006q1	1993q1	1993q2
Slovenia	961	1	2007q1	2007q1	2003q1	1992q2
South Korea	542	1	1982q3	1975q1	1982q3	1970q1
Spain	184	1	1971q1	1971q1	1970q1	1970q1
Sweden	144	1	1970q1	1970q1	1970q1	1970q1
Switzerland	146	1	1970q1	1970q1	1970q1	1970q1
Turkey	186	0	2010q1	2010q1	2002q1	1970q1
United Kingdom	112	1	1970q1	1970q1	1970q1	1970q1
United States	111	1	1970q1	1970q1	1970q1	1970q1

Table A3. Average HAI for each country

Country	IFS Code	HAI	HAI post 2010
Australia	193	37	39
Austria	122	135	142
Belgium	124	86	92
Bulgaria	918	128	157
Canada	156	119	96
Croatia	960	68	85
Cyprus	423	71	77
Czech Republic	935	173	182
Denmark	128	105	146
Estonia	939	159	184
Finland	172	136	204
France	132	71	84
Germany	134	88	153
Greece	174	59	61
Hong Kong SAR	532	29	21
Hungary	944	82	91
Iceland	176	113	128
Ireland	178	72	113
Italy	136	69	118
Japan	158	118	164
Latvia	941	124	141
Lithuania	946	177	223
Luxembourg	137	93	93
Malta	181	175	187
Netherlands	138	80	93
New Zealand	196	68	64
Norway	142	120	137
Poland	964	150	150
Portugal	182	112	116
Romania	968	121	129
Russia	922	38	49
Slovak Republic	936	150	172
Slovenia	961	138	149
South Korea	542	98	176
Spain	184	101	149
Sweden	144	149	191
Switzerland	146	95	108
Turkey	186	30	30
United Kingdom	112	100	109
United States	111	123	158

Table A4. Mortgage rate series details by country

Country	IFS	Mortgage rate definition	Mortgage rate note	Mortgage rate source
Australia	193	Bank Housing Loans, Standard Variable Rate EOP %	.	Reserve Bank of Australia
Austria	122	Footnote 12	.	ECB
Belgium	124	Footnote 12	Extend by long term rate from OECD	ECB
Bulgaria	918	New Loans for House Purchases in BGN %	Extend by long term rate from OECD	Bulgarian National Bank
Canada	156	Residential mortgages, insured, new and existing lending	Extend by policy rate from BIS	Bank of Canada
Croatia	960	Loans for House Purchases % local currency	Extend by policy rate from BIS	Croatian National Bank
Cyprus	423	Footnote 12	Break adjust by policy rate from ECB	ECB
Czech Republic	935	Household CZK Lending Rates: New Bus: House Purchase %	Break adjust by policy rate from BIS	Czech National Bank
Denmark	128	Avg Long Bond Rate for Mortgage Denominated in DKK	Extend by policy rate from BIS	Finance Denmark
Estonia	939	Footnote 12	Break adjust by short term rate from OECD	ECB
Finland	172	Footnote 12	Extend by long term rate from OECD	ECB
France	132	Footnote 12	Extend by long term rate from OECD	ECB
Germany	134	Footnote 12	Extend by policy rate from BIS	ECB
Greece	174	Footnote 12	Break adjust by long term rate from OECD	ECB
Hong Kong SAR	532	Best Lending Rate %	.	HKMA
Hungary	944	Home Loan APR: New Bus Weighted Households %	Break adjust by policy rate from BIS	Magyar Nemzeti Bank
Iceland	176	General Interest Rate %	Extend by policy rate from BIS	Central Bank of Iceland
Ireland	178	Footnote 12	Extend by policy rate from BIS	ECB
Italy	136	Footnote 12	Extend by long term rate from OECD	ECB
Japan	158	Housing Loans, Floating Interest Rate %	Extend by policy rate from BIS	Bank of Japan
Latvia	941	Footnote 12	Break adjust by long term rate from OECD	ECB
Lithuania	946	Footnote 12	Extend by long term rate from OECD and then lending rate from IFS	ECB
Luxembourg	137	Footnote 12	Break adjust and extend by long term rate from OECD	ECB
Malta	181	Footnote 12	Extend by policy rate from ECB	ECB
Netherlands	138	Footnote 12	Extend by long term rate from OECD	ECB
New Zealand	196	First Mortgage Housing Rate % per annum	.	Reserve Bank of New Zealand
Norway	142	Interest Rate on New Loans to HHs Secured on Dwellings %pa	Extend by long term rate from OECD	Statistics Norway
Poland	964	New HH Mortgage Rate: Total %	.	National Bank of Poland
Portugal	182	Footnote 12	.	ECB
Romania	968	New Bus: APRCon HH Loans for House Purchases in RON %	Break adjust by policy rate from BIS	National Bank of Romania
Russia	922	Interest Rates: Credit Rate Weighted Average %	.	Central Bank of the Russian Federation

Slovak Republic	936	New EA Loans for House Purchases: Avg Int Rate: Households and NPISH %	Extend by long term rate from OECD	National Bank of Slovakia
Slovenia	961	Footnote 12	.	ECB
South Korea	542	Weighted Average Mortgage Interest Rate EOP %	Extend by long term rate from OECD	Kookmin Bank
Spain	184	Footnote 12	.	ECB
Sweden	144	New MFI Housing Loans to Households %pa	Extend by policy rate from BIS	Statistics Sweden
Switzerland	146	Interest Rates: Mortgage with Variable Rates %	Extend by policy rate from BIS	Swiss National Bank
Turkey	186	Weighted Average Interest Rate on Bank Loans: Housing %	.	Central Bank of the Republic of Turkey
United Kingdom	112	Variable Mortgage Rate: Banks and Building Societies %	Extend by policy rate from BIS	Bank of England
United States	111	30-year Fixed Mortgage Rate %	Extend by policy rate from BIS	Federal Home Loan Mortgage Corporation

Table A5. Median household income series details by country

Country	IFS	Median household income definition	Notes	Sources
Australia	193	Median Equavalized disposable household income	x household size	OECD
Austria	122	Median Equavalized disposable household income	x household size	Eurostat
Belgium	124	Median Equavalized disposable household income	x household size	Eurostat
Bulgaria	918	Median Equavalized disposable household income	x household size	Eurostat
Canada	156	Median Real Household Total Income	Convert to nominal using inflation rates	Statistics Canada
Croatia	960	Median Equavalized disposable household income	x household size	Eurostat
Cyprus	423	Median Equavalized disposable household income	x household size	Eurostat
Czech Republic	935	Median Equavalized disposable household income	x household size	Eurostat
Denmark	128	Median Equavalized disposable household income	x household size	Eurostat
Estonia	939	Median Equavalized disposable household income	x household size	Eurostat
Finland	172	Median Equavalized disposable household income	x household size	Eurostat
France	132	Median Equavalized disposable household income	x household size	Eurostat
Germany	134	Median Equavalized disposable household income	x household size	Eurostat
Greece	174	Median Equavalized disposable household income	x household size	Eurostat
Hong Kong SAR	532	Median Domestic Household Income	.	Census and Stat. Dep.
Hungary	944	Median Equavalized disposable household income	x household size	Eurostat
Iceland	176	Median Equavalized disposable household income	x household size	Eurostat
Ireland	178	Median Equavalized disposable household income	x household size	Eurostat
Italy	136	Median Equavalized disposable household income	x household size	Eurostat
Japan	158	Median Equavalized disposable household income	x household size	OECD
Latvia	941	Median Equavalized disposable household income	x household size	Eurostat
Lithuania	946	Median Equavalized disposable household income	x household size	Eurostat

Luxembourg	137	Median Equavalized disposable household income	x household size	Eurostat
Malta	181	Median Equavalized disposable household income	x household size	Eurostat
Netherlands	138	Median Equavalized disposable household income	x household size	Eurostat
New Zealand	196	Median Equavalized disposable household income		OECD
Norway	142	Median Equavalized disposable household income	x household size	Eurostat
Poland	964	Median Equavalized disposable household income	x household size	Eurostat
Portugal	182	Median Equavalized disposable household income	x household size	Eurostat
Romania	968	Median Equavalized disposable household income	x household size	Eurostat
Russia	922	Average between 40-50 and 50-60 percentile Household Income Distribution (Equalized)	x household size	Fed. State Stat. Ser.
Slovak Republic	936	Median Equavalized disposable household income	x household size	Eurostat
Slovenia	961	Median Equavalized disposable household income	x household size	Eurostat
South Korea	542	Third Quintile Average Household Income	.	Statistics Korea
Spain	184	Median Equavalized disposable household income	x household size	Eurostat
Sweden	144	Median Equavalized disposable household income	x household size	Eurostat
Switzerland	146	Median Equavalized disposable household income	x household size	Eurostat
Turkey	186	Median Equavalized disposable household income	x household size	Eurostat
United Kingdom	112	Median Equavalized disposable household income	x household size	Eurostat
United States	111	Median Family Household Income	.	Census

Appendix B. Decomposition of HAI

Let MEDINC=*x*, HP=*y*, and IR/12=*z*. Denote LTV with *ltv* and MA with *m*. So, the equations for the HAI can be written as:

$$PMT = y * ltv * z * \left[1 - \frac{1}{(1+z)^m}\right]^{-1} = \frac{ltv * y * z * (1+z)^m}{(1+z)^m - 1},$$

$$QINC = \frac{ltv * y * z * (1+z)^m}{(1+z)^m - 1} * 4 * 12 = \frac{(ltv * 48) * y * z * (1+z)^m}{(1+z)^m - 1},$$

$$HAI = \left(\frac{x}{\frac{(ltv * 48) * y * z * (1+z)^m}{(1+z)^m - 1}} \right) * 100 = \frac{100 * x * ((1+z)^m - 1)}{(ltv * 48) * y * z * (1+z)^m},$$

Then, we calculate the total differential of HAI as:

$$dHAI = HAI_x dx + HAI_y dy + HAI_z dz$$

where dx, dy, dz are the actual changes in x, y, z respectively at time t in country c, and:

$$HAI_x = (100 * ((1+z)^m - 1))/((ltv * 48) * y * z * (1+z)^m),$$

$$HAI_y = (-y^{-2}) * (100 * x * ((1+z)^m - 1))/((ltv * 48) * z * (1+z)^m),$$

$$HAI_z = (100 / (ltv * 48)) * x * (z * (1 + z)\text{^}m * m * (1 + z)\text{^}(m - 1) - ((1 + z)\text{^}m - 1) * ((1 + z)\text{^}m + m * z * (1 + z)\text{^}(m - 1))) / (y * z\text{^}2 * (1 + z)\text{^}(2 * m)).$$

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