

Supplementary Information 1

Contains Supplementary Tables S1-S9.

Table S1. Unconditional correlation matrix for candidate variables for the building height prediction model.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| 1 Building footprint area | 1.000 | 0.331 | -0.030 | -0.031 | 0.077 | 0.047 | -0.044 | -0.171 |
| 2 Building height | 0.331 | 1.000 | 0.263 | 0.350 | 0.467 | 0.428 | 0.172 | -0.188 |
| 3 Build-up surfaces per 100 m grid | -0.030 | 0.263 | 1.000 | 0.684 | 0.484 | 0.581 | 0.307 | -0.039 |
| 4 Soil sealing per 100 m grid | -0.031 | 0.350 | 0.684 | 1.000 | 0.563 | 0.730 | 0.211 | -0.181 |
| 5 Population per 1 km grid | 0.077 | 0.467 | 0.484 | 0.563 | 1.000 | 0.754 | 0.357 | -0.269 |
| 6 Population per 100 m grid | 0.047 | 0.428 | 0.581 | 0.730 | 0.754 | 1.000 | 0.259 | -0.231 |
| 7 Population in an urban cluster | -0.044 | 0.172 | 0.307 | 0.211 | 0.357 | 0.259 | 1.000 | 0.439 |
| 8 Distance from centre of an urban cluster | -0.171 | -0.188 | -0.039 | -0.181 | -0.269 | -0.231 | 0.439 | 1.000 |

Table S2. Sources of data for estimating residential building value.

| Country | Gross stock of dwellings (current and constant prices) | Total floor space area of dwellings |
|----------|---|--|
| Austria | Eurostat | 2004–2017: annual number of dwellings multiplied by average floor space; 2000–2003; number of dwellings multiplied by average floor space in 2004 (Statistics Austria); 2000–2017 revised upwards by 21.9% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Belgium | Eurostat | Number of dwellings (annual 2000–2017) and households (interpolated from 1991, 2001, 2011, 2014–2017 data) (STATBEL) multiplied by average floor space in 2012 (Eurostat)* |
| Bulgaria | Perpetual Inventory Method (PIM) using starting stock in 1999 (average GFCF of dwellings per m ² of completed dwellings multiplied by total floor space of dwellings), adding annual GFCF of dwellings (2000–2017) and removing annual apparent retirement of dwellings (value per m ² from the average value of previous year's stock); deflator of GFCF of dwellings deflator until 2000 and deflator 'Construction cost, new residential buildings' used afterwards; data from Eurostat (GFCF and deflator) and BNSI (dwelling stock and construction) | 2000–2017: annual time series (BNSI); Number of households (interpolated from 1992, 2001, 2011 and 2015 data by BNSI and Eurostat) multiplied by annual average dwelling floor space (BNSI)* |
| Cyprus | Eurostat (2017 value extrapolated from 2016 using change in number of | Annual number of households multiplied by average floor space in 2012; revised upwards by 42.2% to |

| | | |
|---------|---|---|
| | dwelling and deflator 'Construction cost, new residential buildings') | account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Czechia | Eurostat | Number of households (interpolated from 2001 and 2005–2017 data) multiplied by average floor space in 2012; revised upwards by 8.8% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Denmark | Eurostat | Annual time series for occupied dwellings (DST); revised upwards by 13.8% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Estonia | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator 'Construction cost, new residential buildings') | 2000–2011: Annual time series of dwelling floor space, 2012–2017: number of dwellings (interpolated from 2011, 2016 and 2017 data) multiplied by average floor space in 2011 (Statistics Estonia); 2000–2017: annual number households multiplied by average floor space of dwelling in 2000–2011, with 2011 average floor space applied to 2012–2017 (Statistics Estonia)* |
| Finland | Eurostat | Annual number of households multiplied by average floor space by Statistics Finland; revised upwards by 10.7% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| France | Eurostat | Annual number of all/principal dwellings multiplied by average floor space interpolated from 1996, 2001, 2006 and 2013 estimates (INSEE)* |
| Germany | Eurostat | Annual time series (DESTATIS) |
| Greece | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator 'Construction cost, new residential buildings') | Number of households (interpolated from 1991, 2001, 2011 and 2015 data by Eurostat/ELSTAT) multiplied by average floor space interpolated from 2001 and 2012 data (Eurostat/Federcasa 2006); revised upwards by 54.1% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Hungary | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator 'Construction cost, new residential buildings') | Annual number of dwellings (KSH) multiplied by average floor space interpolated from 2001 and 2012 data (Eurostat/Federcasa 2006) |
| Iceland | PIM (service life: 90 years) based on GFCF of dwellings for 1945-2017 and gross national income for 1911-1944; construction price index from 'Building cost index 1939-2019' (Statistics Iceland) | Annual number of dwellings from Nordic Statistics database (DST) multiplied by average floor space in 2012 (Eurostat) |
| Ireland | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator 'Construction cost, new residential buildings') | Number of dwellings/households (interpolated from 1996, 2002, 2006, 2011 and 2016 data by CSO) multiplied by average floor space in 2012 (Eurostat)* |
| Italy | Eurostat | 2001 and 2011 value for occupied dwellings (ISTAT/Federcasa 2006) interpolated and then extrapolated using change in the number of households interpolated from 1991, 2001 and 2009–2017 data (ISTAT); revised upwards by 29.3% to account for unoccupied dwellings as of 2011 census (ISTAT)* |

| | | |
|-------------|---|---|
| Latvia | 2000–2001: Eurostat, 2002–2016 extrapolated by adding annual GFCF of dwellings (Eurostat) to deflated stock of dwellings from preceding year reduced by assumed 0.3% | 2010–2017: Annual time series; 2000–2009: extrapolated using change in number of households (CSP); annual number of households multiplied by average floor space in 2007–2017, with 2007 average floor space used for 2000–2006 (CSP)* |
| Lithuania | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator ‘Construction cost, new residential buildings’) | Annual time series (Statistics Lithuania) |
| Luxembourg | Eurostat | Number of households (interpolated from 1991, 2001 and 2005–2017 data by STATEC/Eurostat) multiplied by average floor space interpolated from 2001 and 2012 data (Eurostat/Federcasa 2006); revised upwards by 6.9% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Malta | PIM (service life: 80 years**) based on GFCF of dwellings for 2000-2017 and deflator ‘Construction cost, new residential buildings’ (Eurostat), total GFCF for 1970-1999 from PWT 9.1, GDP for 1950-1969 from MPD 2018 1969) and 1921–1949 interpolated from 1921, 1930 and 1938 estimates by Apostolides (2010) and 1950 estimate from MPD 2018 | Number of households (2005–2017 from Eurostat, extrapolated with population change for 2000–2004) multiplied by average floor space in 2002 (Federcasa 2006) |
| Netherlands | Eurostat | 2011–2017: annual number of dwellings multiplied by average floor space; 2000–2010: annual number of dwellings multiplied by average floor space in 2011 (CBS) |
| Norway | PIM (service life: 80 years) based on GFCF of dwellings for 1970-2017 (SSB/Eurostat) and total gross investment for 1921-1969 (Grytten 2004) | Number of households (interpolated from 2000 and 2004–2017 data from SSB) multiplied by average floor space in 2012 (Eurostat) |
| Poland | PIM using starting stock in 1995 (average GFCF of dwellings per m ² of completed dwellings multiplied by total floor space of dwellings), adding annual GFCF of dwellings (1996–2017) and removing annual apparent retirement of dwellings (value per m ² from the average value of previous year’s stock); deflator of GFCF of dwellings deflator until 2000 and deflator ‘Construction cost, new residential buildings’ used afterwards; data from Eurostat (GFCF and deflator) and GUS (dwelling stock and construction) | Annual time series (GUS) |
| Portugal | Eurostat (2017 value extrapolated from 2016 using change in number of dwellings and deflator ‘Construction cost, new residential buildings’) | Number of dwellings (interpolated from 1991 and 2001–2017 data by Statistics Portugal) and households (interpolated from 1991, 2001 and 2005–2017 data by Statistics Portugal/Eurostat) multiplied by average floor space in 2011 (Statistics Portugal)* |

| | | |
|----------------|--|--|
| Romania | PIM using starting stock in 2000 (average GFCF of dwellings per m ² of completed dwellings multiplied by total floor space of dwellings), adding annual GFCF of dwellings (2001–2017) and removing annual apparent retirement of dwellings (value per m ² from the average value of previous year's stock); deflator 'Construction cost, new residential buildings' used; data from Eurostat (GFCF and deflator) and INSSE (dwelling stock and construction) | Annual time series (INSSE); Number of households (interpolated from 1992, 2002, 2005–2017 data by INSSE/Eurostat) multiplied by annual average floor space of dwellings (INSSE)* |
| Slovakia | Eurostat | Number of households (interpolated from 2001 and 2005–2017 data by Eurostat) multiplied by average floor space in 2012 data (Eurostat); revised upwards by 7.7% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Slovenia | Eurostat | Annual time series (SiStat) for 2002–2014, extrapolated using change in number of households (interpolated from 1991, 2002, 2005–2017 data by SiStat/Eurostat) |
| Spain | PIM (service life: 60 years) based on GFCF of dwellings for 1964–2017 (Fundación BBVA e Ivie 2018/Eurostat), total GFCF for 1950–1963 from PWT 9.1 and GDP for 1941–1949 from MPD 2018; deflator from 'Construction cost, new residential buildings' (Eurostat) | Number of households (interpolated from 1991, 2001, 2011, 2013–2017 data by INE) multiplied by average floor space from 2001 and 2012 data (Eurostat/Federcasa 2006); revised upwards by 39.4% to account for unoccupied dwellings as of 2011 census (Eurostat)* |
| Sweden | PIM (service life: 73 years) based on GFCF of dwellings for 1993–2017 from SCB/Eurostat and 1928–1992 from Edvinsson (2005); deflator from 'Construction cost, new residential buildings' (Eurostat) | Annual number of dwellings (SCB) multiplied by average floor space in 2012 (Eurostat) |
| Switzerland | PIM (service life: 50 years) based on GFCF of dwellings for 1995–2017 from BFS/Eurostat, 1990–1994 from OECD, 1981–1986 and 1951–1969 from HSSO; and total investment for 1987–1989 and 1970–1980 from HSSO; deflator from 'Construction cost, new residential buildings' (Eurostat) | Number of dwellings (interpolated from 2000 and 2009–2017 data by BFS) and households (interpolated from 2000 and 2011–2017 data by BFS/Eurostat) multiplied by average floor space in 2009–2017 (BFS), with 2009 value used for 2000–2008* |
| United Kingdom | Eurostat | 2017: number of dwellings multiplied by average floor space in 2016; 2004–2016: Annual number of dwellings multiplied by average floor space; 2000–2003: number of dwellings multiplied by average floor space in 2004; Note: average floor space refers only to England and Wales (ONS) |

Notes: * value for all dwellings was used for estimating building value per m², while the value for occupied dwellings/principal dwellings/households was used for estimating contents value per m².

** according to national methodology, service life of dwellings is 85 years, but it was truncated here due to the lack of economic data before year 1921.

GFCF = gross fixed capital formation; GDP = gross domestic product; PIM = Perpetual Inventory Method

PWT 9.1 = Penn World Table 9.1 (Feenstra et al. 2015)

MPD 2018 = Maddison Project Database 2018 (Bolt et al. 2018)

Table S3. A note on methodological differences for Latvia and Poland preventing the use of data on the gross stock of dwellings. Based on Eurostat and OECD (2014) and GUS.

| Country | Description |
|---------|---|
| Latvia | Gross stock of dwellings is calculated based on prices of newly constructed buildings rather on the basis of the replacement costs of existing stock, which substantially differs in type and quality. Consequently, this results in overestimation of the stocks, As the basis of calculation made by the statistical office of Latvia is the situation in year 2000, we use the national estimate of gross stock for that year as the basis for computing time series for 2001–2017 using PIM with annual GFCF and assumed annual retirement equaling 0.3% of the stock (Eurostat and OECD 2014). |
| Poland | Gross stock of dwellings that were built before 1995 is calculated at constant replacement values of September 1994, which results in a very low estimate of the total value of dwellings in Poland. PIM is applied instead using our estimate of the initial stock of dwellings in 1995. |

Table S4. Consumption expenditure categories by COICOP 3-digit codes and durable items included in those categories by COICOP 4-digit codes, with assumption on service life and share of durables in final consumption expenditure COICOP 3-digit categories per country.

| COICOP code | COICOP category name | Durable items (COICOP code and name) | Service life (years) |
|-------------|---|---|----------------------|
| 05.1 | Furniture and furnishings, carpets and other floor coverings | 05.1.1 Furniture and furnishings 05.1.2 Carpets and other floor coverings | 17 |
| 05.3 | Household appliances | 05.3.1 Major household appliances whether electric or not | 15 |
| 05.5 | Tools and equipment for house and garden | 05.5.1 Major tools and equipment | 11 |
| 06.1 | Medical products, appliances and equipment | 06.1.3 Therapeutic appliances and equipment | 7 |
| 08.2 | Telephone and telefax equipment | 08.2.0 Telephone and telefax equipment | 6 |
| 09.1 | Audio-visual, photographic and information processing equipment | 09.1.1 Equipment for the reception, recording and reproduction of sound and picture 09.1.2 Photographic and cinematographic equipment and optical instruments 09.1.3 Information processing equipment | 10 |
| 09.2 | Other major durables for recreation and culture | 09.2.1 Major durables for outdoor recreation 09.2.2 Musical instruments and major durables for indoor recreation | 16 |
| 12.1 | Personal care | 12.1.2 Electric appliances for personal care | 10 |
| 12.3 | Personal effects n.e.c. | 12.3.1 Jewellery, clocks and watches | 45 |

Notes:

- COICOP = Classification of Individual Consumption by Purpose.
- Final consumption expenditure of households is expenditure incurred by resident households on goods or services that are used for the direct satisfaction of individual needs or wants or the collective needs of

members of the community. It includes or excludes many specific types of expenditure, for instance excludes purchases of dwellings, land and valuables. See paragraphs 3.94-3.96 of the European System of Accounts (ESA) 2010 manual (Eurostat 2013).

- Service life should include normal wear and tear, obsolescence and accidental damage which can be insured against. It excludes, among other things, exceptional or catastrophic losses, unforeseen obsolescence and uncompensated seizures. See paragraphs 3.139-3.142 and 6.08-6.13 of the ESA 2010 manual.

Table S5. Assumptions on the share of durables in final consumption expenditure COICOP 3-digit categories per country (based on expenditure surveys listed in Table S5).

| Country | Spending on durables as % of total spending per COICOP 3-digit category | | | | | | | | |
|----------------|---|--------|--------|--------|-------|--------|-------|--------|--------|
| | 05.1 | 05.3 | 05.5 | 06.1 | 08.2 | 09.1 | 09.2 | 12.1 | 12.3 |
| Austria | 99.6 | 76.9 | 34.0 | 45.3 | 100.0 | 78.7 | 96.6 | 2.2 | 46.3 |
| Belgium | 98.7 | 74.2 | 30.2 | 23.9 | 100.0 | 66.4 | 85.6 | 2.2 | 47.0 |
| Bulgaria | 99.7 | 79.3 | 24.5 | 3.7 | 100.0 | 86.7 | 90.5 | 0.7 | 40.4 |
| Cyprus | 99.0 | 87.4 | 42.2 | 11.1 | 100.0 | 88.0 | 91.4 | 0.2 | 44.7 |
| Czechia | 99.2 | 78.4 | 46.9 | 20.5 | 100.0 | 85.6 | 95.7 | 2.7 | 40.9 |
| Denmark | 97.5 | 82.6 | 30.5 | 34.5 | 100.0 | 77.1 | 96.5 | 2.5 | 59.2 |
| Estonia | 99.7 | 85.8 | 44.6 | 11.9 | 100.0 | 89.3 | 93.8 | 1.0 | 32.5 |
| Finland | 91.9 | 84.4 | 36.7 | 25.5 | 100.0 | 81.6 | 91.7 | 2.0 | 51.2 |
| France | 98.8 | 83.9 | 31.6 | 37.1 | 100.0 | 67.5 | 93.4 | 0.7 | 46.1 |
| Germany | 94.0 | 70.5 | 45.1 | 36.7 | 100.0 | 77.7 | 88.5 | 1.6 | 65.9 |
| Greece | 95.8 | 84.9 | 18.6 | 21.3 | 100.0 | 73.1 | 80.0 | 1.1 | 28.1 |
| Hungary | 96.9 | 83.7 | 27.6 | 11.6 | 100.0 | 89.4 | 91.7 | 0.7 | 31.2 |
| Iceland | 91.0 | 70.8 | 21.7 | 30.8 | 100.0 | 70.4 | 87.3 | 8.8 | 55.8 |
| Ireland | 98.7 | 59.2 | 21.8 | 15.9 | *4.6 | 69.6 | 88.1 | 0.9 | 63.2 |
| Italy | 90.5 | 52.8 | 16.3 | 23.4 | 100.0 | 64.0 | 93.4 | 1.1 | 55.2 |
| Latvia | 96.9 | 80.4 | 48.6 | 7.0 | 100.0 | 90.5 | 88.9 | 1.0 | 28.3 |
| Lithuania | 99.3 | 81.7 | 35.1 | 6.8 | 100.0 | 90.6 | 91.7 | 1.1 | 24.5 |
| Luxembourg | 99.6 | 83.0 | 30.8 | 44.2 | 100.0 | 81.4 | 89.0 | 7.6 | 63.3 |
| Malta | 99.5 | 73.0 | 16.3 | 22.3 | 100.0 | 82.5 | 78.4 | 0.7 | **15.5 |
| Netherlands | 97.9 | 75.9 | 14.3 | 50.0 | 100.0 | 77.3 | 79.2 | 4.5 | 57.8 |
| Norway | 99.4 | 83.7 | 8.3 | 29.1 | 100.0 | 83.8 | 90.1 | 1.8 | 55.4 |
| Poland | 99.4 | 80.8 | 26.2 | 8.0 | 100.0 | 86.8 | 95.2 | 1.3 | 16.4 |
| Portugal | 97.3 | 80.0 | 20.9 | 15.5 | 100.0 | 78.0 | 70.3 | 0.5 | 48.1 |
| Romania | 97.5 | 72.8 | 41.7 | 2.5 | 100.0 | 91.4 | 100.0 | 0.7 | 47.6 |
| Slovakia | 99.2 | 79.4 | 31.6 | 9.4 | 100.0 | 90.7 | 98.4 | 1.2 | 28.6 |
| Slovenia | 98.7 | 85.7 | 69.0 | 37.9 | 100.0 | 88.3 | 90.0 | 1.1 | 28.0 |
| Spain | 96.5 | 76.8 | 15.3 | 36.2 | 100.0 | 69.8 | 82.6 | 1.9 | 60.5 |
| Sweden | 99.0 | 83.1 | 29.5 | 34.3 | 100.0 | 68.5 | 88.8 | 2.6 | 55.7 |
| Switzerland*** | [38.1] | [14.2] | [11.9] | [26.5] | [4.4] | [14.2] | [2.6] | [48.5] | [16.5] |
| | 80.7 | 70.6 | 19.2 | 11.1 | 100.0 | 86.8 | 100.0 | 3.0 | 61.8 |
| United Kingdom | 99.9 | 74.0 | 29.5 | 44.5 | 100.0 | 70.2 | 94.9 | 2.7 | 61.3 |

Note: * share in COICOP 2-digit category 08 (Communications), ** share in total spending for COICOP categories 12.3, 12.4, 12.5 and 12.6; *** - upper row – share of COICOP 3-digit category in respective COICOP 2-digit categories (05, 06, 08, 09, 12).

Table S6. Availability of household final consumption expenditure data by country.

| Country | Annual final consumption expenditure data (COICOP 3-digit) – sources by year | Detailed consumption expenditure data (COICOP 4-digit) – available surveys (from Eurostat unless otherwise noted) |
|----------|--|---|
| Austria | 1995-2017: Eurostat; 1976-1994: OECD; 1956-1975: extrapolated using total household consumption expenditure from PWT 9.1 | 1994, 1999, 2005, 2010, 2015 |
| Belgium | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010, 2015 |
| Bulgaria | 1995-2017: Eurostat; 1970-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1956-1969: extrapolated using GDP from MPD 2018 | 2005, 2010, 2015 |
| Cyprus | 1995-2017: Eurostat; 1960-1994: extrapolated using total private consumption expenditure from CYSTAT; 1956-1959: extrapolated using total household consumption expenditure from PWT 9.1 | 2005, 2010, 2015 |
| Czechia | 1990-2017: CZSO; 1956-1989: extrapolated using GDP from MPD 2018 (Czechoslovakian GDP before 1970) | 2005, 2010, 2015 |
| Denmark | 1966-2017: DST; 1956-1965: extrapolated using total household consumption expenditure from PWT 9.1 | 1994, 1999, 2005, 2010 |
| Estonia | 1995-2017: Eurostat; 1990-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1950-1989: extrapolated using GDP from MPD 2018 (Soviet GDP per capita before 1980) | 2005, 2010, 2015 |
| Finland | 1980-2017: Eurostat; 1956-1979: extrapolated using total private consumption expenditure from Statistics Finland | 1994, 1999, 2005, 2010, 2015 |
| France | 1975-2017: Eurostat; 1959-1974: OECD; 1956-1958: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010 |
| Germany | 1991-2017: DESTATIS; 1956-1990: extrapolated using total household consumption expenditure from PWT 9.1 | 1994, 1999, 2010, 2015 |
| Greece | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010, 2015 |
| Hungary | 1995-2017: Eurostat; 1970-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1950-1969: extrapolated using GDP from MPD 2018 | 2005, 2010, 2015 |
| Iceland | 1990-2017: Statistics Iceland; 1956-1989: extrapolated using total private consumption expenditure (Statistics Iceland) | Not available - average shares for the European Union (15 member states) from 1999, 2005, 2010 surveys used |
| Ireland | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1994, 1999, 2005, 2010, 2015 |

| | | |
|-------------|--|---|
| Italy | 1995-2017: Eurostat; 1992-1994: OECD; 1956-1991: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2010, 2015 |
| Latvia | 1995-2017: Eurostat; 1990-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1950-1989: extrapolated using GDP from MPD 2018 (Soviet GDP per capita before 1980) | 2005, 2010, 2015 |
| Lithuania | 1995-2017: Eurostat; 1990-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1950-1989: extrapolated using GDP from MPD 2018 (Soviet GDP per capita before 1980) | 2005, 2010, 2015 |
| Luxembourg | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010, 2015 |
| Malta | 2000-2017: Eurostat; 1970-1999: extrapolated using total household consumption expenditure from PWT 9.1; 1956-1969: extrapolated using GDP from PWT 9.1 | 2005, 2010, 2015 |
| Netherlands | 1995-2017: Eurostat; 1980-1994: OECD; 1956-1979: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2015 |
| Norway | 1970-2016: SSB; 1956-1969: extrapolated using total private consumption expenditure from Grytten (2004); 2017 extrapolated | 2005, 2010 |
| Poland | 1995-2017: Eurostat; 1970-1994: extrapolated using total private consumption expenditure from PWT 9.1; 1956–1969: extrapolated using total consumption expenditure from GUS | 2005, 2010, 2015 |
| Portugal | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010, 2015 |
| Romania | 1995-2017: Eurostat; 1960-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1956-1959: extrapolated using GDP from MPD 2018 | 2005, 2010, 2015 |
| Slovakia | 1995-2017: Eurostat; 1990-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1956-1989: extrapolated using GDP from MPD 2018 (Czechoslovakian GDP before 1970) | 2005, 2010, 2015 |
| Slovenia | 1995-2017: Eurostat; 1990-1994: extrapolated using total household consumption expenditure from PWT 9.1; 1956-1989: extrapolated using GDP from MPD 2018 | 2005, 2010, 2015 |
| Spain | 1995-2017: Eurostat; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | 1988, 1994, 1999, 2005, 2010, 2015 |
| Sweden | 1980-2016: SCB; 1956-1979: extrapolated using total private consumption expenditure from Edvinsson (2005); 2017 extrapolated | 1994, 1999, 2005, 2010, 2015 |
| Switzerland | 1995-2017: COICOP 2-digit level data from BFS; 1956-1994: extrapolated using total household consumption expenditure from PWT 9.1 | Swiss surveys of 2006–2008, 2009–2011 and 2012–2014 (BFS) |

| | | |
|----------------|---|------------------------------|
| United Kingdom | 1985-2017: ONS; 1956-1984: extrapolated using total household consumption expenditure from Blue Book 2018 (ONS) | 1988, 1994, 1999, 2005, 2010 |
|----------------|---|------------------------------|

Notes: PWT 9.1 = Penn World Table 9.1 (Feenstra et al. 2015)

MPD 2018 = Maddison Project Database 2018 (Bolt et al. 2018)

Table S7. Equations and ranges of validation measures used in the paper.

| Measure | Equation | Range |
|--|--|---------------------|
| Pearson's coefficient of determination (R^2) | $r^2 = \left(\frac{\sum_{i=1}^n (x_i - \bar{x}_i)(y_i - \bar{y}_i)}{\sqrt{\sum_{i=1}^n (x_i - \bar{x}_i)^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y}_i)^2}} \right)^2$ | $[-1,1]$ |
| Mean absolute error (MAE) | $I_{MAE} = \frac{\sum_{i=1}^n x_i - y_i }{n}$ | $[0, \infty]$ |
| Mean bias error (MBE) | $I_{MBE} = \frac{\sum_{i=1}^n x_i - y_i}{n}$ | $[-\infty, \infty]$ |
| Symmetric mean absolute percentage error (SMAPE) | $I_{SMAPE} = \frac{\sum_{i=1}^n x_i - y_i }{\sum_{i=1}^n x_i + y_i }$ | $[0,1]$ |

Symbols: x_i is the i -th observation, y_i is the i -th prediction, n is the sample size.

Table S8. Validation results of the building height predictions per city. In all cases the results are for an out-of-sample validation (i.e. the model's sample excluded the city that was validated).

| City | N | R ² | MAE (m) | MBE (m) | SMAPE | Observed mean (m) |
|------------|------|----------------|---------|---------|-------|-------------------|
| Amsterdam | 4885 | 0.30 | 2.49 | -0.23 | 0.15 | 8.67 |
| Athens | 3683 | 0.25 | 4.38 | -1.68 | 0.16 | 14.20 |
| Berlin | 5138 | 0.50 | 3.66 | -1.39 | 0.19 | 10.57 |
| Bratislava | 181 | 0.43 | 7.28 | -5.38 | 0.32 | 14.22 |
| Brussels | 4031 | 0.11 | 3.78 | -0.96 | 0.17 | 11.41 |
| Bucharest | 327 | 0.39 | 6.25 | 0.76 | 0.28 | 10.65 |
| Budapest | 395 | 0.34 | 4.23 | -1.62 | 0.19 | 11.87 |
| Copenhagen | 2158 | 0.24 | 2.50 | 1.96 | 0.17 | 6.46 |
| Dublin | 2534 | 0.06 | 1.73 | 1.23 | 0.12 | 6.48 |
| Helsinki | 1657 | 0.34 | 2.76 | 0.89 | 0.18 | 7.27 |
| Lisbon | 679 | 0.10 | 5.39 | -0.88 | 0.21 | 13.45 |
| Ljubljana | 232 | 0.16 | 3.05 | 2.06 | 0.21 | 6.18 |
| London | 4556 | 0.10 | 3.36 | 2.69 | 0.18 | 7.76 |
| Luxembourg | 112 | 0.12 | 2.53 | -0.63 | 0.13 | 10.10 |
| Madrid | 966 | 0.10 | 6.43 | -1.44 | 0.21 | 16.22 |
| Nicosia | 65 | 0.02 | 3.57 | -0.81 | 0.20 | 9.37 |
| Oslo | 921 | 0.45 | 2.74 | 1.61 | 0.18 | 6.95 |
| Paris | 4547 | 0.25 | 3.03 | 1.00 | 0.16 | 8.97 |
| Prague | 1325 | 0.48 | 3.99 | -1.93 | 0.19 | 11.51 |
| Reykjavik | 475 | 0.04 | 3.04 | 1.97 | 0.22 | 5.87 |
| Riga | 305 | 0.25 | 4.23 | -1.30 | 0.21 | 10.90 |
| Rome | 1025 | 0.34 | 4.02 | -1.84 | 0.16 | 13.29 |
| Sofia | 857 | 0.39 | 4.50 | -0.68 | 0.22 | 10.68 |
| Stockholm | 1733 | 0.30 | 2.24 | 0.81 | 0.16 | 6.80 |
| Tallinn | 277 | 0.45 | 3.19 | 0.79 | 0.19 | 7.78 |
| Valletta | 24 | 0.14 | 4.27 | 0.56 | 0.18 | 11.50 |
| Vienna | 1696 | 0.55 | 2.80 | 0.06 | 0.15 | 9.26 |
| Vilnius | 144 | 0.39 | 3.10 | -1.04 | 0.18 | 9.10 |
| Warsaw | 1513 | 0.28 | 3.11 | -0.33 | 0.17 | 9.41 |
| Zagreb | 1025 | 0.18 | 2.57 | 0.44 | 0.16 | 8.04 |

Table S9. Alternative exposure estimates for residential buildings per m² in nominal prices, euro.

| Country | Huizinga et al. (2017), based on a survey by EC Harris (2010) | Huizinga et al. (2017), based on a survey by Turner & Townsend (2013) | Ozcebe et al. (2014) |
|----------------|---|---|----------------------|
| | Reference year 2010 | Reference year 2010 | Reference year 2011 |
| Austria | 1485 | | 1155 |
| Belgium | 1431 | | 1124 |
| Bulgaria | 584 | | 961 |
| Cyprus | | | 939 |
| Czechia | 1065 | | 838 |
| Denmark | 2082 | | 1260 |
| Estonia | | | 797 |
| Finland | 1854 | | 1147 |
| France | 1621 | | 1080 |
| Germany | 2159 | 1067 | 1098 |
| Greece | 1108 | | 888 |
| Hungary | 750 | | 772 |
| Iceland | | | 1097 |
| Ireland | 1696 | 1228 | 1142 |
| Italy | 1365 | | 993 |
| Latvia | 889 | | 759 |
| Lithuania | | | 765 |
| Luxembourg | | | 1820 |
| Malta | | | 844 |
| Netherlands | 1015 | 1253 | 1159 |
| Norway | | | 1651 |
| Poland | 1092 | 554 | 766 |
| Portugal | 837 | | 855 |
| Romania | 816 | | 978 |
| Slovakia | 828 | | 808 |
| Slovenia | | | 873 |
| Spain | 1099 | | 951 |
| Sweden | 1688 | | 1231 |
| Switzerland | 2117 | | 1501 |
| United Kingdom | 1600 | 1655 | 1022 |

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