Panel Data Research Center, Keio University

PDRC Discussion Paper Series

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29 September, 2023

DP2023-001
https://www.pdrc.keio.ac.jp/en/publications/dp/8792/

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Acknowledgement: We would like to thank Shinya Kajitani, Daiji Kawaguchi, Tsunao Okumura, Kazuto Sumita, participants of workshops at the University of Bristol, Musashino University, and Toyo University, participants of the 2022 Japanese Economic Association Spring Meeting and the 26th Asian Real Estate Society Annual Conference for their valuable comments and constructive suggestions. We would also like to thank Ralph Paprzycki for his excellent English editing service. We are grateful to Misa Izuhara for encouraging us to write this paper. Finally, we would like to thank the Panel Data Research Center at Keio University for providing us with access to its micro-data and Norifumi Yukutake for his useful advice on the analysis of this data. This research was supported by JSPS KAKENHI Grant Numbers JP19K01603 and JP19K01703 and ESRC-AHRC UK-Japan SSH Connections Grant ES/S013695/1.

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1 Introduction

The impact of positive house price shocks on labor supply decisions is an issue that has received considerable attention, since housing represents an important form of asset holdings for households. There are at least two channels through which an increase in house prices affects labor supply. The first channel is through the higher price households receive when they sell their home, which increases the lifetime/permanent income of those who sell their home and downsize and may lead them to reduce their labor supply. Second, even if households do not sell their home, the increase in value can still have an income effect on their labor supply: if homeowners have a certain amount in mind that they want to bequeath to their children, an increase in the value of their home allows them to use more of their other assets for consumption and reduce their labor supply while maintaining the same level of consumption. According to the life-cycle/permanent income hypothesis (LC-PIH), if leisure is a normal good and house price changes are unanticipated, an increase in house prices should tend to reduce the labor supply of homeowners through these two channels.[1] Moreover, the LC-PIH suggests that elderly people are more likely to respond to house price shocks because of their shorter expected time horizon before death.

Consistent with these theoretical predictions, a number of previous studies for the UK and the US have found that house price shocks tend to decrease the labor supply of homeowners (e.g., Henley, 2004; Disney & Gathergood, 2018 for the UK, Ondrich & Falevich, 2014; Farnham & Sevak, 2016; Zhao & Burge, 2017; Begley & Chan, 2018 for the US). Especially for the elderly, a few previous studies that estimated the effects both on the probability that individuals continued work and on their working hours found that they tend to decrease labor supply by leaving the labor market rather than by reducing their working hours (Zhao & Burge, 2017; Disney & Gathergood, 2018).

However, these results may not necessarily hold for other countries, because the nature of the housing market differs across countries. In Japan, for example, the first channel likely to

[1] A third channel through which an increase in house prices potentially affects labor supply, even when the price increase is anticipated, is through the relaxation of liquidity constraints on liquidity-constrained households due to the increase in collateral value. We do not consider this case, since we solely focus on unanticipated house price shocks.

be less important, because the selling and buying of used houses in the second-hand market is not very common (Kanemoto, 1997; Kobayashi, 2016).[2] According to the Ministry of Land, Infrastructure, Transport and Tourism (2019), sales of existing homes account for only 14.7 percent of total home sales in Japan, compared with 88.2 percent in the UK and 83.1 percent in the US. Moreover, selling existing homes is becoming increasingly difficult in municipalities whose population is shrinking. In such municipalities, offspring often refuse inheriting houses left by their parents. This means that the second channel – a reduction in labor supply through the increase in the size of the assets to be bequeathed to offspring – is also less likely to work. In sum, because of the nature of the housing market in Japan, the benefits of a positive house price shock are likely to be smaller than in the UK and the US.

Another factor is that the nature of the Japanese labor market also differs from that of the other two countries. Japanese firms generally pay wages based on tenure rather than productivity, especially for full time workers. Tenures therefore tend to be long. According to the Japan Institute for Labour Policy and Training (2023), the share of employees that have worked for the same company for 10 years or more is relatively high at 46.8 percent, exceeding the corresponding shares in the UK (30.6 percent) and the US (26.9 percent). The nature of the labor market in Japan means that Japanese employees likely are more hesitant to quit their job even if house prices rise substantially, since re-entering the labor market if things do not work out in all probability would involve a substantial wage cut.

Against this background, our study contributes to the literature in the following two respects. First, to the best of our knowledge, this study is the first analysis of the impact of house price shocks on labor supply in Japan taking the lack of a liquid housing market and of a rigid labor market into account.

Second, this study further contributes to the literature on the impact of house price shocks on labor supply by dividing individuals into detailed age groups in order to examine whether the

[2] Against this background, another way in which higher house prices theoretically could allow homeowners to reduce their labor supply is through equity loans. That is, homeowners could borrow against the equity in their home and reduce their labor supply. However, Japanese banks generally do not provide equity loans against property of uncertain value (Mitchell & Piggott, 2004), and figures by the Ministry of Land, Infrastructure, Transport and Tourism (2021) suggest that only 1.4 percent of commercial banks (out of a total of 1,105 banks) provide this kind of loans.

impact of house price shocks differs by age. While most studies divide individuals into two or three age groups (e.g., the young, middle-aged, and elderly), we create seven groups from 40 to 70+ in 5-year increments. This allows us to examine in greater detail whether age heterogeneity in the labor response to house price shocks is in line with the LC-PIH.[3]

For our analysis, we use the Japan Household Panel Survey, a longitudinal survey of Japanese households covering the period from 2005 to 2019. The data is ideal for our analysis because it contains respondents' self-reported value of their home as well as a variety of measures for labor supply outcomes such as information on whether respondents participate in the labor force, the number of days worked per month, and the hours worked per week. To identify the impact of house price shocks, we extract unanticipated changes in house prices, since, according to the LC-PIH, people change their behavior as soon as they expect a change in their income, so that there should be no change in labor supply when that change actually occurs. Specifically, following previous studies such as Farnham & Sevak (2016) and Begley & Chan (2018), we estimate an equation with self-reported house prices as the dependent variable and their lag as well as year dummies as explanatory variables. We then use the residuals as the unanticipated components of house prices (house price shocks) in the estimation of the labor supply function.

House price shocks likely reflect a variety of events that occurred during our observation period from 2005 to 2019. For example, Japan won the race to host the 2019 Rugby World Cup, the 2020 Olympic and Paralympic Games, and the 2025 World Exposition, which may have led to positive house price shocks in certain local housing markets (Kontokosta, 2012). On the other hand, Japan is a country that is prone to major natural disasters, which generally inflict a negative shock to house prices in certain geographical areas (Naoi et al., 2009). Therefore, house price shocks contain sufficient variation to estimate their impact on labor supply.

We obtain three main results. First, when we estimate the effect of house price shocks without taking respondents' age into account, we find no significant effect for any of the labor supply outcomes. This result is highly plausible given the nature of Japan's housing and labor

[3]Relatedly, studies focusing on the impact of house price shocks on household consumption rather than labor supply in Japan have found a small but significant effect for the middle-aged and the elderly but no effect for the young (Naoi, 2014; Hori & Niizeki, 2019). This finding is consistent with the LC-PIH and the argument regarding the role played by the low liquidity in Japan's housing market.

markets.

Second, when taking age into account, we find that only the working hours of people in their 60s or over show a significant response to house price shocks. Specifically, a positive house price shock of 10 percent leads to a reduction in weekly working time of 14 minutes for elderly women and 21 minutes for elderly men. The results are in line with the LC-PIH, which suggests that the elderly are more likely to respond to a house price shock, although they contrast with the aforementioned findings for other countries that the elderly are more likely to leave the labor market than reduce their working hours.

There are at least two likely explanations why our findings differ from those for the UK and US. One, as discussed above, is that due to the low liquidity in the market for existing houses in Japan, it is difficult for the elderly to sell their home and downsize when the value of their house rises. Another is that, as mentioned too, people hesitate to fully retire, presumably because the cost of reversing that decision in Japan is much higher than in the UK and US.

Our main finding is that women respond to house price shocks at younger age than men. Women decrease their weekly working hours from the age of 60, while men start to reduce their weekly working hours only from the age of 65. This suggests that women face lower opportunity costs of reducing working hours than men.

The remainder of the paper is organized as follows. Section 2 provides a review of the literature. Sections 3, 4, and 5 then respectively present the empirical models, datasets, and empirical findings. Finally, Section 6 concludes the paper.

2 Literature review

2.1 Endogeneity issues related to house prices

Previous studies on the UK and the US have found that housing windfalls tend to reduce the labor supply of homeowners. Because of the endogeneity issues associated with house prices, a simple OLS estimation with labor supply as the dependent variable and (self-reported or regional) house prices as the independent variable is unlikely to identify the impact of house prices on labor supply. This section, therefore, explains how previous studies have addressed the following three types of endogeneity: (i) measurement errors in (self-reported) house prices, (ii) the correlation between house prices and the local labor market, and (iii) the correlation of house prices with respondents' income expectations.

The first type of endogeneity potentially leads to attenuation bias of the effect of house price shocks. In fact, Tur-Sinai et al. (2020) showed that homeowners are likely to overestimate the price of their residence. To avoid the measurement error in self-reported house prices, several studies have estimated house price shocks using regional house price indices (Farnham & Sevak, 2016; Zhao & Burge, 2017; Begley & Chan, 2018). Farnham & Sevak (2016), for example, used regional house price indices from the US Federal Housing Finance Agency as a proxy variable for house prices. A different approach was taken by Fu et al. (2016) to deal with this issue, which will be discussed shortly.

Moving on the second type of endogeneity issue, (self-reported) house prices (or changes therein) in a particular area may be correlated with the local labor market, since where people live is not randomly assigned. For example, individuals who want to work long hours and/or for longer years may decide to live in areas with abundant employment opportunities, giving rise to a situation in which both house prices and labor supply outcomes are correlated with regional characteristics (e.g., local economic conditions). Begley & Chan (2018) in their study therefore add US Zip code-level region-with-year fixed effects and the local unemployment rate as control variables.

The third type of endogeneity is the possible correlation between individuals' income expectations and house prices. If income expectations are not controlled for, they will be included in the error term, leading to omitted variable bias, since income expectations affect both current labor supply and current house prices through housing demand. Therefore, if we fail to control for income expectations, this will lead to an overestimation of the impact of house price shocks on labor supply. Fu et al. (2016) estimated the impact of housing capital gain, measured as the difference between the purchase price and the current price of a house, on labor supply in China. To deal with the correlation of house prices with income expectations as well as the possible measurement error in self-reported house prices, they use the average housing capital gain of all respondents other than the respondent in a given community as an instrumental variable.

To address these endogeneities, some previous studies have estimated the differences in responses to house price shocks between homeowners (as the treatment group) and renters (as the control group) using difference-in-differences estimation (Farnham & Sevak, 2016; Zhao & Burge, 2017; Disney & Gathergood, 2018). However, renters may also change their current labor supply in response to house price changes due to concerns that higher house prices will increase the cost of purchasing their own home in the future (Begley & Chan, 2018). Therefore, there is no consensus on how to address these endogeneity issues.[4]

2.2 House price shocks and labor supply

Next, studies examining the association between house price shocks and labor supply – taking the mentioned endogeneity issues into account – are reviewed. Starting with studies for the UK, Henley (2004) found that a 10 percent increase in house prices leads to a 28 minute decline in weekly hours of work for women aged 18-65, while a 10 percent fall in house prices is associated with an 18 minute increase for men in the same age bracket. Meanwhile, focusing not only on hours of work but also on the likelihood of labor force participation, Disney & Gathergood (2018) examine the labor supply response distinguishing the following three age groups: the young (under 40), the middle-aged (age 40-54 years old), and the elderly (over 54). Their empirical results indicate that an increase in house prices reduces both working hours and the likelihood of participation for young female homeowners. They also find that an increase in house prices lowers the likelihood of participation for elderly men. Elderly men's working hours, however, do not respond to house price shocks. These results are similar to those obtained by Zhao & Burge (2017) for the elderly in the US. They showed that a decline in house prices increased their likelihood of participation, while it did not have any effect on their hours of work when house prices fell.

Continuing with studies on the US and the link between house price shocks and labor supply, a number of studies have focused on the impact on the the retirement decisions of the elderly.

[4] One possible solution is to employ a quasi-experimental design comprising exogenous house price shocks. See, for example, Li et al. (2020)

Ondrich & Falevich (2014), for instance, found that negative house price shocks lowered retirement probabilities of elderly males, while Farnham & Sevak (2016) showed that an increase in house prices led elderly men to retire sooner. Conversely, Begley & Chan (2018) found that elderly men who experienced a negative house price shock were less likely to retire and more likely to reverse retirement.

3 Empirical models

3.1 House price function and house price shocks

Previous studies have tried to capture the unanticipated component of house price changes, i.e., house price shocks, by calculating the difference between actual house prices and house prices predicted from an autoregressive house price model (Farnham & Sevak, 2016; Begley & Chan, 2018; Burrows, 2018). In this paper, we assume that individuals form expectations about current house prices on the basis of an autoregressive lag (AR2) model. Based on this model, the predicted natural log of individual house prices is given by

$$\ln hp_{ij,t} = \lambda_0 + \lambda_1 \ln hp_{ij,t-1} + \lambda_2 \ln hp_{ij,t-2} + \lambda_3 \ln b_{it} + \mu_i + \phi_t + \zeta_j + \varepsilon_{ij,t}, \tag{1}$$

where $hp_{ij,t}$ is the price of individual i's house in location j in year t, b_{it} is the age of the building, μ_i represents unobserved housing unit fixed effects, ϕ_t represents year fixed effects to control for aggregate economic conditions in a particular year, ζ_j represents location fixed effects, and $\varepsilon_{ij,t}$ is the error term. Using the estimated parameters, we calculate house price shocks $\ln hp^u_{ij,t}$ as the difference between the actual house price ($\ln hp_{ij,t}$) and the house price predicted based on Eq.(1) ($\ln \widehat{hp}_{ij,t}$). Note that we focus on individuals that have lived in the same house for at least three consecutive years when estimating Eq. (1). This is becuase, $\ln hp^u_{ij,t}$ seeks to capture house price fluctuations due to exogenous shocks rather than fluctuations due to individuals' own decisions such as moving to a different house or renovating their house.[5]

The signs of the coefficients λ_1 and λ_2 depend on homeowners' forecasts of the price of their home and are therefore difficult to know a priori. The signs will be positive if homeowners expect

[5] Note that our house price estimates may not fully reflect renovation spending because of the thin second-hand market in Japan.

the price of their home to increase as the lagged value of the price of their home increases and vice versa.

We estimate Eq. (1) using Arellano-Bond dynamic panel GMM estimators (Arellano & Bond, 1991), which generate consistent and efficient parameter estimates in lagged dependent variable models.

3.2 Labor supply function

Using the information on house price shocks ($\ln hp^u_{ij,t}$), we next explore the relationship between house price shocks and homeowners' labor supply. We estimate two specifications of the labor supply function. The first specification is as follows:

$$ls_{ij,t} = \gamma_0 + \gamma_1 \ln hp^u_{ij,t} + X_{it}\gamma + \nu_i + \psi_t + \xi_j + \xi_j\psi_t + u_{ij,t}, \quad (2)$$

where $ls_{ij,t}$ is the labor supply outcome of individual i in location j in year t, X_{it} represents socio-economic characteristics of the individual, ν_i stands for unobserved individual fixed effects, ψ_t for year fixed effects, ξ_j for location fixed effects, $\xi_j\psi_t$ for location-with-year fixed effects, and $u_{ij,t}$ is the error term.[6] Year fixed effects control for the impact of macroeconomic fluctuations on the labor supply, while location fixed effects control for regional differences in the labor supply. Following Begley & Chan (2018), the interaction terms between location and year fixed effects in Eq. (2) are added to control for time series variations in region-specific macroeconomic shocks. In addition, following Farnham & Sevak (2016) and Begley & Chan (2018), we also include the regional employment rate, which we obtain from the Labour Force Survey. When we estimate Eq. (2), we omit individuals under 40, since the majority of those under 40 are renters rather than homeowners.

The parameter of primary interest is γ_1, which captures the extent to which the labor supply of individual i reacts to a house price shock. The LC-PIH implies that the sign of γ_1 should be negative.

The second specification aims to capture the heterogeneous impact of house price shocks across age groups. The sample is the same as that when estimating Eq. (2), i.e., we focus on

[6] In our analysis, we try to reduce the effect of measurement error in self-reported house prices/house price shocks driven by time-invariant respondent characters (such as an optimistic personality) by controlling for individual fixed effects.

individuals aged 40 years or over. The second specification is as follows:

$$ls_{ij,t} = \gamma_0 + \sum_{a=1}^{7} \gamma_a (\ln hp^u_{ij,t} \times d^a_{it}) + \sum_{a=2}^{7} \delta_a d^a_{it} + X_{it}\gamma + \nu_i + \psi_t + \xi_j + \xi_j\psi_t + u_{ij,t}, \tag{3}$$

where d^a_{it} is a binary variable, which takes 1 if individual i falls into age group a and 0 otherwise. There are seven 5-year age groups ranging from $a = 1$ (for those aged 40-44 years old) to $a = 7$ (70 years or over).

The parameter γ_a captures to which extent the labor supply of individual i in group a responds to a house price shock. As previously noted, according to the LC-PIH, the impact of a house price shock should become larger with age, because the elderly have a shorter remaining life expectancy. The parameter δ_a aims to control for inherent differences in the level of the labor supply across age groups (the reference group is those aged 40-44).

We estimate both Eqs. (2) and (3) separately for each sex. Moreover, we estimate the equations using a fixed-effects model to allow for unobserved individual fixed effects. Since we use generated regressors ($\ln hp^u_{ij,t}$), we calculate the standard errors of the estimates employing a bootstrap procedure using 500 bootstrapped resamples clustered at the household level.

4 Data

To estimate Eqs. (1), (2), and (3), we use information from the Japan Household Panel Survey (JHPS), which is compiled by the Panel Data Research Center at Keio University. The JHPS is a nationally representative, large-scale longitudinal survey of Japanese households conducted annually in January. The JHPS comprises two sets of surveys: one that was started in 2004 (originally called the Keio Household Panel Survey, KHPS) and another started in 2009 (the initial JHPS sample). Both surveys initially started with a sample of approximately 4,000 respondents. To address sample attrition, the KHPS added approximately 1,400 new respondents in 2007 and another 1,000 in 2012. The KHPS was integrated into the JHPS in 2014. In the following analysis, we use 15 waves of the JHPS (integrated with the KHPS after 2014) from 2005 to 2019. The JHPS is particularly suited to address the research questions of this study since it contains detailed information on self-reported house prices for homeowners, individual labor supply, and a rich set of data on respondents' socio-economic characteristics.

4.1 House prices

Self-reported house prices are used to estimate Eq. (1). The survey asks "How much do you think the house and lot would sell for in today's market?". Self-reported house prices are converted to 2005 prices using the national consumer price index.

The number of homeowners who answered this question with a value larger than 0 is 42,853. Of these 42,853 observations, we can use 18,276 observations to estimate Eq. (1). The reason for the large reduction in the number of observations is that many of the households did not provide self-reported values for the same house for at least three consecutive years. The mean house price for $hp_{ij,t}$ is 22.2 million JPY, and the standard deviation of house prices is 21.1 million JPY. The minimum and maximum values for $hp_{ij,t}$ are 0.1 million JPY and 650.0 million JPY.

4.2 Labor supply

To examine the labor supply response to house price shocks, we focus only on individuals that worked in the previous year. We also restrict our sample to non-regular employees for women and regular employees for men because the Japanese labor market is characterized by a high part-time employment rate for females and a high full-time employment rate for males. According to the Ministry of Health, Labour and Welfare (2016), the share of male employees hired by a business establishment that were in full-time employment was 77.4 percent, while that of female employees hired by a business establishment was 45.2 percent.

The dependent variables in Eqs. (2) and (3), i.e. $ls_{ij,t}$, are: (i) a dummy variable for labor force participation (LFP) and (ii) two continuous variables, namely, one for the days of work per month (Monthly Days of Work) and one for the hours of work per week (Weekly Hours of Work). The JHPS asks respondents (and their spouse if they are married) to report whether they did any paid work in the survey month. Thus, our LFP dummy for women takes a value of 1 if an individual was working as a non-regular (part-time) employee in the previous year and continued working as a non-regular employee in the current year and 0 if she quite working. Similarly, the LFP dummy for men takes a value of 1 if an individual worked as a regular (full-time) employee in the previous year and continued to do so in the current year and 0 if he stopped working.

If respondents participate in the labor market, they are also asked, "On average, how many days of paid work do you perform each month?", and "On average, how many hours of paid work do you perform each week (including overtime)?". For respondents (or their spouses) who were not working on the survey date, the number of monthly days of work and weekly hours of work were set to zero.

4.3 Control variables

Location fixed effects (ζ_j in Eq. 1, and ξ_j in Eqs. 2 and 3) are based on respondents' place of residence. The JHPS classifies respondents' place of residence into 8 regions (Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu).

In Eqs. (2) and (3), we include the regional unemployment rate (Regional Unemployment Rate) from the Labour Force Survey (Statistics Bureau of Japan). Regional unemployment rates are calculated by the authors based on the above 8 regions.

To control for respondents' socio-economic characteristics, X_{it} in Eqs. (2) and (3), we use the following four variables. The first is a dummy variable that takes value 1 if respondent i's household has a mortgage and 0 otherwise (Mortgage). Generally, households pay off their mortgage in monthly payments, and having a mortgage may affect individuals' labor supply. The survey asks both whether respondents have a mortgage and, if so, what their yearly mortgage payments are and what the outstanding mortgage amount is. However, information on mortgage payments and the outstanding mortgage amount is missing for many observations, so that we only construct a dummy variable reflecting whether respondents have a mortgage or not. The second control variable tries to capture whether households are financially constrained. Specifically, we construct a dummy (No Financial Assets) that takes 1 for households that have no financial assets and 0 otherwise. Households with no financial assets are more likely to be liquidity constrained, which may force them to work. Third, we control for the number of household members (Household Size). On the one hand, a larger household may have more dependents and some household member may decide to reduce their labor supply to take care of dependents. On the other hand, a larger household has more mouths to feed, so that household members maybe more inclined to to work to contribute to living expenses. Fourth, we include the number of children under the age of 7 in the household (Children Aged 0-6), since parents (especially mothers) may reduce their labor supply when they have preschool-aged children.

4.4 Summary statistics

We restrict the sample to respondents for whom information necessary to estimate Eqs. (2) and (3) is available.[7] The number of person-year observations is 4,934 (1,216 persons) for women and 7,164 (1,640 persons) for men.

Table 1 displays summary statistics for our sample. LFP takes a high value for both men and women, since we limit the sample to those who worked in the previous year. Looking at monthly days of work and weekly hours of work, we find that men tend to work more days a month and hours a week than women. This reflects the fact that for women we focus on non-regular workers, while for men we concentrate on regular workers. The average age of women in our sample is 0.6 years higher than that of men. Meanwhile, at least half of all respondents have a mortgage, and 1 in 5 have no financial assets. The average number of household members is around 3.5, which may reflect the fact that remaining observations consist mainly of married couples.[8] Finally, the number of preschool children in the household is quite small for both women and men since we focus on individuals aged 40 years or over.

5 Results

5.1 House price function

The estimation results for Eq. (1) are presented in Table 2. We find that while the coefficient on ln(House Price $t-2$) is not significant, that on ln(House Price $t-1$) is negative and significant. The negative sign of the coefficient on ln(House Price $t-1$) suggests that homeowners tend to expect that when the price of their house rises in a particular year, it will decrease in the next year.[9] The coefficient on Building Age is negative and significant, indicating that self-reported

[7] The JHPS includes information on individuals' annual income from their main job in the previous year. In the estimation stage, we discard the top 1 percent observations in terms of labor income to exclude extreme outliers. We also restrict our sample to persons who worked not more than 100 hours per week.

[8] As highlighted by Disney & Gathergood (2018), individuals' marital status (i.e., whether they are single or married/cohabiting) matters for their labor supply decision. However, in our sample, only 5.9 percent of women and 5.6 percent of men are single.

[9] As mentioned in Section 3.1, from a theoretical perspective, the sign is undetermined. Therefore, whether it is positive or negative is an empirical question. In fact, the sign here differs from that obtained by Burrows (2018) for the UK.

house prices are likely to fall with building age. The coefficients on the year dummies (the reference year is 2007) are significantly negative and increase in absolute value over time.

Using the estimated parameters in Table 2, we calculate the natural log of house price shocks, $\ln hp^u_{ij,t}$ ($= \ln hp_{ij,t} - \ln \widehat{hp}_{ij,t}$). Fig. 1 shows the density function for $\ln hp^u_{ij,t}$. House price shocks are distributed in the range from -8.1 percent to 4.5 percent, which means that there is sufficient variation to estimate the impact of house price shocks on labor supply.

5.2 Scatter plots between house price shocks and labor supply

Fig. 2 displays the association between $\ln hp^u_{ij,t}$ (horizontal axis) and labor supply (vertical axis) by sex together with fitted lines. Panel A of Fig. 2 suggests that men's LFP is negatively associated with house price shocks, while women's LFP does not show such a negative association. Meanwhile, Panels B and C indicate that days of work per month and hours of work per week decrease in response to positive house price shocks both for men and for women. The negative slope of the fitted line in these panels is steeper for women than for men, suggesting that women are more sensitive to house price shocks than men in terms of how much they work.

Because we are interested in the heterogeneous effects with respect to age, Fig. 3 presents scatter diagrams for 5-year age groups. For women, monthly days of work and weekly hours of work appear to be negatively correlated with house price shocks across all age groups. For men, Fig. 3 suggests that labor supply outcomes are more consistent with the LC-PIH than for women, i.e., the negative association between labor supply and house price shocks becomes stronger with age.

5.3 Benchmark results for the labor supply function

Table 3 shows the estimation results of Eq. (2). Column A displays the results for the LFP of women and men separately, based on the sample of women who worked as non-regular employees and men who worked as regular employees in the preceding year. Similarly, column B presents the results for monthly days of work, while column C shows the results for weekly hours of work. The estimated coefficients on the variable of primary interest, ln(House Price Shock), have – except for the LFP for men – the expected negative sign, although none of them are significant at conventional levels.[10]

Next, let us look at the result for the other control variables. The coefficients on Mortgage are positive and significant in the equations for men's LFP and monthly days of work, suggesting that men are more likely to work and/or work more if they have a mortgage. The coefficient on No Financial Assets is positive and significant in the equation for women's weekly hours of work, implying that women tend to work longer hours when they lack financial resources. The coefficient on Household Size is negative and significant in the equation for women's LFP, indicating that women are less likely to participate in the labor force the larger the number of household members. This likely reflects that a larger household increases the time spent on domestic chores such as preparing food, general cleaning, and clothing maintenance. The coefficient on Children Aged 0-6 is negative and significant in all equations for women, indicating that women with a child or children of preschool age tend to reduce their labor supply due to child-rearing demands. For men, the coefficient on Children Aged 0-6 is negative and significant only in the case of weekly hours of work. Moreover, the size of the coefficient is less than half of that for women. Overall, the number of household members (Household Size) and having a small child or children (Children Aged 0-6) matters especially for women. The coefficient of Regional Unemployment Rate is negative and significant only in the men's LFP equation, suggesting that men are less likely to be in work when the unemployment rate is higher. On the other hand, for those that have a job, the unemployment rate does not affect how much they work.

Fig. 4 presents the coefficient estimates for the interaction terms between house price shocks and 5-year age group dummies, together with 90 and 95 percent confidence intervals. Looking at the impact of house price shocks on LFP (Panel A), for women the coefficients on the interaction term are close to 0 and insignificant, suggesting that women's LFP does not respond to house price shocks for any age group. On the other hand, for men the coefficient on the interaction term is negative for those aged 65-69 and 70+, and the coefficient is larger in absolute value for those aged 70+ than for those aged 65-69. Therefore, men's LFP appears to behave in line with

[10] A possible reason for the insignificant results could be that some individuals take a while to change their labor supply after experiencing a house price shock. To examine whether this is the case, instead of using contemporaneous shocks $hp^u_{ij,t}$, we use one- and two-year lagged house price shocks, $hp^u_{ij,t-1}$ and $hp^u_{ij,t-2}$, as alternative measures. However, we still find no significant response in individuals' labor supply.

the LC-PIH in the sense that the elderly respond more strongly to house price shocks, although both coefficients are insignificant. The results for monthly days of work (Panel B) show broadly similar patterns to those for LFP.

Turning to the results for weekly hours of work (Panel C), we find that the coefficients on the interaction terms for women aged 40-44, 45-49, 50-54, and 50-59 are not significant, indicating that weekly working hours among women in their 40s and 50s do not respond to unexpected housing gains. However, house price shocks do have a large impact on the labor supply of women in their 60s or over. Although the coefficient on the interaction term for women aged 65-69 is insignificant, those for the 60-64 and 70+ age groups are negative and significant, indicating that women in these age groups do reduce their hours of work per week. Therefore, the estimation results for women's weekly hours of work are consistent with the predictions of the LC-PIH.

Meanwhile, the response of men's weekly hours of work also differs across age groups in line with the LC-PIH: the coefficients on the interaction terms for men aged 40-44, 45-49, 50-54, 50-59, 60-64 are not significantly different from 0, while that for men aged 65-69 is negative and significant and the significant negative impact is even larger for men aged 70+.

Our main findings from Table 3 and Fig. 4 can be summarized as follows. First, as expected, Table 3 suggests that Japanese individuals' labor supply is hardly affected by house price shocks. Second, when we examine the impact by age group, we find that house price shocks lead to a reduction in weekly hours worked only for the elderly in their 60s or over, in a manner consistent with the LC-PIH. As mentioned in the introduction, in Japan it is difficult for individuals to fully take advantage of house price shocks because of the peculiarities of the housing and labor markets. Under these circumstances, it is difficult for those close to retirement to substantially decrease their labor supply by withdrawing from the labor force or reducing their monthly days of work. Therefore, they moderately adjust their labor supply by reducing weekly hours of work. Third, we find that women reduce their weekly hours of work in response to a house price shock at a younger age than men. In comparison with men, who predominantly work as full-time workers, women, who predominantly work as part-time workers, are more likely to adjust their working hours.

5.4 Robustness checks for the labor supply function

5.4.1 Alternative definition of age dummies

This section reports the results of additional specifications to assess the robustness of our main findings from Fig. 4. Eq. (2) divides individuals into seven 5-year age groups. The disadvantage of this disaggregation is that the number of observations for each age group becomes relatively small, resulting in a larger standard error of the coefficient estimates. In order to examine whether this substantially affects our findings, we divide the sample into two age groups only, the middle-aged and the elderly.

To define the elderly group, we use the following two age cutoffs. First, we define the elderly as persons aged 60 years or over (Aged 60+), since Japanese firms generally set the mandatory retirement age at 60 years. Second, we define the elderly as those 65 years or over (Aged 65+), since in 2013 the government stipulated that employers need to continue to employ those who wish to keep working until the age of 65.

In order to use the alternative definitions of the age dummies, we employ the following specification of the labor supply function:

$$ls_{ij,t} = \gamma_0 + \gamma_1(\ln hp^u_{ij,t} \times d^m_{it}) + \gamma_2(\ln hp^u_{ij,t} \times d^e_{it}) + \delta d^e_{it} + X_{it}\gamma + \nu_i + \psi_t + \xi_j + \xi_j\psi_t + w_{ij,t}, \quad (4)$$

where d^m_{it} and d^e_{it} are binary variables that respectively take 1 if individual i was middle-aged (m) or elderly (e) in year t, and zero otherwise. The parameters γ_1 and γ_2 capture the extent to which the labor supply of individuals in the middle-aged or elderly group reacts to house price shocks.

Fig. 5 shows the estimates of γ_1 and γ_2 from Eq. (4), together with 90 and 95 percent confidence intervals. The charts on the left show the results for when the elderly are defined as those aged 60+, while those on the right show the results for when the elderly are defined as those aged 65+. Starting with the right-hand chart of Panel A, this shows that only the coefficient for elderly males (Aged 65+) is negative and significant at the 10 percent level, although it is economically insignificant. That is, the coefficient estimate implies that a 10 percent increase in house prices leads to a 0.005 percentage point reduction in the likelihood of being in employment, which is almost zero.[11]

Panel B shows the results for monthly days of work. Both charts indicate that women's monthly days of work do not change, which conflicts with the LC-PIH. On the other hand, the right-hand chart of Panel B suggests that men's monthly days of work respond negatively to a house price shock and the response of the elderly group is larger than that of the middle-aged group, although the coefficients are not statistically significant. Overall, the results for LFP and monthly days of work do not provide evidence supporting the LC-PIH, which is consistent with the previous section.

In contrast, for weekly hours of work we again find that the results are in line with the LC-PIH. Both charts of Panel C show that the response of the elderly to a house price shock is larger and more significant than that of the middle-aged. The empirical results for women in the left chart of Panel C show that the coefficient on the interaction term $\ln hp^u_{ij,t} \times d^m_{it}$ is insignificant, while the coefficient on $\ln hp^u_{ij,t} \times d^e_{it}$ is negative and significant. The coefficient estimate for the latter implies that a 10 percent increase in house prices is associated with a reduction of 0.23 hours (14 minutes) per week for elderly women who work as a non-regular employee. Given that the average weekly hours of work for the women in our sample is 21.9 hours (Table 2), a 0.23 hour decrease translates into a 1.1 percent reduction. According to the 2019 Labour Force Survey (Statistics Bureau of Japan, 2019), 3.25 million women aged 60+ worked as non-regular employee. Therefore, a 1.1 percent reduction is equivalent to 34,000 women withdrawing from non-regular employment.

Turning to men, the right chart of Panel C shows that the coefficient on $\ln hp^u_{ij,t} \times d^m_{it}$ is insignificant, suggesting that weekly hours of work for middle-aged men is unaffected by unexpected housing gains. However, we do find a negative and significant coefficient on $\ln hp^u_{ij,t} \times d^e_{it}$, with the size of coefficient suggesting that for elderly men a 10 percent increase in house prices is associated with a work reduction of 0.35 hours (21 minutes) per week. Given that the average weekly hours of work for men in the sample is 45.2 hours (Table 2), a 0.35 hour decrease corresponds to a 0.8 percent reduction. The 2019 Labour Force Survey (Statistics Bureau of

[11] This result differs from Disney & Gathergood's (2018) finding for the UK, where a 10 percent increase in house prices lowered the likelihood of labor force participation of elderly men by 1.3 to 1.5 percentage points.

Japan, 2019) shows that 75,000 men aged 65 or over worked as regular employees. A 0.8 percent reduction, therefore, is equivalent to 5,800 men withdrawing from regular employment.

5.4.2 Alternative definition of fixed effects

Previous studies have carefully examined the endogeneity that arises from the correlation between house price shocks and local labor market. So far, we took into account this endogeneity by incorporating location-with-year fixed effects into the estimation models. In this section, we instead incorporate industry, occupation, or firm size dummies as well as interaction terms between industry, occupation, or firm size dummies and year fixed effects into Eq. (2). Specifically, we replace $\xi_j + \xi_j\psi_t$ with $\iota_{it} + \iota_{it}\psi_t$, where ι_{it} represents industry/occupation/firm size fixed effects and $\iota_{it}\psi_t$ represents industry/occupation/firm size-with year fixed effects. Similar industries, occupations, and firm sizes tend to cluster in certain regions rather than being randomly located, so these variables may proxy for regions.

Panel A of Fig. 6 shows the results for the impact of house price shocks on weekly hours worked with industry fixed effects and industry-with year fixed effects. Based on their work, the JHPS divides respondents as belonging to one of 18 industry categories.[12] Next, Panel B of Fig. 6 shows the results when we use occupation fixed effects and occupation-with year fixed effects. The JHPS asks respondents for their occupation and classifies these into 12 categories.[13] Finally, Panel C of Fig. 6 presents the results when we control for firm size fixed effects and firm size-with year fixed effects. The JHPS asks respondents about the number of employees of the firm they usually work for. Firms are categorized into 6 size groups.[14]

As shown in Fig. 6, these alternative specifications yield very similar patterns to our benchmark results for weekly hours of work shown in Fig. 4, suggesting that our main empirical

[12] The 18 industries are 1. Agriculture; 2. Fishery, forestry, marine products; 3. Mining; 4. Construction; 5. Manufacturing; 6. Wholesale, retail; 7. Restaurants, accommodations; 8. Finance, insurance; 9. Real estate; 10. Transportation; 11. Information services and surveys; 12. Information & telecommunications other than information services and surveys; 13. Utilities; 14. Medicine, welfare; 15. Education, learning support; 16. Other services; 17. Public service; and 18. Other.

[13] The 12 occupation categories are 1. Agriculture, forestry, or fishery worker; 2. Mine worker; 3. Salesperson; 4. Service worker; 5. Manager; 6. Clerical worker; 7. Transportation or communications worker; 8. Manufacturing, construction, maintenance, or freight worker; 9. Information technology engineer; 10. Specialized or technical worker; 11. Public safety employee; 12. Other.

[14] The six firm size groups are 1. 1-4 persons; 2. 5-29 persons; 3. 30-99 persons; 4. 100-499 persons; 5. 500 persons or more; 6. Government.

findings are not unduly influenced by the correlation between house prices and the local labor market.

6 Conclusion

Focusing on Japan, this study examined individuals' labor supply response to a house price shock against the background of Japan's housing and labor market idiosyncrasies. Specifically, we argued that while the life-cycle/permanent income hypothesis suggests that elderly individuals are likely to reduce their labor supply in response to unanticipated housing gains, the low liquidity in the market for second-hand homes as well as low labor market mobility make it difficult for individuals to flexibly adjust their labor supply.

Our empirical results indicate that neither labor force participation, monthly days of work, nor weekly hours of work show a significant response to house price shocks when respondents' age is ignored. However, when respondents' age is taken into account, we find that house price shocks do have a significant effect in some cases. Specifically, while we generally find no effect on labor force participation or monthly days of work, we do find a significant reduction in weekly hours of work for people in their 60s or over. Our estimation results suggest that a 10 percent increase in house prices leads to a reduction of 14 minutes of work per week for elderly women and 21 minutes per week for elderly men. Our empirical results also suggest that women respond to house price shocks at an earlier age than men.

Due to Japan's housing and labor market idiosyncrasies, it is difficult for individuals to respond to a positive house price shock: they cannot sell their house to downsize, quit their job, and live off the capital gains. They also cannot reduce their monthly days of work, so all they can do is reduce their weekly hours of work a bit as they get older. In sum, Japan's institutional setting tends to prevent individuals from flexibly adjusting their labor supply in response to a positive house price shock.

Although it is still difficult for elderly homeowners to liquidize housing assets, reverse mortgages for the elderly are becoming increasingly popular in Japan because of innovations in the financial industry. Our results suggest that more widespread use of reverse mortgages will allow homeowner to benefit to a greater extent from house price gains by adjusting their labor supply. At the same time, however, it may also have an effect on the labor market by exacerbating the labor shortages Japan is experiencing as a result of demographic trends.[15]

Acknowledgments

We would like to thank Shinya Kajitani, Daiji Kawaguchi, Tsunao Okumura, Kazuto Sumita, participants of workshops at the University of Bristol, Musashino University, and Toyo University, participants of the 2022 Japanese Economic Association Spring Meeting and the 26th Asian Real Estate Society Annual Conference for their valuable comments and constructive suggestions. We would also like to thank Ralph Paprzycki for his excellent English editing service. We are grateful to Misa Izuhara for encouraging us to write this paper. Finally, we would like to thank the Panel Data Research Center at Keio University for providing us with access to its micro-data and Norifumi Yukutake for his useful advice on the analysis of this data.

Funding

This research was supported by JSPS KAKENHI Grant Numbers JP19K01603 and JP19K01703 and ESRC-AHRC UK-Japan SSH Connections Grant ES/S013695/1.

[15] Favilukis and Li (2023), for example, focusing on the "Great Resignation" in the US – the substantial decrease in labor force participation among the elderly beginning in early 2021 in the wake of the COVID-19 pandemic – show that this can almost entirely be explained by the increase in house prices.

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Table 1

Descriptive statistics.

	Women			Men		
Variables	N	Mean	SD	N	Mean	SD
LFP (dummy)	4,678	0.9	0.3	7,431	1.0	0.2
Monthly Days of Work	4,934	16.0	6.6	7,164	21.0	4.6
Weekly Hours of Work	4,896	21.9	13.2	7,067	45.2	15.5
Age	4,934	52.1	8.3	7,164	51.4	7.5
Age 40-44 (dummy)	4,934	0.2	0.4	7,164	0.2	0.4
Age 45-49 (dummy)	4,934	0.2	0.4	7,164	0.2	0.4
Age 50-54 (dummy)	4,934	0.2	0.4	7,164	0.2	0.4
Age 55-59 (dummy)	4,934	0.2	0.4	7,164	0.2	0.4
Age 60-64 (dummy)	4,934	0.1	0.3	7,164	0.1	0.3
Age 65-69 (dummy)	4,934	0.1	0.2	7,164	4.E-02	0.2
Age 70+ (dummy)	4,934	2.E-02	0.1	7,164	1.E-02	0.1
Mortgage (dummy)	4,934	0.5	0.5	7,164	0.6	0.5
No Financial Assets (dummy)	4,934	0.2	0.4	7,164	0.2	0.4
Household Size (#)	4,934	3.5	1.3	7,164	3.6	1.3
Children Aged 0-6 (#)	4,934	3.E-02	0.2	7,164	0.1	0.4
Regional Unemployment Rate	4,934	3.4	1.0	7,164	3.5	1.0

Note: Descriptive statistics for the year, the location, and the location-with-year dummies not shown.

Table 2

Estimation results for the natural log of house prices.

Variables	Coefficient	Robust SE
ln(House Price $t-1$)	–0.105*	0.057
ln(House Price $t-2$)	–0.043	0.029
ln(Building Age)	–0.218***	0.030
2008	–0.030**	0.015
2009	–0.052***	0.018
2010	–0.080***	0.021
2011	–0.109***	0.023
2012	–0.133***	0.025
2013	–0.153***	0.028
2014	–0.184***	0.031
2015	–0.205***	0.035
2016	–0.227***	0.038
2017	–0.263***	0.040
2018	–0.267***	0.044
2019	–0.281***	0.047
Constant	4.064***	0.270
First-order Autocorrelation	(–7.480)	[0.000]
Second-order Autocorrelation	(–0.979)	[0.328]
Observations	18,276	

Notes: The model is estimated using the Arellano-Bond dynamic panel GMM estimator. Arellano-Bond tests for zero autocorrelation in first-differenced errors are reported. z-values are reported in parentheses and $\text{Prob} > z$ is reported in square brackets.

***, **, * denote significance at the 1 percent, 5 percent, 10 percent levels, respectively.

Table 3

Estimation results for the labor supply function.

	A: LFP		B: Monthly Days of Work		C: Weekly Hours of Work	
	Women	Men	Women	Men	Women	Men
ln(House Price Shock)	−0.010	0.007	−0.010	−0.109	−0.691	−0.429
	(0.012)	(0.007)	(0.283)	(0.213)	(0.591)	(0.683)
Mortgage	−0.009	0.019**	0.078	0.585*	0.094	0.680
	(0.021)	(0.009)	(0.417)	(0.302)	(0.945)	(0.957)
No Financial Assets	0.016	0.006	0.664	0.153	1.471*	−0.264
	(0.020)	(0.007)	(0.427)	(0.196)	(0.888)	(0.842)
Household Size	−0.016*	0.002	−0.195	0.066	0.363	0.119
	(0.009)	(0.004)	(0.177)	(0.109)	(0.417)	(0.444)
Children Aged 0-6	−0.077*	−0.005	−1.736**	−0.161	−2.421*	−1.189*
	(0.042)	(0.005)	(0.708)	(0.166)	(1.409)	(0.676)
Regional Unemployment Rate	0.009	−0.186*	−3.753	2.158	−18.135	16.787
	(0.340)	(0.098)	(9.874)	(4.289)	(18.146)	(12.962)
Within R^2	0.048	0.028	0.035	0.024	0.027	0.036
Observations	4,678	7,431	4,934	7,164	4,896	7,067

Notes: Bootstrap standard errors obtained by bootstrap approximation using 500 resamples clustered at the household level are shown in parentheses.

Additional controls include individual-level fixed effects, year fixed effects, location fixed effects, and location-with-year fixed effects.

** and * denote significance at the 5 percent and 10 percent levels, respectively.

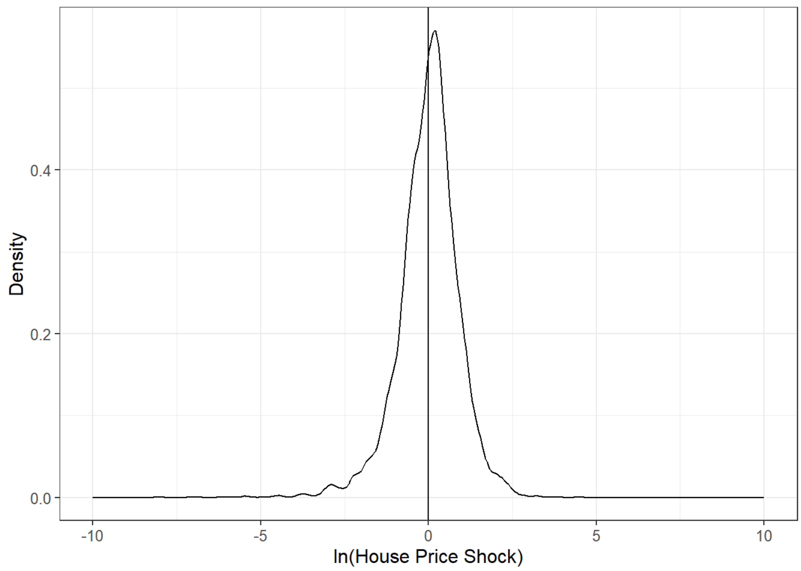

Fig. 1. Density function for house price shocks.

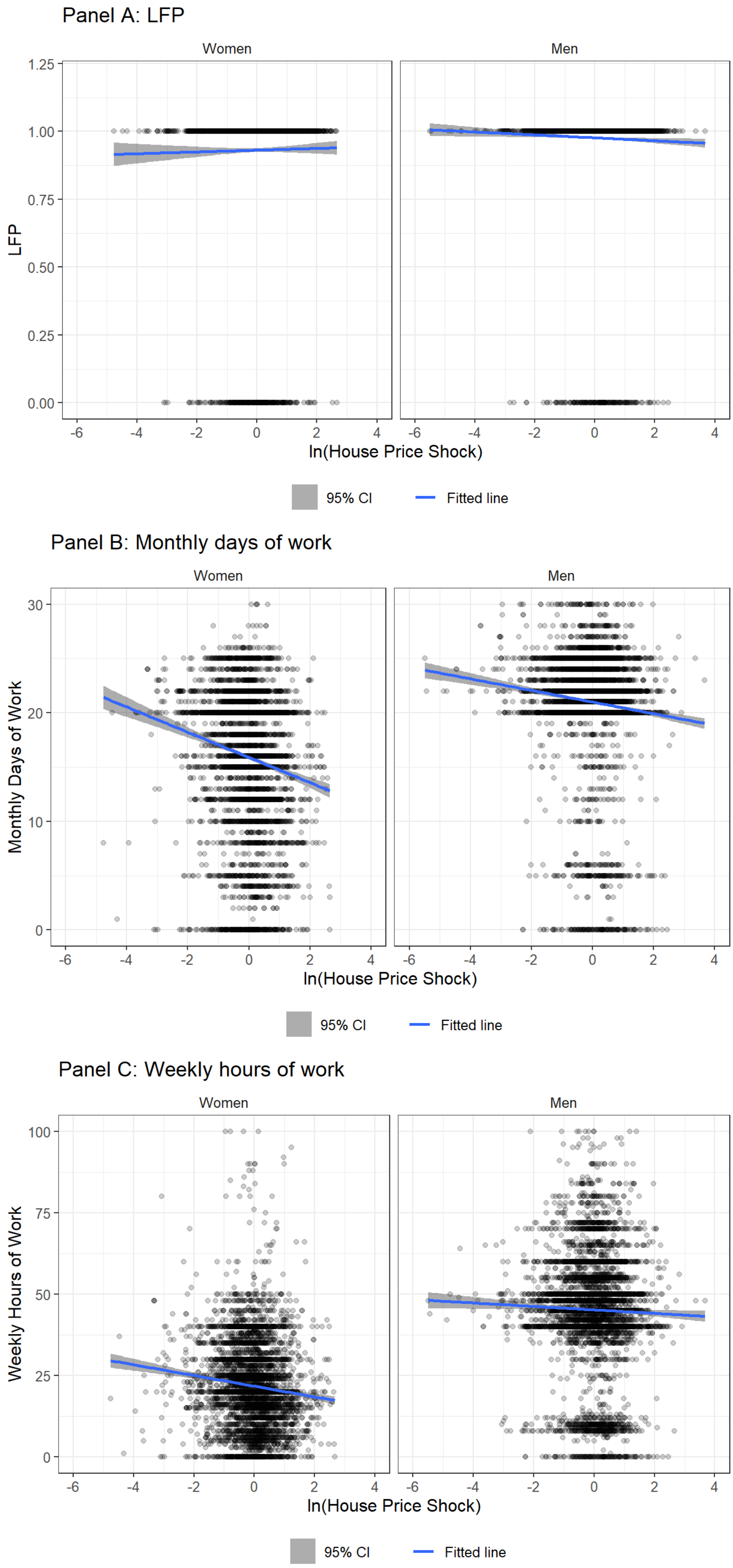

Fig. 2. Association between labor supply and house price shocks.

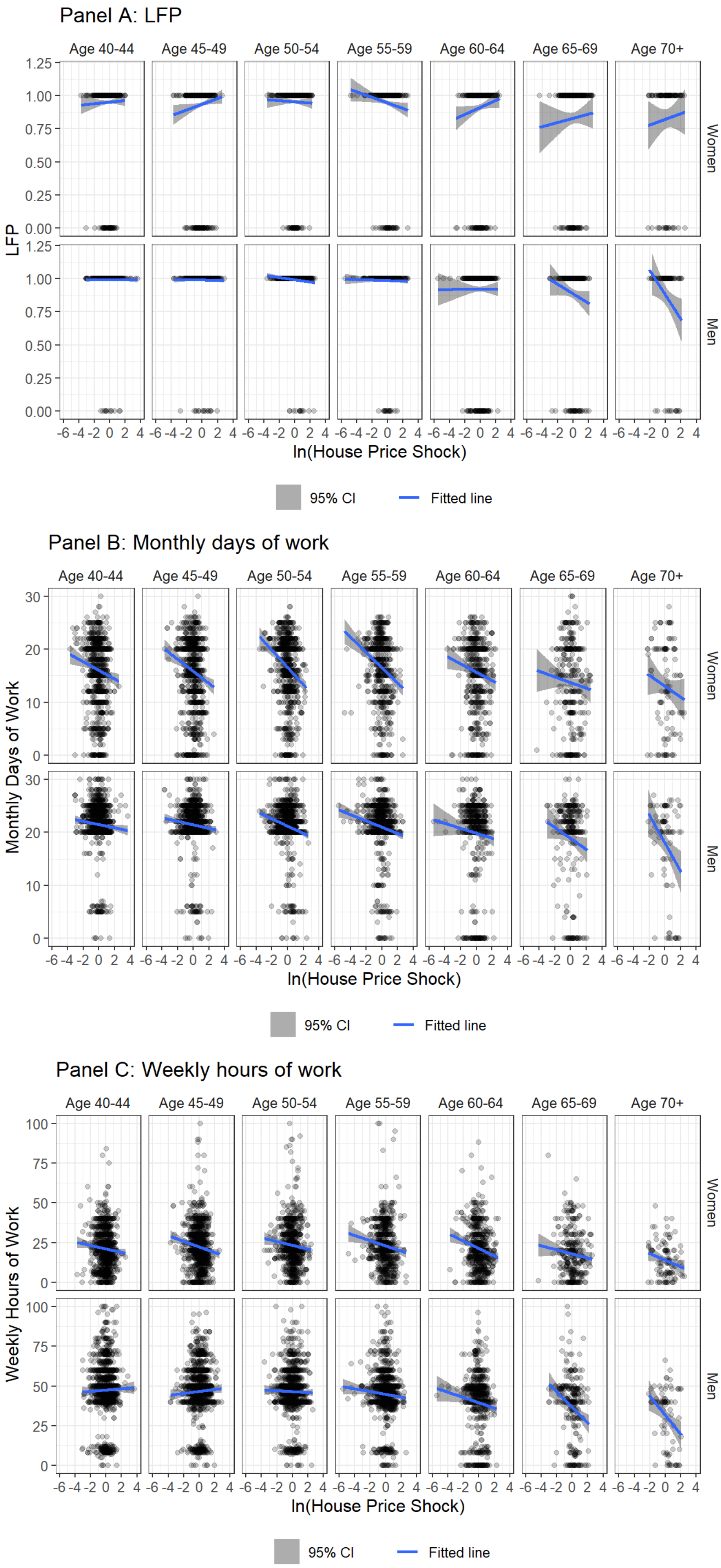

Fig. 3. Association between labor supply and house price shocks by age group.

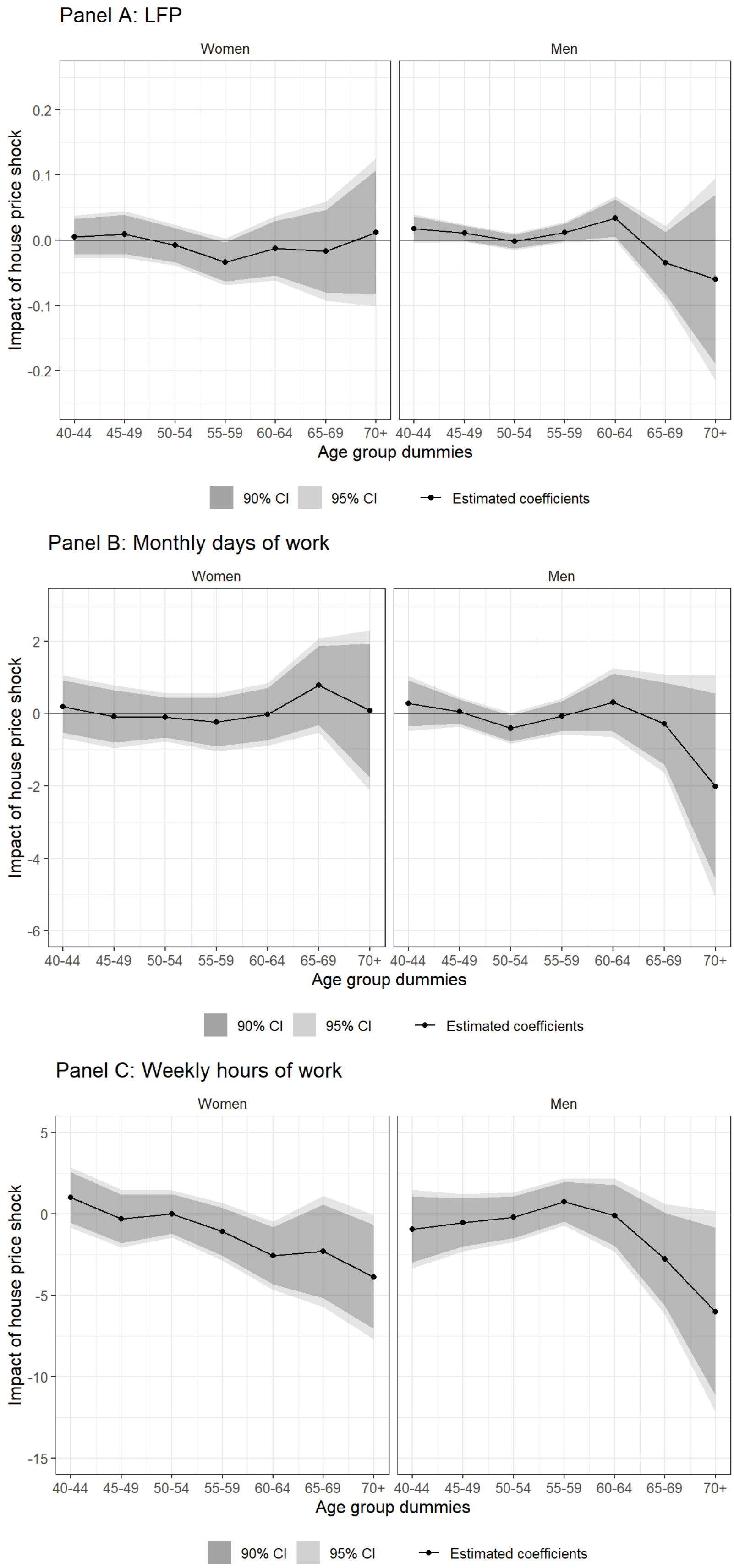

Fig. 4. Estimated coefficients of ln(House Price Shocks) × age group dummies.

Notes: Additional controls include age group dummies, the mortgage dummy, the dummy for households with no financial assets, household size, and the number of children aged 0-6. Individual-level fixed effects, year fixed effects, location fixed effects, and location-with-year fixed effects are also controlled for. Bootstrap standard errors are obtained by bootstrap approximation using 500 resamples clustered at the household level.

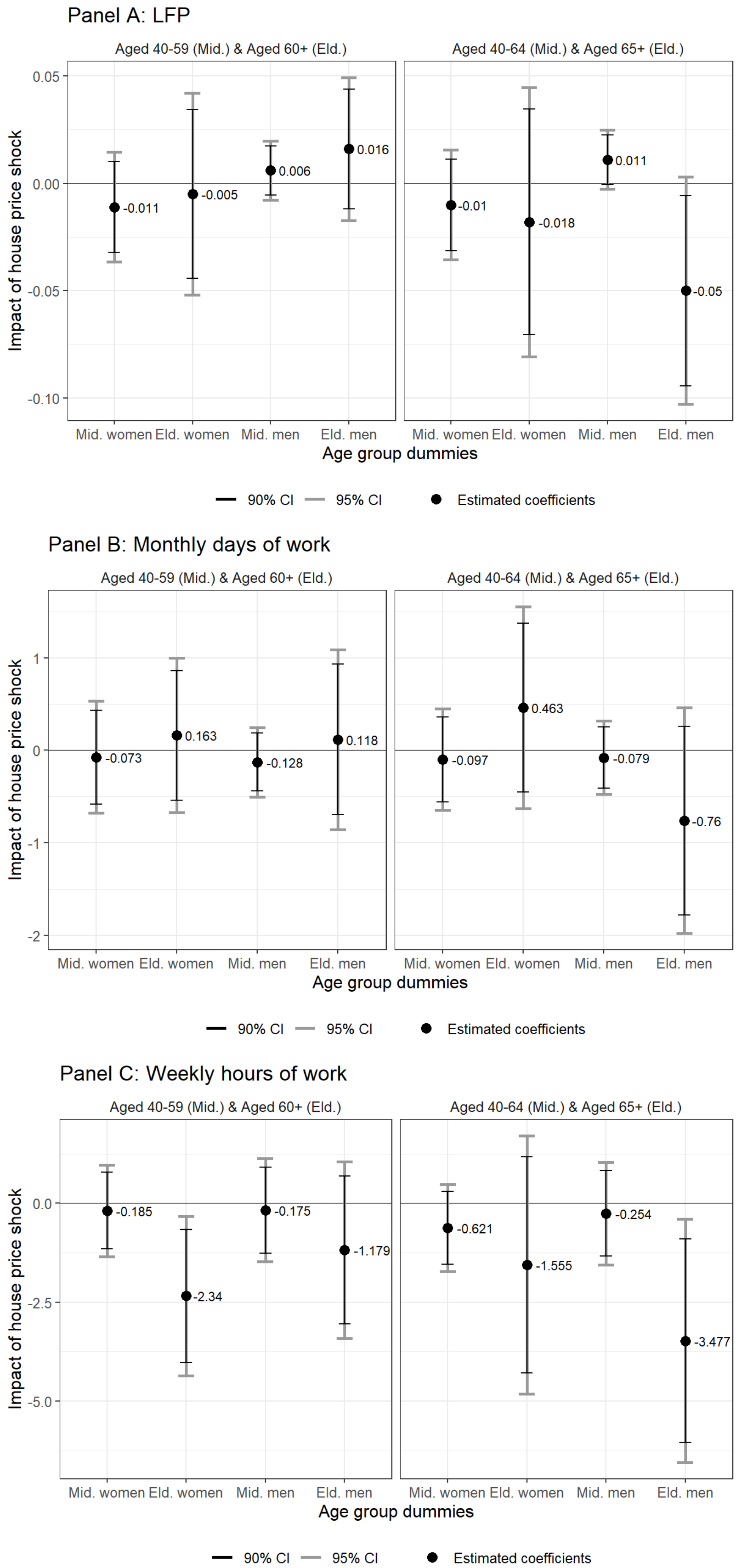

Fig. 5. Changing age group dummies.

Notes: Additional controls include age group dummies, the mortgage dummy, the dummy for households with no financial assets, household size, and the number of children aged 0-6. Individual-level fixed effects, year fixed effects, location fixed effects, and location-with-year fixed effects are also controlled for. Bootstrap standard errors are obtained by bootstrap approximation using 500 resamples clustered at the household level.

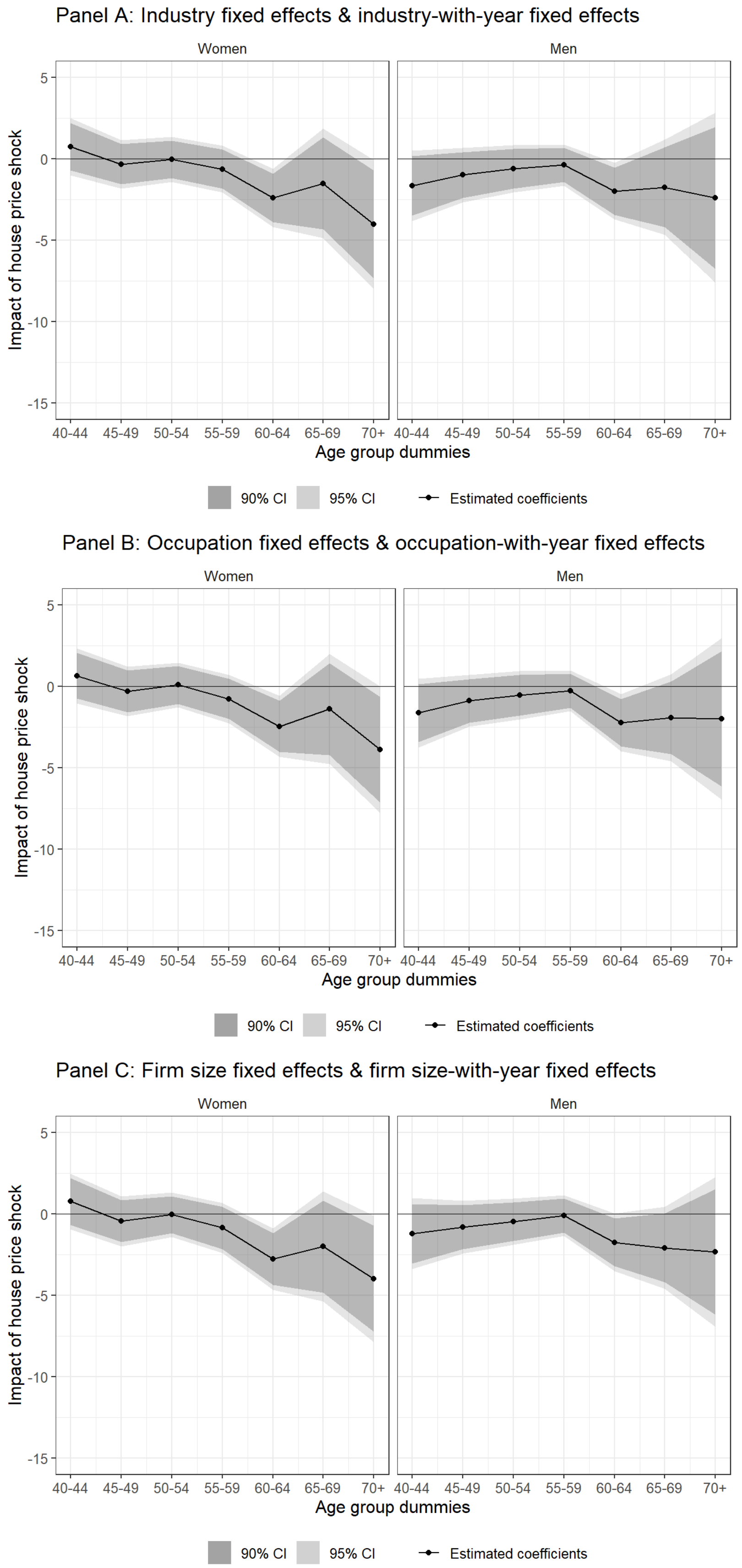

Fig. 6. Estimation results for weekly hours of work with industry/occupation/firm size fixed effects.

Notes: Additional controls include age group dummies, the mortgage dummy, the dummy for households with no financial assets, household size, the number of children aged 0-6, individual-level fixed effects, and year fixed effects. The number of observations is 4,888 for women and 7,056 for men in Panel A, 4,865 for women and 7,046 for men in Panel B, and 4,855 for women and 7,041 for men in Panel C. Bootstrap standard errors are obtained by bootstrap approximation using 500 resamples clustered at the household level.