Urbanization and housing prices in OECD countries: 1870 to 2016

[1]Sefa Awaworyi Churchill, [2]Abebe Hailemariam, [3,4]Michael Odei Erdiaw-Kwasie
[1]School Economics, Finance & Marketing, RMIT University, Australia
[2]Department of Economics, Monash University, Australia
[3]Transparency International Australia, Melbourne, Australia
[4]Institute for Resilient Regions, University of Southern Queensland, Australia
[1]Email: sefa.awaworyichurchill@rmit.edu.au
[2]Email: abebe.hailemariam@monash.edu
[3]Email: michael.erdiaw@transparency.org.au

Abstract

We examine relationship between urbanization and real house prices for a panel of OECD countries using a long historical data that covers the period 1870 to 2016. We use parametric and non-parametric panel data models that estimate the impulse responses and the time-varying coefficients. Our parametric estimates show that an increase in the rate of urbanization has a significant positive effect on real house prices, while the non-parametric estimates show that the relationship between urbanization and real house prices is time-varying. We find that mortgage to GDP ratio is a channel through which urbanization contributes to higher house prices.

Keywords: House price; housing affordability; urbanization; mortgage; Panel VAR; nonparametric panel data.

1. Introduction

Much research has focused on the global increase in house prices (see, e.g., Ball, 1973; Canarella et al., 2019; Fan et al., 2006; Gong et al., 2015; Jordà et al., 2017; Knoll et al., 2017); among which a subset has examined different determinants of house prices (see, e.g., Caudill et al., 2014; Nellis & Longbottom, 1981; Richardson et al., 1974; Zhu et al., 2018). A related body of literature investigates the implications of rising house prices and suggest that changes in house prices can have important implications at both the macro and micro levels. For instance, a persistent increase in house prices has been associated with lower investments and inflation, with adverse implications for monetary policy and the overall standard of living for low-income households (Easterly & Fischer, 2001; Gholipour, 2020; Stroebel & Vavra, 2019; Valadkhani & Smyth, 2016). Rising house prices have been also linked with a lower probability of homeownership (Coulter, 2017; Dewilde & Lancee, 2013), an issue that is of much concern for policymakers, given that homeownership is positively associated with health and wellbeing (Cairney, 2005; Cairney & Boyle, 2004; Zumbro, 2014).

At the same time as the persistent growth in house prices, a large proportion of the world's population is becoming urbanized, with a persistent shift in residence of populations from rural to urban areas (Zhang, 2016). As of 2019, more than half of the population globally lived in urban areas, and this is expected to increase to more than two-thirds by 2050 (OECD, 2010; United Nations, 2019). Among other things, this increase in urbanization is argued to be driven by climate change, economic and social factors (see, e.g., Bastin et al., 2019; Beauchemin & Bocquier, 2004; Cardoso et al., 2019; Crankshaw & Borel-Saladin, 2018; Hendrigan, 2020; Paye, 1995; Veneri & Murtin, 2019). In OECD countries, which are the focus of this study, it is expected that the urban population will increase to more than 85% by 2050 (OECD, 2010). This has led to a growing interest in understanding the implications of urbanization (see, e.g., Cali & Menon, 2013; Chauvin et al., 2017; Domene & Saurí, 2006; Liu et al., 2014; Luo et al., 2016; Salim & Shafiei, 2014).

What is the effect of urbanization on house prices? While a few studies examine the relationship between urbanization and different aspects of housing, several questions remain unanswered. Much of what has been done on the impact of urbanization on housing focus on housing demand and investment (see, e.g., Chen et al., 2011a; Dasgupta et al., 2014). This literature demonstrates that urbanization increases housing demand and investments. Very few studies examine the relationship between urbanization and house prices, all of which focus on individual countries, use cross-section data or focus on a relatively short timeframe (Chen et al., 2011b; Liu & Roberts, 2013; Wang et al., 2017). There is also a lack of robust empirical evidence on the channels through which urbanization influences house prices. For instance, findings from the literature suggest that changes in housing demand and investment because of urbanization tends to put an upward pressure on house prices. However, urbanization has been associated with undesirable neighbourhood characteristics such as crime (Cao & Maume, 1993; Cobbinah et al., 2015;

Johnson, 2002), which could negatively influence house prices (Lynch & Rasmussen, 2001; Tita et al., 2006).

We examine the effects of urbanization on house prices using data on a panel of 17 OECD countries from 1870 to 2016.[1] OECD countries make for an important case study given trends in both urbanization and house prices. Evidence shows that OECD countries are severely affected by the persistence of its urbanization trends, and have been faced with a wide range of urban management challenges (Cavaco et al., 2020). Thus, OECD countries do not only have the highest rates of urbanization in the world but are also faced with significant challenges in managing trends associated with this urbanization. Providing insights on the implications of urbanization for OECD countries will thus provide important lessons for policy. House prices in the OECD countries have also increased persistently with significant cross-country variations since the second half of the twentieth century (Knoll et al., 2017). Providing insights that help in understanding the relationship between two interesting trends for policymakers in the OECD, especially drawing on a historical perspective, will provide useful practical insights for setting up a comprehensive urban development agenda.

By examining the relationship between urbanization and house prices, we contribute to at least two bodies of literature. First, we contribute to studies that examine the impact of related concepts such as migration and population growth on housing (see, e.g., Birrell & Healy, 2018; Geng, 2018; Gonzalez & Ortega, 2013; Johnes & Hyclak, 1994; Ley & Tutchener, 2001; Sá, 2015). The second is the small literature that has examined the impact of urbanization on house prices (see, Chen et al., 2011b; Liu & Roberts, 2013; Wang et al., 2017). However, we differ from these studies in that they focus on single countries and a relatively short period of time. We make three important contributions to the literature on the relationship between urbanization and house prices. The first is that we use an extended sample that spans about 150 years, thus allowing us to understand how the evoluation of urbanization, in what are now the most urbanized countries, has influenced house prices. The use of a long panel for OECD countries allows us to capture considerable variation in urbanization and house prices overtime, especially since both urbanization and increasing house prices have been defining features of OECD countries since the second half of the twentieth century (Knoll et al., 2017).

Our second contribution is that we examine the role of housing investment and crime rates as important channels through which urbanization influences house prices. As noted earlier, the existing literature argues that changes in housing demand and investment resulting from urbanization tends to put an upward pressure on house prices, thus increasing house prices. In addition to empirically testing this assumption, we also empirically test a competing argument which suggests that urbanization is associated with undesirable neighbourhood characteristics such as crime, which can cause house prices to decline. While we do not have data on housing demand,

[1] Our sample period ends in 2016 given that for some variables included in this analysis, we do not have data beyond 2016.

we draw on mortgage data to proxy housing investment and data on homicides, thefts and robberies to examine the role of housing investment and crime rates as potential mediators in the relationship between urbanization and house prices. By focusing on housing investment and crime as channels, we examine two important factors that are known to influence housing.

Third, we apply robust methods that address endogeneity while we also take into account the span of the dataset and provide non-parametric estimates. To address the endogeneity of urbanization, we use a panel vector autoregressive (PVAR) model that allows us to examine the contributions of each shock in our series to the variations in real house prices (Canova & Ciccarelli, 2013; Holtz-Eakin et al., 1988). We also apply the heteroskedasticity-based Lewbel (2012) method, which allows us to identify the causal effect of urbanization on house prices. We further relax the restrictive parametric assumptions to capture the time-varying effects of urbanization using a non-parametric model. The non-parametric local linear dummy variable estimation (LLDVE) model (Li et al., 2011; Zhang et al. 2012), which we use, allows the coefficient on urbanization to be time-varying with unknown functional form (see, e.g., Churchill et al., 2019b; 2020; Hailemariam et al., 2019).

Our results show that urbanization has a positive relationship with real house prices, and this relationship is time varying. The effect of urbanization on house prices becomes more pronounced and persistent from the 1960s, with the effect becoming even stronger in recent years. We find that the housing investment (proxied by mortgage to GDP ratio) is an important channel through which higher urbanization leads to higher house prices.

2. Data and methodology

2.1. Data

We combine data from multiple sources. Data for house price, consumer price index (CPI), mortgage credit, real GDP, interest rate are taken from the Jordà-Schularick-Taylor Macrohistory Database, which is available at http://www.macrohistory.net/data/.[2] The dataset provides house price indices over the long-run for several advanced economies. The data brings together urban and national house price indices from various sources. Originally, reported in Knoll et al. (2017), the authors compare the constructed indices and show that the trends in the data fully correspond or follow similar trend. The details of the procedure followed in constructing the data can be found in Knoll et al. (2017).

Historical data on urbanization rate are from Madsen et al. (2018) and updated using data from World Development Indicators. Based on data availability, our sample consists of the following 17 OECD countries over the period 1870 to 2016.[3] Data on robbery rate used in the potential channel analysis date back to 1900 and captures robberies per 100,000 people. The data on robbery

[2] See Jordà et al. (2017) for details on variables construction.
[3] The 17 OECD countries include Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

rate for all 17 OECD countries from 1900 to 1974 are taken from Archer and Gartner (2006) and updated using data from Von Hofer et al. (2012), the US Department of Justice UCR Database, the UK Government Statistics Office and the Global Economy Database.[4]

Table 1 provides a description and summary statistics. It shows significant cross-country variations in our variables of interest. The standard deviations of the log of real hose price and the log of urbanization rate are 0.122 and 0.019, respectively. The time series plot for log real house price in Figure A1 shows a surge in real house price over time except for declines during recessions and the two world wars. Figure A2 shows that urbanization rate steeply increased until 1960 when the rate of increase slowed down. There is also evidence in the rate of convergence in urbanization over time.

2.2. Cross-sectional dependence and panel unit root tests

To begin our analysis, we first examine the time series properties of our variables. Table 2 presents the results of panel unit root tests that accounts for cross-sectional dependence in units (Pesaran, 2007). The results show that we cannot reject the null hypothesis of a unit root in levels except for interest rate. However, we reject the null hypothesis in the first difference for all variables. This suggests that urbanization and house prices are integrated of order 1, I(1). Our empirical specifications below are therefore based on first difference of the variables.

2.3. Methodology

Our benchmark estimates are based on a standard first-differenced panel data model for real house prices as follows:

$$\Delta hp_{it} = \alpha_i + \beta_1 \Delta urb_{it} + \sum_n \beta_n \Delta X_{n,it} + \mu_t + \varepsilon_{it} \quad (1)$$

where Δ is the first difference operator; hp_{it} represents real house prices (logged) and urb_{it} denotes our measure of urbanization; i and t index country and year, respectively; X_{it} denotes a vector of control variables, including GDP per capita, the interest rate, current account to GDP ratio, and population growth; α_i and μ_t are country and time fixed effects, respectively. ε_{it} is the error term that captures all other omitted factors. For our baseline estimates, we use ordinary least squares (OLS) and panel fixed effect estimators. However, these estimators may not necessarily indicate the causal effect of urbanization and mortgage credits on real house prices. For instance, while the panel fixed effect estimator may be efficient in addressing issues of omitted variable, it is limited in addressing endogeneity that may arise form reverse causality or measurement errors.

[4] For the UK, see, https://www.gov.uk/government/statistics/historical-crime-data; for the US, see https://www.ucrdatatool.gov/Search/Crime/State/RunCrimeStatebyState.cfm; for the Global Economy Database, see https://www.theglobaleconomy.com/download-data.php

Thus, in addition to our main estimation strategy discussed below, we also estimate a baseline model that controls for endogeneity using the two stage least squares (2SLS) approach proposed by Lewbel (2012). To achieve identification, the Lewbel (2012) 2SLS estimator, which is widely used in the literature to address endogeneity (see, e.g., Churchill et al., 2019a; Belfield & Kelly, 2012; Mishra & Smyth, 2015), relies on heteroskedastic covariance restrictions. The main advantage of the this method is that, the constructed instruments can be used as a valid identification strategy in the absence of valid external instruments. Moreover, the generated instruments improve model efficiency and allow us to test for over-identifying restrictions.[5]

We employ a panel vector autoregressive (PVAR) model introduced by Holtz-Eakin et al. (1988) as our main estimation strategy to address endogeneity. The main advantage of the PVAR method is its ability to combine the features of the traditional VAR model that accommodates endogeneity with the panel-data approach that captures unobserved heterogeneity (Canova & Ciccarelli, 2013; Holtz-Eakin et al., 1988). The PVAR model is, thus, able to address potential endogeneity between urbanization rate and house prices, and enable us to estimate the contribution of each variable in the system to the variations in house prices

The PVAR representation for our research question can be specified as:

$$Y_{it} = A_0 + A_1 Y_{i,t-1} + \theta_i + \gamma_t + \varepsilon_{it} \quad (2)$$

where Y_{it} is a set of variables in the PVAR system; A_0 and A_1 are coefficients to be estimated; θ_i and γ_t denote country and time fixed effects, respectively; ε_{it} is a vector of error terms. The indices $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots, N$, indicate country and year, respectively.

We use forward orthogonal deviation procedure to remove country fixed effects. This process allows us to preserve the orthogonality between the transformed variables and the lagged regressors. As in the case of the generalized method of moments (GMM) (Arellano and Bover, 1995), the lagged regressors serve as instruments in estimating the parameters by system GMM. We choose optimal lag order of 2 for our PVAR estimation using consistent moment and model selection criteria (MMSC) (Abrigo & Love, 2016; Andrews & Lu, 2001).

To address the potential issues of time dependence and model misspecification in the relationship between our variables, we also employ the nonparametric LLDVE method (Li et al., 2011; Zhang et al., 2012). The LLDVE method enables us to estimate the time-varying coefficient and trend functions. We estimate the time-varying non-parametric model of the form:

$$\Delta hp_{it} = f_i(\mathrm{t}) + \phi_1(t)\Delta urb_{it} + X_{it}^T \beta_t + \alpha_i + \varepsilon_{it} \quad (3)$$

[5] See Lewbel (2012) for more details.

where Δ is the first difference operator; hp_{it} is log of real house price for country *i* and year *t*; $f_i(t) = f_i\ (t/T)$ are time-varying trend functions; urb_{it} denotes the log of urbanisation; X_{it} is a vector of control variables described above. $\phi_j(\mathrm{t}) = \phi_j(\mathrm{t/T})$ and $\beta_j(\mathrm{t}) = \beta_j(\mathrm{t/T})$, are time-varying estimates; α_i is an unknown individual effect and ε_{it} is the error term. We estimate coefficient and trend functions that vary over time with confidence bands that are based on wild bootstrapping method.

3. Results

3.1. Benchmark results

Table 3 presents the baseline results for the relationship between urbanization and house prices. Column 1 reports pooled OLS results, Column 2 reports panel fixed effect results while Column 3 reports instrumental variable (IV) estimates using the Lewbel (2012) approach. Across all columns, we find a positive effect of urbanization on real house prices. From Column 1, we find that the coefficient on urbanization is statistically significant at 5% level, and, on average, a 1% increase in the rate of urbanization is associated with a 0.31% increase in real house prices. From Column 2, we find a similar relationship with statistical significance at the 10%. Here, a 1% increase in the rate of urbanization is associated with a 0.26% increase in real house prices.

From Column 3, we find that endogeneity is associated with a marginal downward bias in pooled fixed effect estimates given that the coefficient on urbanization from the Lewbel 2SLS estimation is marginally higher with improved statistical significance. Specifically, we find that, on average, a 1% increase in the rate of urbanization is associated with a 0.28% increase in house prices. The p-value of the Hansen test for over-identifying restrictions is 0.59, thus lending support to the validity of the constructed instruments.

A common assumption is that during urbanization, land and property value will increase for urban centers while that of rural areas decrease. Given that the house price indices in Knoll et al. (2012) are based on either urban or national data, we re-estimate equation 1 using the sample for urban and national data separately to examine whether house price data that primarily comes from urban areas will induce a strong positive bias in the national house prices, since it omits information on rural areas.

Table 4 presents results that distinguish between house price indices based on urban data (Panel A) and national data (Panel B). As shown in the Panel A of Table 4, the effect of urbanization on urban house prices is positive and statistically significant across all regressions. More precisely, a 1% increase in urbanization is associated with an increase in urban house price of about 0.33% to 0.49%. Interestingly, the results in panel B of Table 4 shows that the effect on national house prices is statistically indistinguishable from zero. This suggests that the finding that urbanization is positively associated with higher house prices is mostly driven by urban house prices. The insignificant effect in the national data might, thus, be explained by the rapid decline in rural house prices that may offset the increase in urban house rises following urbanization. Our results,

therefore, lend support to the findings of Glaeser & Gyourko (2005) who document that urbanization driven by rural-to-urban migration lead to a decline in house prices in rural areas that are declining in population and a rise in house pries in urban areas.

3.2. Main Parametric Results

Impulse Responses

Figure 1 reports the estimates of the orthogonalized impulse response functions (IRF) from our PVAR model described in Section 2 using the full sample. The IRF indicates the response of real house prices to each shock in the series. The solid lines show the estimated responses of real house price to a standard deviation shock in the explanatory variables while the shaded region shows the 95% confidence band for the estimates.

As shown in Figure 1, the response of house prices to a positive shock in urbanization is positive and statistically significant. Specifically, a standard deviation shock in urbanization rate causes a positive and significant increase in house prices. This effect quickly dies off 5 years following the shock. This finding supports the conclusions of some recent studies (e.g., Chauvin et al., 2017; van Doorn et al., 2019), which suggest that urbanization is linked with unintended consequences including rising house prices, inflexible housing stock and affordable housing shortages.

While the impulse response functions in Figure 1 are useful to track the response of real house prices to a one-time shock in the covariates, they cannot capture the dynamic accumulated effect over time. We therefore report Figure 2, which shows the plots of the orthogonalized cumulative impulse response functions based on the estimates from PVAR model. The cumulative impulse responses are useful to understand how real house price responds to some exogenous shock on impact, as well as the accumulation of the shock's impact on house prices across time. The results in Figure 2 show that the commutative effect of urbanization on real house prices is persistent over time. As shown in the Figure, a one-standard-deviation shock in the rate of urbanization leads to a permanent increase in house prices of about 2% after some time lag.

Consistent with our results in Table 4, Figures 3 and 4 show that the orthogonalized impulse responses and the cumulative impulse responses of urban house price to a positive shock in urbanization is positive, persistent and statistically significant. These results are quantitatively larger than the results reported in Figures 1 and 2. However, Figure 5 shows that the response of national house price is not significant.

The impulse response functions of the other covariates have the expected sign and effect. Specifically, positive shocks in GDP per capita and population growth cause a significant and persistent increase in house prices up to 3 years and then decline thereafter. The response of real house prices to interest rates and current account is negative and statistically significant, suggesting that contractionary monetary policy could be effective in controlling the rising house prices and promoting housing affordability.

3.3.Non-parametric results

The parametric estimates in the previous section provide important insights into the relationship between real house prices and urbanization. However, they do not capture the time-varying effects of urbanization on real house prices. In this section, we present the time-varying estimates using the LLDVE method described in Section 2.

Nonparametric time-varying coefficients

Figure 6 shows LLDVE estimates and their 90% confidence bands. From Figure 6, the coefficient on urbanization evolves over time as an increasingly important determinant of real house prices. We find that the estimated time-varying coefficient function of urbanization is relatively flat until the 1960s. Since the 1960s there was a positive and significant effect on house prices until 1980 when there was a reversal until the late 1990s. We further observe a relatively sharp increase from the year 2000. Our result is consistent with the argument that the arrival of new migrants into cities, motivated by the prospects for higher wage and productivity triggers unintended consequences that drives up house prices (China Development Research Foundation, 2010). In the United States, Chauvin et al. (2017) find that housing value increases significantly with urban population.

Common and country-specific trend functions

We also report LLDVE estimates for country-specific as well as common trend functions in Figure 7. For comparison, we include the estimated country-specific and common trend function in the same plots. The estimated common trend function is represented by the solid line along with the upper and lower confidence bands, whereas the dashed lines show the country-specific trend functions. The common trend in real house price to income ratio had declined significantly until the 1990s indicating that national per capita income has grown at a faster rate than the cost of housing. Interestingly, the common trend also increased sharply since 2000 highlighting the issue of housing affordability in recent years.

3.4. Channels of influence

We discuss housing demand, investment, and crime rates as important channels through which urbanization influences house prices. On the one hand, changes in demand and investment resulting from urbanization tends to push up house prices. On the other hand, urbanization is associated with undesirable neighbourhood characteristics such as crime, which can cause house prices to decline. That our results suggest a positive effect of urbanization on house prices leads us to believe that mechanism at play here is likely to be housing demand and investment. However, we take advantage of available data and test both competing mechanisms. We use data on mortgage to GDP ratio to proxy housing investment, while we use data on robberies per 100,000 people to measure crime.

To examine mortgage and crime as potential mechanisms, we adopt a standard approach used in the literature (see, e.g., Alesina & Zhuravskaya, 2011; Churchill et al., 2019a). For a variable (in this case mortgage and crime) to quality as a mechanism through which urbanization transmits to house prices, it first needs to be correlated with urbanization rate. Second, the variable should be correlated with house prices and its inclusion as an additional control variable in the regression linking house prices to urbanization should either render the coefficient on urbanization statistically insignificant or decrease its magnitude. Thus, we study the role of mortgage and crime in alternating models.

Table 5 reports the effect of urbanization on mortgage and crime rates. Column 1 reports effects on mortgage while Columns 2 reports effects on robbery rates. We find that an increase in the rate of urbanization is associated with an increase in mortgage credit and robberies. Given that the effect of urbanization is statistically significant in both columns, we estimate house prices regressions with mortgage and robberies as additional covariates. Given that we have some missing observations, the number of observations differ with the inclusion of the channel variables in the house prices regression. Thus, we first re-estimate the effect of urbanization on house prices using the sub-sample of observations simultaneously available for house prices mortgage to GDP, robberies and control variables. This ensures that the same sample is used in the channel analysis.

Column 1 of Table 6 re-estimates the effect of urbanization on house prices, while Columns 2 and 3 add mortgage and robberies as additional covariates, respectively. While, the effect of robberies on house prices is statistically insignificant, we find that an increase in mortgage credit is associated with an increase in house prices. Comparing the coefficient on urbanization in Columns 1 and 2, we find that with the inclusion of mortgage as an additional covariate, the size of the coefficient on urbanization reduces. This result confirms that housing investment (proxied by mortgage to GDP ratio) is a channel through which income inequality lowers house prices. This finding reinforces argument suggesting that urbanization is likely to increase housing demand and investment, and thus increase house prices.

4. Conclusion

Rapid urbanization is known to present some benefits but can also pose significant challenges. This is particularly the case for OECD countries, which have experienced urbanization at a rate above the global average. The persistence of urbanization and its associated management challenges has, thus, been of concern for policymakers. Research into understanding the impact of urbanization is particularly relevant to ensure that policymakers are able to appropriately navigate around the wide range of urban management challenges. This has inspired a body of literature that seeks to understand the antecedents and implications of urbanization. In this study, we contribute to the literature that has examined the implications of urbanization. We take a historical perspective to our analysis and provide evidence on the relationship between urbanization and house prices over time.

We examine the effect of urbanization rate on real house prices in a sample of OECD countries using long historical data over the period 1870 to 2016. The use of a historical dataset is particularly important given that the history of urbanization is traced back into the 1800s (Narain, 1960), and thus, by using an extended dataset that covers about 150 years, we are able to understand how the evolution of urbanization has influenced house prices over time. We use a series of empirical strategies including the PVAR and data-driven LLDVE methods to address endogeneity and the time-varying relationship between urbanization and house prices. We further examine the transmission role played by mortgage credit availability and crime rates. We find that urbanization has had a positive effect on house prices, and that this positive effect has channeled via high investment demand. The non-parametric results further reveal that the relationship between urbanization and real house prices is time-varying, with evidence pointing persistent effects of urbanization in recent years.

The findings from this research offer some insights for policy. On the one hand, the positive effect of urbanization on house prices suggests that urbanization is able to aid in wealth accumulation given that for most people, especially in OECD countries, wealth is often tied to investments in homes with large mortgages take to purchase such homes. Thus, an increase in urbanization could mean accumulation of household wealth and decrease in mortgage overhang. However, on the other hand, the positive effect of urbanization suggests that housing affordability might be an issue. Thus, households with the resources that are able to invest in houses are likely to accumulate wealth as a result of urbanization while at the same time, this might hinder the wellbeing of other households that are unable to afford homes given increases in house prices, and ultimately promote inequality. This finding lends support to the argument that urbanization could provide both opportunities and challenges, and thus, it is important for policymakers to understand the population composition of the citizenry with regards to income and implement policies that are unlikely to engender inequality in house ownership.

References

Abrigo, M. R., & Love, I. (2016). Estimation of panel vector autoregression in Stata. *The Stata Journal, 16*(3), 778-804.

Alesina, A., & Zhuravskaya, E. (2011). Segregation and the Quality of Government in a Cross Section of Countries. *The American Economic Review, 101*(5), 1872-1911. doi:10.2307/23045625

Andrews, D. W. K., & Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of Econometrics, 101*(1), 123-164. doi:https://doi.org/10.1016/S0304-4076(00)00077-4

Archer, D. & Gartner, R. (2006) Violence and Crime in Cross-National Perspective, 1900-1974. Michigan: Inter-university Consortium for Political and Social Research.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*(1), 29-51. doi:https://doi.org/10.1016/0304-4076(94)01642-D

Ball, M. J. (1973). Recent Empirical Work on the Determinants of Relative House Prices. *Urban Studies, 10*(2), 213-233. doi:10.1080/00420987320080311

Bastin, J.-F., Clark, E., Elliott, T., Hart, S., van den Hoogen, J., Hordijk, I., . . . Maschler, J. (2019). Understanding climate change from a global analysis of city analogues. *PLoS ONE, 14*(7).

Beauchemin, C., & Bocquier, P. (2004). Migration and Urbanisation in Francophone West Africa: An Overview of the Recent Empirical Evidence. *Urban Studies, 41*(11), 2245-2272. doi:10.1080/0042098042000268447

Belfield, C. R., & Kelly, I. R. (2012). The benefits of breast feeding across the early years of childhood. *Journal of Human Capital, 6*(3), 251-277.

Birrell, B., & Healy, E. (2018). *Immigration and the Housing Affordability Crisis in Sydney and Melbourne*. Middle Camberwell: The Australian Population Research Institute.

Cairney, J. (2005). Housing tenure and psychological well-being during adolescence. *Environment and Behavior, 37*(4), 552-564.

Cairney, J., & Boyle, M. H. (2004). Home ownership, mortgages and psychological distress. *Housing Studies, 19*(2), 161-174. doi:10.1080/0267303032000168577

Cali, M., & Menon, C. (2013). Does urbanization affect rural poverty? Evidence from Indian districts. *The World Bank Economic Review, 27*(2), 171-201.

Canarella, G., Gil-Alana, L., Gupta, R., & Miller, S. M. (2019). Persistence and cyclical dynamics of US and UK house prices: Evidence from over 150 years of data. *Urban Studies*, 0042098019872691. doi:10.1177/0042098019872691

Canova, F., & Ciccarelli, M. (2013). Panel vector autoregressive models: A survey* the views expressed in this article are those of the authors and do not necessarily reflect those of the ecb or the eurosystem. In T. B. Fomby, A. Murphy, & L. Kilian (Eds.), *Var models in macroeconomics–new developments and applications: Essays in honor of Christopher A. Sims* (pp. 205-246). Bingley: Emerald Group Publishing Limited.

Cao, L., & Maume, D. J. (1993). Urbanization, inequality, lifestyles and robbery: A comprehensive model. *Sociological Focus, 26*(1), 11-26.

Cardoso, R., Meijers, E., Van Ham, M., Burger, M., & de Vos, D. (2019). Why bright city lights dazzle and illuminate: A cognitive science approach to urban promises. *Urban Studies, 56*(2), 452-470.

Caudill, S. B., Affuso, E., & Yang, M. (2014). Registered sex offenders and house prices: An hedonic analysis. *Urban Studies, 52*(13), 2425-2440. doi:10.1177/0042098014547368
Cavaco, C., Florentino, R., & Pagliuso, A. (2020). Urban Policies in Portugal. In S. Armondi & S. De Gregorio Hurtado (Eds.), *Foregrounding Urban Agendas: The New Urban Issue in European Experiences of Policy-Making* (pp. 49-73). Cham: Springer International Publishing.
Chauvin, J. P., Glaeser, E., Ma, Y., & Tobio, K. (2017). What is different about urbanization in rich and poor countries? Cities in Brazil, China, India and the United States. *Journal of Urban Economics*, 98, 17-49.
Chen, J., Guo, F., & Wu, Y. (2011a). Chinese urbanization and urban housing growth since the mid-1990s. *Journal of Housing and the Built Environment, 26*(2), 219-232.
Chen, J., Guo, F., & Wu, Y. (2011b). One decade of urban housing reform in China: Urban housing price dynamics and the role of migration and urbanization, 1995–2005. *Habitat International, 35*(1), 1-8.
China Development Research Foundation (2010). Trends in urbanisation and urban policies in OECD countries: What lessons for China. Paris: OECD Publishing.
Churchill, S., Farrell, L., & Smyth, R. (2019a). Neighbourhood ethnic diversity and mental health in Australia. *Health Economics, 28*(9), 1075-1087. doi:10.1002/hec.3928
Churchill, S., Inekwe, J., Smyth, R., & Zhang, X. (2019b). R&D intensity and carbon emissions in the G7: 1870–2014. *Energy Economics, 80*, 30-37. doi:https://doi.org/10.1016/j.eneco.2018.12.020
Churchill, S. A., Inekwe, J., Ivanovski, K., & Smyth, R. (2020). The Environmental Kuznets Curve across Australian States and Territories. *Energy Economics*, *90*, 104869.
Cobbinah, P. B., Erdiaw-Kwasie, M. O., & Amoateng, P. (2015). Africa's urbanisation: Implications for sustainable development. *Cities*, *47*, 62-72.
Coulter, R. (2017). Local house prices, parental background and young adults' homeownership in England and Wales. *Urban Studies, 54*(14), 3360-3379. doi:10.1177/0042098016668121
Crankshaw, O., & Borel-Saladin, J. (2018). Causes of urbanisation and counter-urbanisation in Zambia: Natural population increase or migration? *Urban Studies, 56*(10), 2005-2020. doi:10.1177/0042098018787964
Dasgupta, B., Lall, S. V., & Lozano-Gracia, N. (2014). *Urbanization and housing investment*. Washington, DC: The World Bank.
Dewilde, C., & Lancee, B. (2013). Income Inequality and Access to Housing in Europe. *European Sociological Review, 29*(6), 1189-1200. doi:10.1093/esr/jct009
Domene, E., & Saurí, D. (2006). Urbanisation and Water Consumption: Influencing Factors in the Metropolitan Region of Barcelona. *Urban Studies, 43*(9), 1605-1623. doi:10.1080/00420980600749969
Easterly, W., & Fischer, S. (2001). Inflation and the Poor. *Journal of Money, Credit and Banking, 33*(2), 160-178. doi:10.2307/2673879
Fan, G.-Z., Ong, S. E., & Koh, H. C. (2006). Determinants of House Price: A Decision Tree Approach. *Urban Studies*, *43*(12), 2301-2315. doi:10.1080/00420980600990928
Geng, M. N. (2018). *Fundamental drivers of house prices in advanced economies*. Washington, D.C.: International Monetary Fund.
Glaeser, E. L., & Gyourko, J. (2005). Urban decline and durable housing. *Journal of Political Economy*, 113(2), 345-375.

Gholipour, H. F. (2020). Urban house prices and investments in small and medium-sized industrial firms: Evidence from provinces of Iran. *Urban Studies*, 0042098019897887. doi:10.1177/0042098019897887

Gong, Y., Boelhouwer, P., & de Haan, J. (2015). Interurban house price gradient: Effect of urban hierarchy distance on house prices. *Urban Studies, 53*(15), 3317-3335. doi:10.1177/0042098015608090

Gonzalez, L., & Ortega, F. (2013). Immigration and housing booms: Evidence from Spain. *Journal of Regional Science, 53*(1), 37-59.

Hailemariam, A., Smyth, R., & Zhang, X. (2019). Oil prices and economic policy uncertainty: Evidence from a nonparametric panel data model. *Energy Economics, 83*, 40-51.

Hendrigan, C. (2020). Freedom in Cities. In C. Hendrigan (Ed.), *A Future of Polycentric Cities: How Urban Life, Land Supply, Smart Technologies and Sustainable Transport Are Reshaping Cities* (pp. 1-15). Singapore: Springer Singapore.

Holtz-Eakin, D., Newey, W., & Rosen, H. S. (1988). Estimating vector autoregressions with panel data. *Econometrica: Journal of the Econometric Society*, 1371-1395.

Johnes, G., & Hyclak, T. (1994). House prices, migration, and regional labor markets. *Journal of Housing Economics, 3*(4), 312-329.

Johnson, E. A. (2002). *Urbanization and crime: Germany 1871-1914*. Cambridge: Cambridge University Press.

Jordà, Ò., Schularick, M., & Taylor, A. M. (2017). Macrofinancial history and the new business cycle facts. *NBER Macroeconomics Annual, 31*(1), 213-263.

Knoll, K., Schularick, M., & Steger, T. (2017). No price like home: Global house prices, 1870-2012. *American Economic Review, 107*(2), 331-353.

Lewbel, A. (2012). Using Heteroscedasticity to Identify and Estimate Mismeasured and Endogenous Regressor Models. *Journal of Business & Economic Statistics, 30*(1), 67-80. doi:10.1080/07350015.2012.643126

Ley, D., & Tutchener, J. (2001). Immigration, globalisation and house prices in Canada's gateway cities. *Housing Studies, 16*(2), 199-223.

Li, D., Chen, J., & Gao, J. (2011). Non-parametric time-varying coefficient panel data models with fixed effects. *The Econometrics Journal, 14*(3), 387-408.

Liu, N., & Roberts, D. (2013). Counter-urbanisation, planning and house prices: an analysis of the Aberdeen Housing Market Area, 1984-2010. *Town Planning Review, 84*(1), 81-105.

Liu, T.-Y., Su, C. W., & Jiang, X.-Z. (2014). Is economic growth improving urbanisation? A cross-regional study of China. *Urban Studies, 52*(10), 1883-1898. doi:10.1177/0042098014540348

Luo, J. M., Qiu, H., & Lam, C. F. (2016). Urbanization impacts on regional tourism development: A case study in China. *Current Issues in Tourism, 19*(3), 282-295.

Lynch, A. K., & Rasmussen, D. W. (2001). Measuring the impact of crime on house prices. *Applied Economics, 33*(15), 1981-1989.

Madsen, J. B., Islam, M. R., & Doucouliagos, H. (2018). Inequality, financial development and economic growth in the OECD, 1870–2011. *European Economic Review, 101*, 605-624. doi:https://doi.org/10.1016/j.euroecorev.2017.11.004

Mishra, V., & Smyth, R. (2015). Estimating returns to schooling in urban China using conventional and heteroskedasticity-based instruments. *Economic Modelling, 47*, 166-173.

Narain, D. (1960). Urbanization and Some Social Problems. *Sociological Bulletin, 9*(2), 1-6. doi:10.1177/0038022919600201
Nellis, J. G., & Longbottom, J. A. (1981). An Empirical Analysis of the Determination of House Prices in the United Kingdom. *Urban Studies, 18*(1), 9-21. doi:10.1080/00420988120080021
OECD. (2010). *Trends in Urbanisation and Urban Policies in OECD Countries: What Lessons for China?* Paris: OECD Publishing.
Paye, J.-C. (1995). Why cities matter to the wealth of nations. *OECD Observer*(197), 4-6.
Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics, 22*(2), 265-312.
Richardson, H. W., Vipond, J., & Furbey, R. A. (1974). Determinants of Urban House Prices. *Urban Studies, 11*(2), 189-199. doi:10.1080/00420987420080341
Sá, F. (2015). Immigration and House Prices in the UK. *The Economic Journal, 125*(587), 1393-1424.
Salim, R. A., & Shafiei, S. (2014). Urbanization and renewable and non-renewable energy consumption in OECD countries: An empirical analysis. *Economic Modelling, 38,* 581-591. doi:https://doi.org/10.1016/j.econmod.2014.02.008
Stroebel, J., & Vavra, J. (2019). House Prices, Local Demand, and Retail Prices. *Journal of Political Economy, 127*(3), 1391-1436. doi:10.1086/701422
Tita, G. E., Petras, T. L., & Greenbaum, R. T. (2006). Crime and Residential Choice: A Neighborhood Level Analysis of the Impact of Crime on Housing Prices. *Journal of Quantitative Criminology, 22*(4), 299. doi:10.1007/s10940-006-9013-z
United Nations. (2019). *World Population Prospects 2019: Highlights*. New York: UN Department of Economic and Social Affairs Population Division.
Valadkhani, A., & Smyth, R. (2016). Self-exciting effects of house prices on unit prices in Australian capital cities. *Urban Studies, 54*(10), 2376-2394. doi:10.1177/0042098016643476
van Doorn, L., Arnold, A., & Rapoport, E. (2019). In the Age of Cities: The Impact of Urbanisation on House Prices and Affordability. In *Hot Property* (pp. 3-13). Springer, Cham.
Veneri, P., & Murtin, F. (2019). Where are the highest living standards? Measuring well-being and inclusiveness in OECD regions. *Regional Studies, 53*(5), 657-666.
Von Hofer H, Lappi-Seppälä T and Westfelt L (2012). *Nordic Criminal Statistics 1950-2010: Summary of a Report*. Stockholm: Stockholm University.
Wang, X.-R., Hui, E. C.-M., & Sun, J.-X. (2017). Population migration, urbanization and housing prices: Evidence from the cities in China. *Habitat International, 66,* 49-56.
Zhang, X. Q. (2016). The trends, promises and challenges of urbanisation in the world. *Habitat International, 54,* 241-252.
Zhang, Y., Su, L., & Phillips, P. C. (2012). Testing for common trends in semi-parametric panel data models with fixed effects. *The Econometrics Journal, 15*(1), 56-100.
Zhu, J., Pryce, G., & Brown, S. (2018). Immigration and house prices under various labour market structures in England and Wales. *Urban Studies, 56*(9), 1801-1817. doi:10.1177/0042098018777420
Zumbro, T. (2014). The Relationship Between Homeownership and Life Satisfaction in Germany. *Housing Studies, 29*(3), 319-338. doi:10.1080/02673037.2013.773583

Table 1: Summary statistics

	Variable	Mean	Std. Dev.	Min	Max
Changes in log of real house price (index, 1990=100)	Δhp	0.012	0.122	-2.096	0.756
Changes in log urbanization	Δurb	0.005	0.019	-0.228	0.230
Changes in current account to GDP ratio	Δcay	0.000	0.025	-0.204	0.167
Changes in long-term interest rate	Δltrate	-0.040	0.894	-10.300	11.047
Changes in log real GDP per capita	Δlrgdp	0.018	0.054	-1.081	0.514
Changes in log population	Δlpop	0.002	0.011	-0.291	0.227
Changes in mortgage loans to GDP ratio	Δmortgdp	0.005	0.022	-0.157	0.157
Changes in log robbery rate (per 100,000 people)	Δrob	-0.055	0.270	-2.115	2.066

Table 2: CIPS panel unit root test results

Variable	Levels		First difference	
	$Z(\bar{t})$	p-value	$Z(\bar{t})$	p-value
hp	0.517	0.697	-8.020***	0.000
urb	-1.805	0.964	-11.896***	0.000
mortgdp	-0.117	0.453	-7.402***	0.000
gdp	3.359	1.000	-4.694***	0.000
lpop	-4.722	1.000	-3.572***	0.000
irate	-3.360***	0.000	-15.200***	0.000
cay	0.751	0.774	-14.539***	0.000
rob	0.751	0.774	-5.276***	0.000

Table 3: Benchmark Results

	(1) OLS	(2) FE	(3) Lewbel (2012) IV
Δurb	0.307**	0.262*	0.275***
	(0.130)	(0.138)	(0.100)
Δlrgdp	0.667***	0.602***	0.455***
	(0.058)	(0.067)	(0.073)
Δlpop	0.816***	0.730**	0.806**
	(0.288)	(0.303)	(0.378)
Δirate	0.001	0.002	0.003
	(0.003)	(0.003)	(0.003)
Δcay	-0.403***	-0.491***	-0.310***
	(0.087)	(0.090)	(0.104)
N	1779	1779	1761
R-sq	0.103	0.247	0.206
Hansen J stat			139
Hansen J p-value			0.697

Notes: The dependent variable is the change in log of real house price. Robust standard errors in parenthesis. ***, **, * denote significance levels at 1%, 5% and 10% levels. OLS=ordinary least square, FE=Fixed effect.

Table 4: The effect of urbanization on urban house prices

	(1) OLS	(2) FE	(3) Lewbel (2012) IV
Panel: dependent variable is urban house price			
Δurb	0.486***	0.429**	0.327**
	(0.176)	(0.200)	(0.155)
Δlrgdp	0.617***	0.538***	0.443***
	(0.072)	(0.082)	(0.076)
Δlpop	0.701**	0.672*	0.593
	(0.341)	(0.376)	(0.384)
Δirate	-0.002	-0.002	-0.001
	(0.004)	(0.005)	(0.004)
Δcay	-0.350***	-0.480***	-0.370***
	(0.106)	(0.114)	(0.113)
N	1187	1187	1169
R-sq	0.085	0.239	0.208
p-value			0.593
Panel B: dependent variable is national house price			
Δurb	-0.067	-0.003	0.076
	(0.161)	(0.149)	(0.057)
Δlrgdp	0.859***	1.273***	1.265***
	(0.098)	(0.159)	(0.103)
Δlpop	3.103***	2.635***	2.394***
	(0.751)	(0.818)	(0.594)
Δirate	0.003	0.006*	0.007**
	(0.003)	(0.003)	(0.003)
Δcay	-0.724***	-0.595***	-0.629***
	(0.154)	(0.164)	(0.134)
N	591	591	591
R-sq	0.192	0.457	0.180
Hansen J p-value			0.466

Notes: See Table 3

Table 5: Effect of urbanization (Potential channel analysis)

	(1)	(2)
	Δmortgdp	Δrob
Δurb	0.090***	0.916***
	(0.018)	(0.333)
Δlrgdp	-0.053***	-1.204***
	(0.011)	(0.204)
Δlcpi	-0.144**	0.800
	(0.057)	(0.932)
Δirate	-0.000	0.001
	(0.001)	(0.004)
Δcay	-0.057***	-0.166
	(0.015)	(0.275)
N	1669	804
R-sq	0.015	0.031
J p-value	0.770	0.772

***, **, * denote significance levels at 1%, 5% and 10% levels.

Table 6: Effects of mortgage and crime (potential channel analysis)

	(1)	(2)	(3)
	Δhp	Δhp	Δhp
Δurb	0.220**	0.232**	0.313***
	(0.102)	(0.102)	(0.085)
Δmortgdp		0.447***	
		(0.087)	
Δrob			0.011
			(0.010)
Δlrgdp	0.601***	0.639***	0.655***
	(0.063)	(0.063)	(0.068)
Δlcpi	0.215	0.265	1.764***
	(0.250)	(0.237)	(0.654)
Δirate	0.005	0.004	0.001
	(0.003)	(0.003)	(0.003)
Δcay	-0.381***	-0.339***	-0.197*
	(0.074)	(0.074)	(0.112)
N	1532	1532	751
R-sq	0.064	0.077	0.085
J p-value	0.586	0.501	0.517

Notes: See Table 3

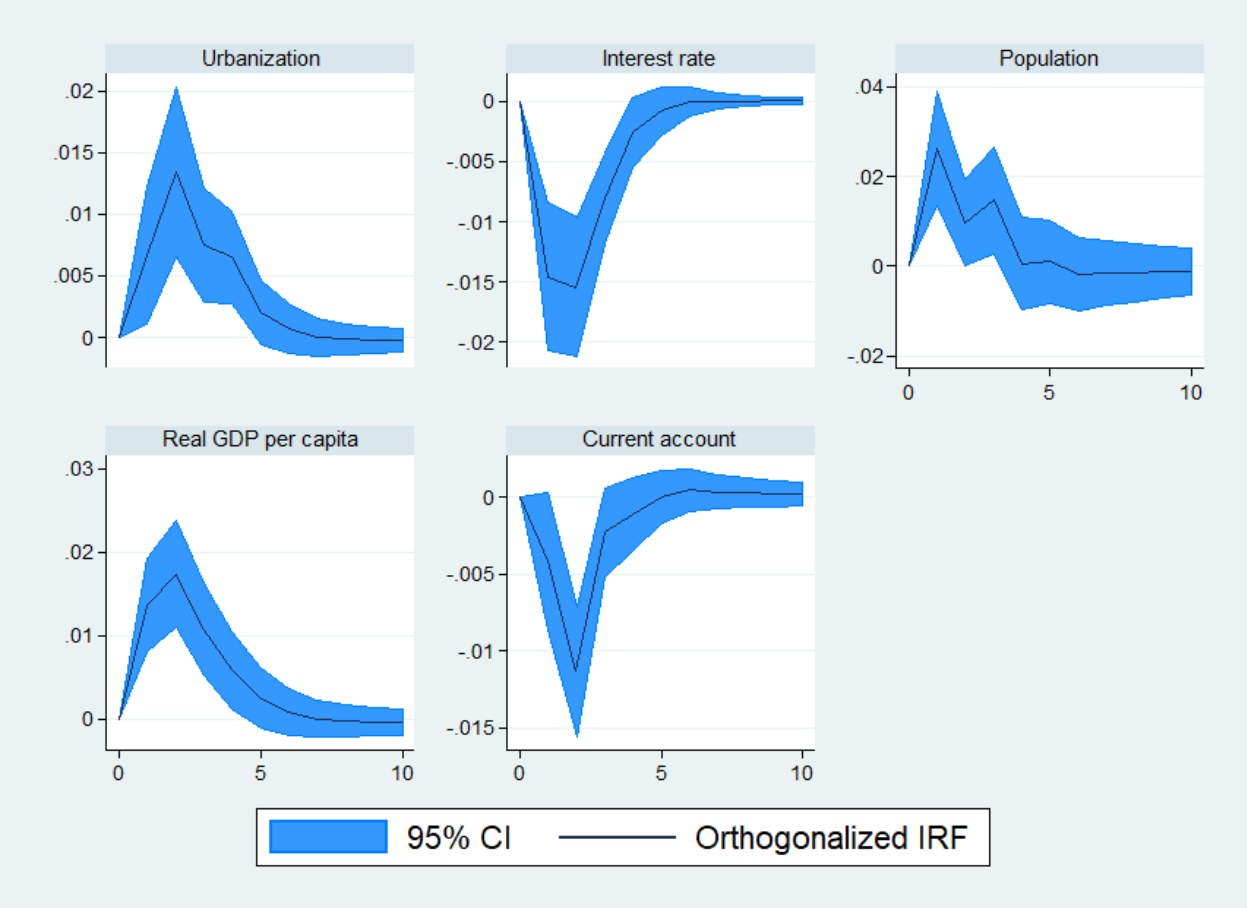

Figure 1: The responses of house prices to a standard deviation shock in the covariates.

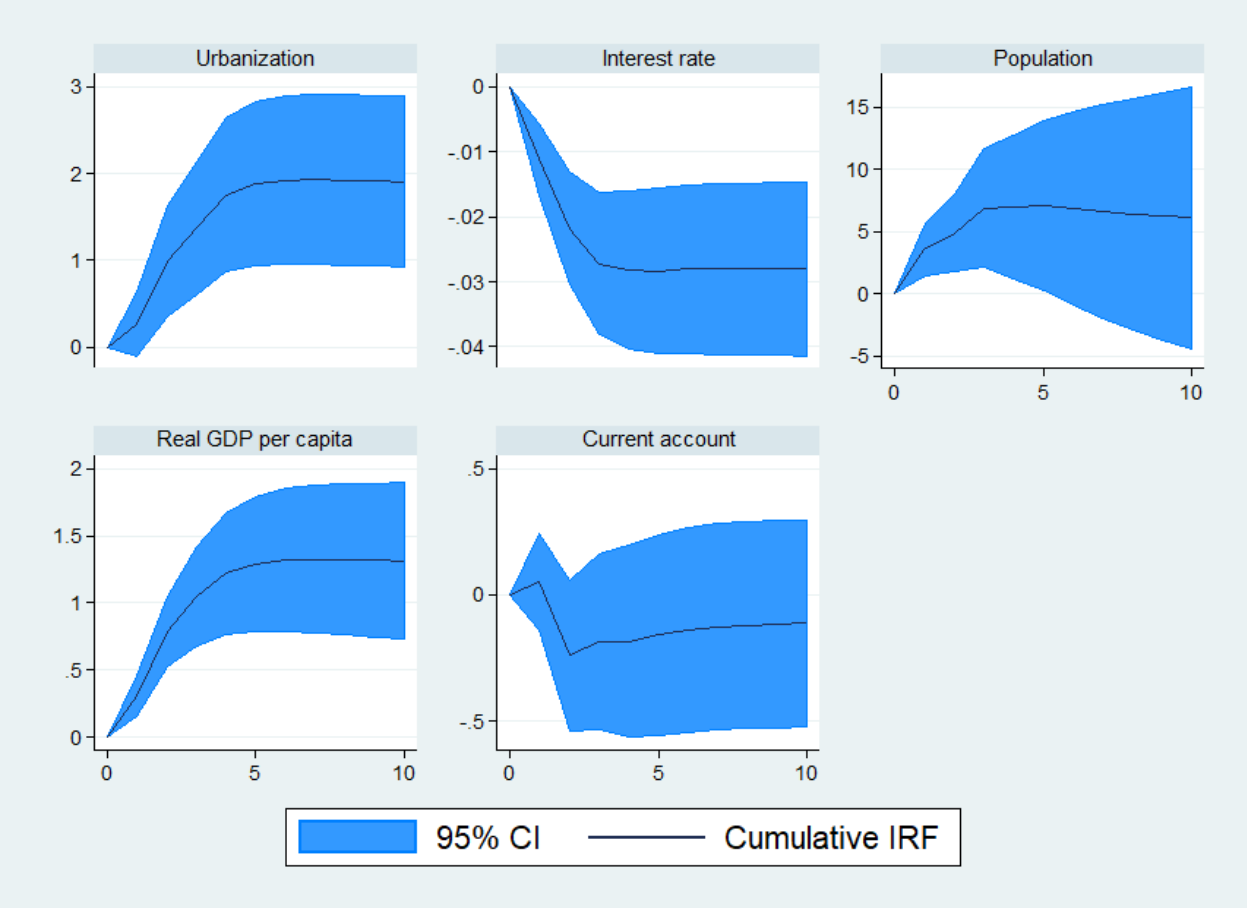

Figure 2: The cumulative responses of house prices to a standard deviation shock in the explanatory variable.

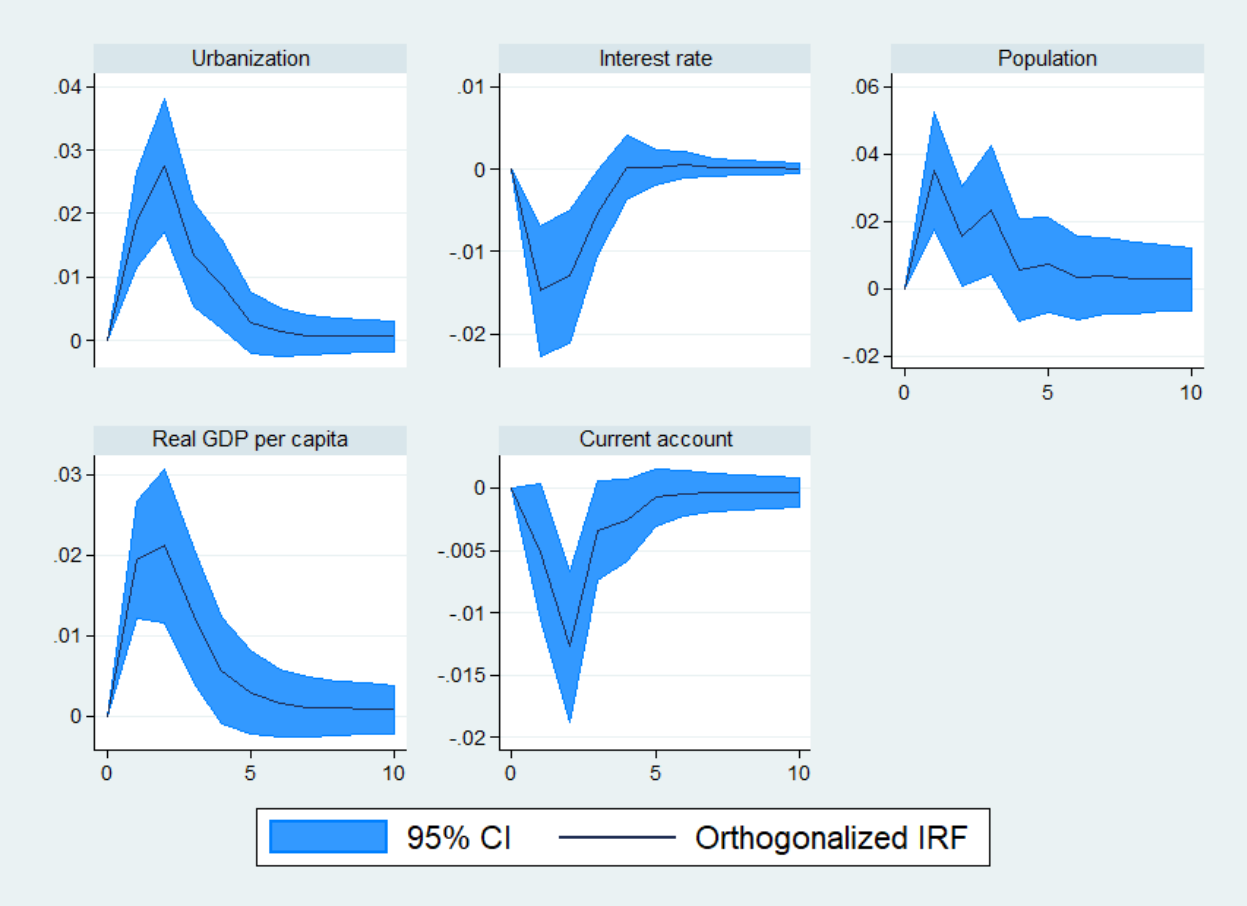

Figure 3: The responses of house prices to a standard deviation shock in the covariates (urban only).

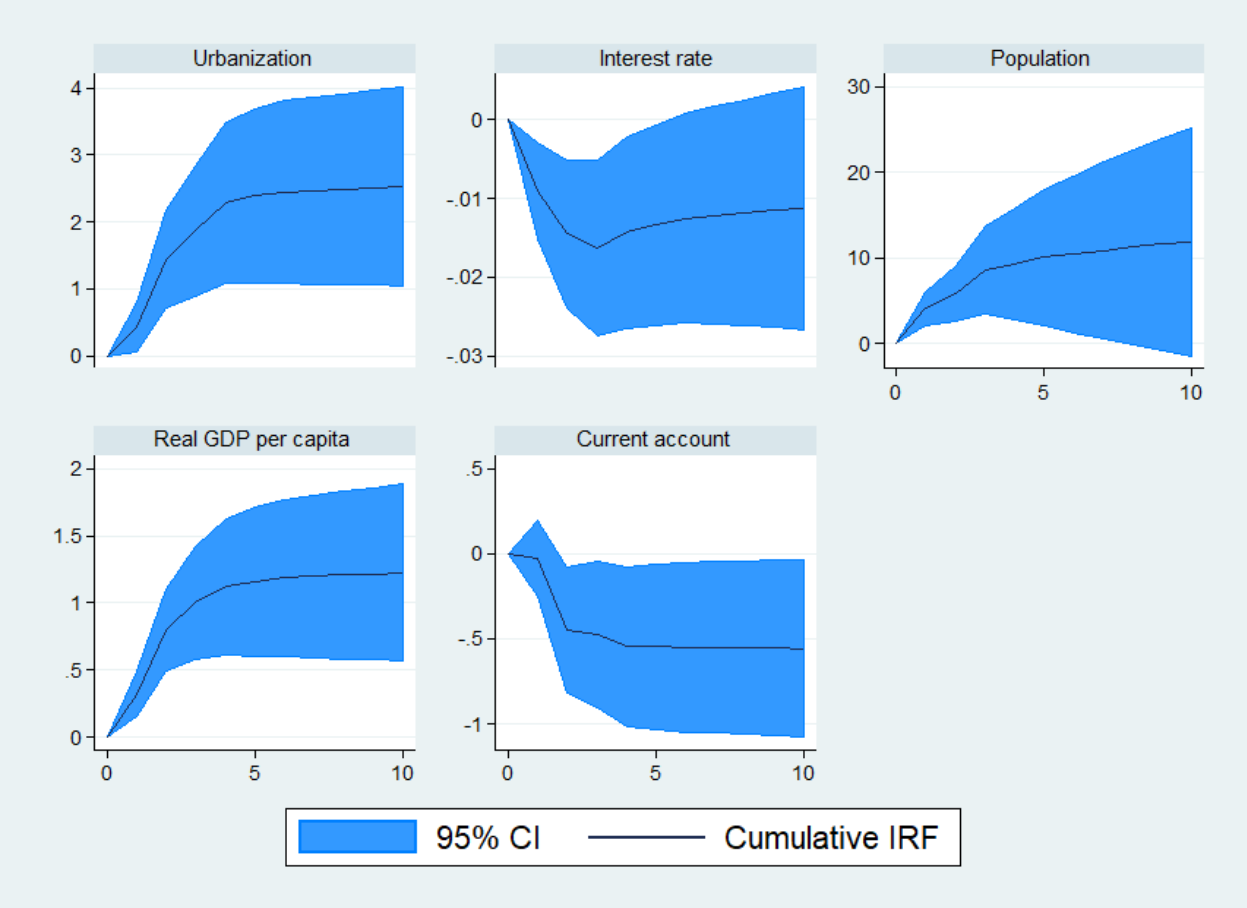

Figure 4: The cumulative responses of house prices to a standard deviation shock in the explanatory variables (urban only).

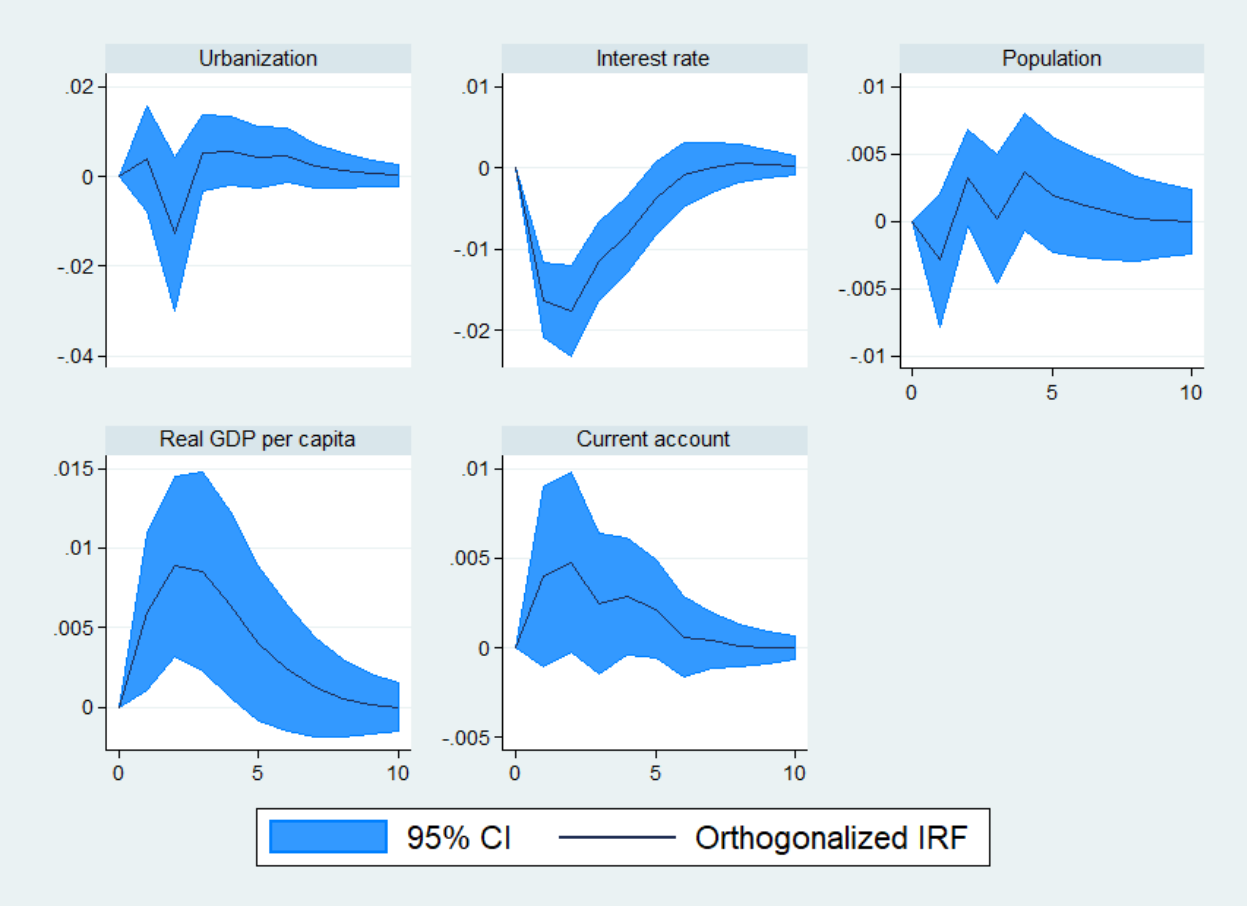

Figure 5: The responses of house prices to a standard deviation shock in the covariates (national prices).

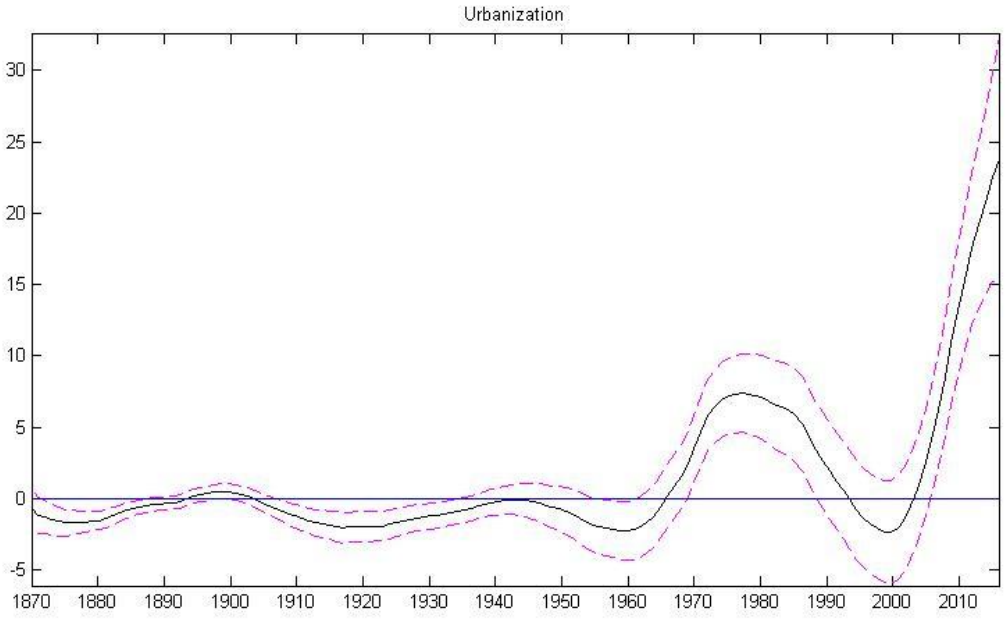

Figure 6: LLDVE estimates of coefficient functions

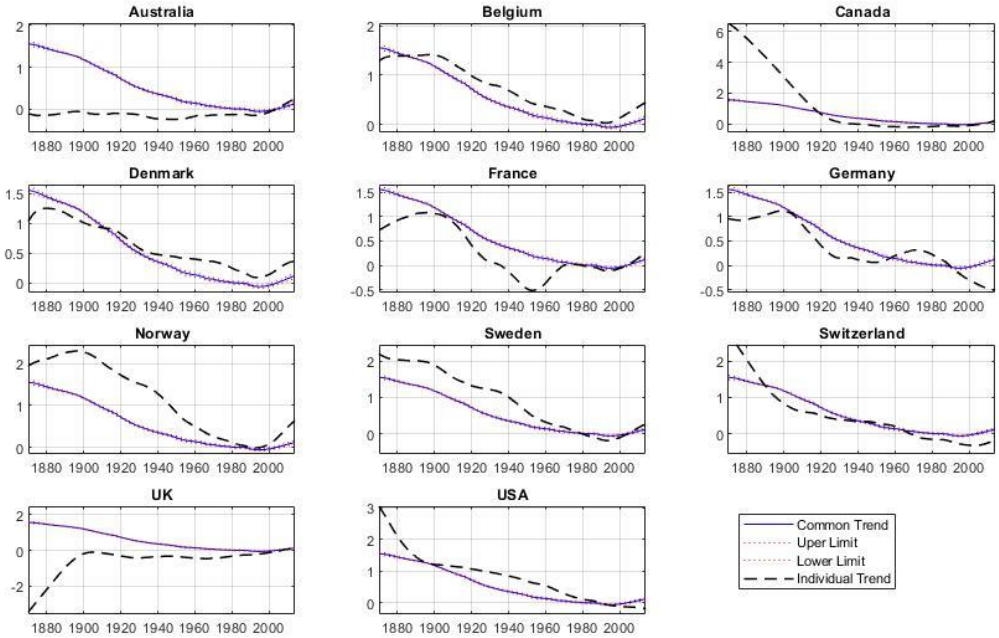

Figure 7: LLDVE estimates of common and country-specific trend functions

Appendix: Figures

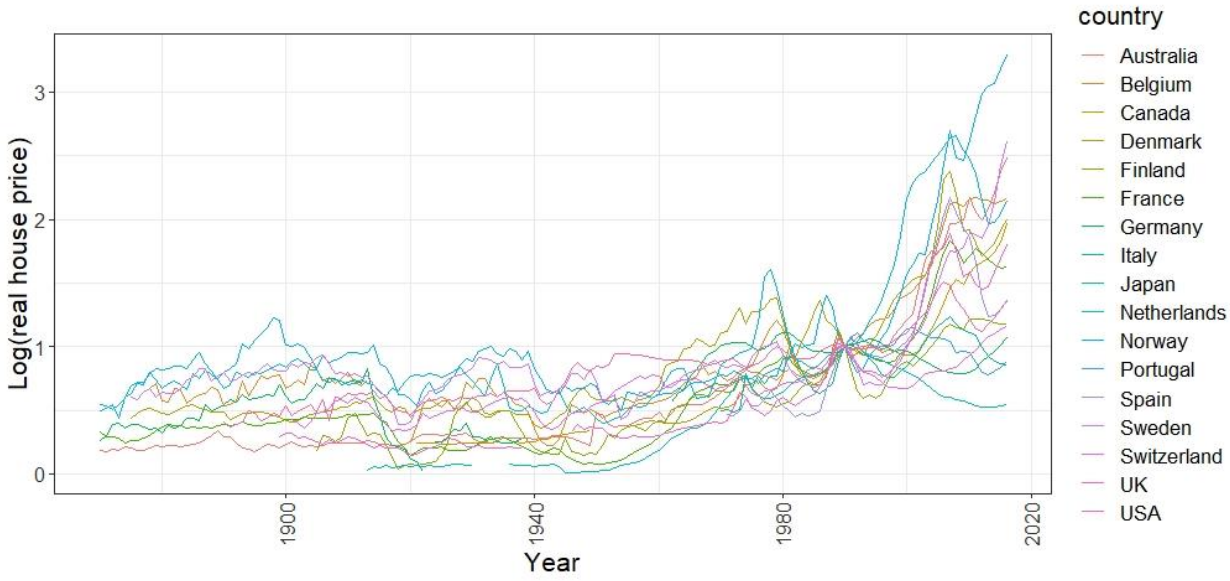

Figure A1: Log real house price: 1870-2016

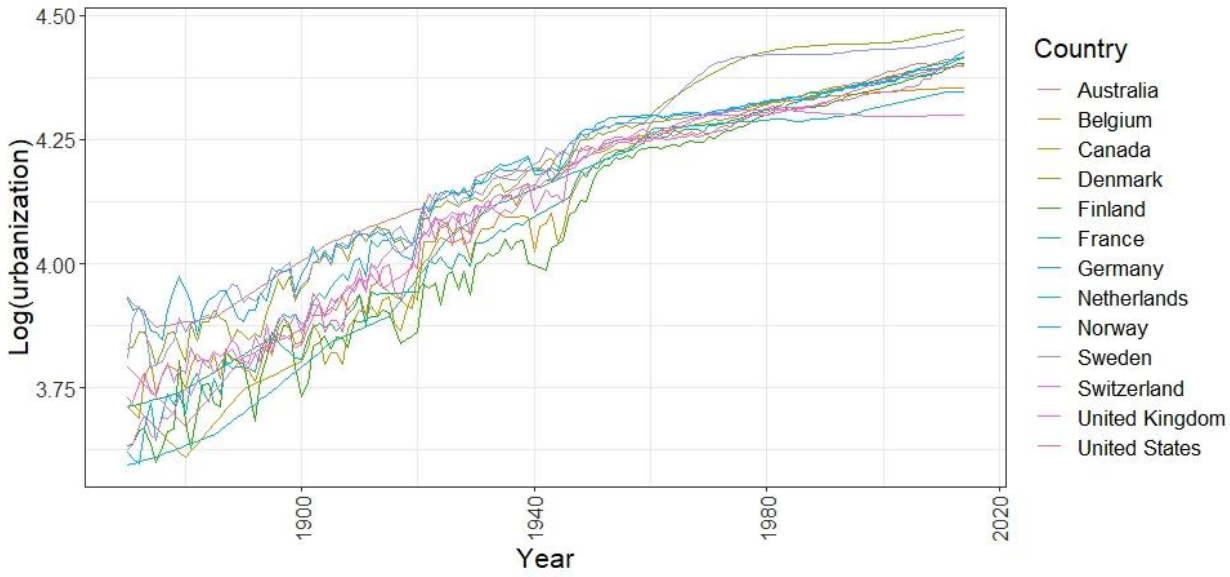

Figure A2: Trends in urbanization rate