NBER WORKING PAPER SERIES

HOUSE VALUATIONS AND ECONOMIC GROWTH: SOME INTERNATIONAL EVIDENCE

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Working Paper 22699
http://www.nber.org/papers/w22699

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2016

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NBER Working Paper No. 22699
September 2016
JEL No. F41,F43

ABSTRACT

This paper evaluates the relation between house prices and economic growth. Using a dataset that covers house prices for 19 countries from the first quarter of 1975 to the third quarter of 2013. We find that house price appreciations are positively associated with economic growth, while the relation between house price depreciations and economic growth is highly non-linear, depending on country-specific characteristics. In the absence of concurrent banking crisis, large house price depreciations (rather than prolonged and modest ones) are positively associated with economic growth. We also find that the positive association between house price depreciations and economic growth is more pronounced in countries with civil-law legal systems, in countries without mortgage insurance or personal bankruptcy law.

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1. Introduction

House price appreciations contribute to the economic growth through increasing household consumption (i.e. via the wealth effect, see Mian, Gao and Sufi, 2013, Mian and Sufi, 2014) and firm investment beyond new housing construction (i.e. via the network or collateral effect, see Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi, 2012, Chaney, Sraer and Thesmar, 2012). Large house price appreciations, however, can lead to overinvestment (Miao, Wang and Zhou, 2015), which crowd out the funding supply to more productive sectors and reduce economic output (Chakraborty, Goldstein, and MacKinlay, 2016). The eventual house price depreciations tend to happen with tightening credit conditions due to falling collateral value, declining real-estate related employment and deteriorating consumption demand. The large depreciations that follow prolong appreciations can potentially reduce capital market distortion and improve investment efficiency, which subsequently enhances economic growth via reducing existing economic slack (Lau and Zheng, 2015). Understanding the dynamics of house prices and economic growth is the objective of this paper.

To study the relation between economic growth and house valuations, we look at house prices in a panel of 19 countries from the first quarter of 1975 to the third quarter of 2013. In the econometric analyses, we find that there is a positive relation between house price appreciations and economic growth. Interestingly, the eventual house price depreciation has a non-linear relationship with economic growth. Similar to Jordà, Schularick and Taylor (2015a), we find that house price cycles can be costly if it is accompanied by a banking crisis. In the absence of a banking crisis, a large house price depreciation (rather than a prolonged and modest one) is associated with a stronger economic output and productivity growth. This result is consistent with the finding by Mian, Sufi and Trebbi (2015) that economic activity recovers faster after a larger decline in house prices, driven by more foreclosure by delinquent homeowners. We also find that the positive relation between large

house price depreciations and economic output growth is more pronounced in countries with a civil law system, and without mortgage insurance or personal bankruptcy law.

This paper is related to Mian, Sufi and Trebbi (2015) who use the U.S. household level data to evaluate the impact of house prices on economic activity. We extend their exercise to an international context using country-level data and find similar evidence that a country's economic output grows faster when its house price undergoes sharp and deep corrections. The new evidence adds to the existing literature that study the dynamic interaction between house price shocks and global macroeconomic fluctuations (Beltratti and Morana 2010; Musso, Neri, and Stracca, 2011; Jordà, Schularick and Taylor, 2015b). This paper is also related to Borio, Disyatat, and Juselius (2015), who find that credit conditions and property prices explain the cyclical variations of output gap in the U.S. significantly, and Miller, Peng, and Sklarz (2011), who find that houses prices affect aggregate economic growth using U.S. metropolitan data. While these studies focus on the U.S. market, we offer cross-country evidence on the relation between house valuations and economic growth. Moreover, we document a positive linkage between large house depreciations and economic growth, which may channel through increasing capital allocation efficiency (Borensztein and Lee, 2002; Caballero, Hoshi and Kashyap, 2008) and labour mobility (Donovan and Schnure, 2011; Schulhofer-Wohl, 2011). These new findings have important policy implications for managing bursting house bubbles.

The remainder of this paper as organized as follows. Section 2 describes the data, Section 3 presents the results, Section 4 explores the implications of house price cycles on aggregate economic growth, Section 5 discusses the possible mechanisms that drive the positive relation between large house price depreciations and economic growth, and Section 6 concludes.

2. Data

House price data come from The Economist's house-price index[1]. Our estimation sample includes quarterly house prices in real terms and price-to-rent ratios for 19 countries (both OECD and non-OECD) from the first quarter of 1975 to the third quarter of 2013. We look at two measures: House Price Return ($HPR_{i,t}$), a three-year cumulative return on real house price index in country *i* at period *t*, and House Price to Rent Ratio (*PRR*), which is calculated as a three-year cumulative change on real price-to-rent ratio. Housing market related policies, including maximum loan to value ratio (LTV), mortgage subsidies/insurance, personal bankruptcy law, are drawn mainly from Shim, Bogdanova, Shek and Subelyte (2013).

Country-level macroeconomic variables come from IMF's International Financial Statistics and Bank for International Settlements (BIS). A set of dependent variables includes real GDP growth, per capita GDP growth, and total factor productivity growth. In addition to house prices, we also include a set of control variables: (i) *Log(initialGDP)*, the log of real GDP lagged by one year; (ii) *Investment*, the annual return on the gross capital formation to GDP calculated as the log difference in the gross capital formation to GDP between current quarter and the same quarter of last year; (iii) *Unemployment*, the annual change in the log of unemployment rate; (iv) *Inflation*, the annual change in the log of CPI index; (v) *GovExp*, the nominal government consumption divided by the nominal GDP; (vi) *TradeOpenness*, the sum of nominal exports and imports as a ratio of the nominal GDP; and (vii) *Credit*, the domestic credit to private sector divided by GDP. Appendix Table A1 summarizes the data sources and variable definitions in details.

On aggregate, we have 1,920 common country-quarter observations for our regressions. The sample starts from the first quarter of 1978 (the first three year observations are dropped when calculating *HPR* and *PRR*).

[1] The data is available from http://www.economist.com/blogs/dailychart/2011/11/global-house-prices. The original data covers 21 countries, Singapore and China are excluded from the final sample due to the lack of quarterly data on trade and inflation in International Financial Statistics.

Table 1 reports summary statistics of these variables. House price appreciations are more frequent and larger in size than house price depreciations: there are 1,212 country-quarter episodes of housing price appreciations with an average *HPR* of 17%, and 718 episodes of housing price depreciations with an average *HPR* of -11%.

3. Results

3.1. Baseline Estimation

To estimate the association between economic growth and house prices, we use the following specification:

$$y_{i,t} = \theta \cdot HPR_{i,t} + \gamma \cdot |HPR_{i,t}| \cdot D_{i,t} + B \cdot \Lambda_{i,t} + \delta \cdot \text{Country}_i + \text{Quarter}_t + \varepsilon_{i,t}, \quad (1)$$

where we denote y for economic growth, *HPR* for house price return for country *i*, and time period *t* (quarterly). House price depreciation variable, $D_{i,t}$, is a dummy variable identifying the degree of house price depreciation: $D_{HPR_{i,t}<0}$, ($D_{HPR_{i,t}<m}$, or $D_{m\leq HPR_{i,t}<0}$) is equal to one if *HPR* is negative (lower than median of *HPR* depreciation, or higher than the median of *HPR* depreciation), and zero otherwise. The main independent variable is the interaction between *HPR* and house price depreciation dummy. To differentiate between house price appreciations and depreciations, we use the absolute of house price return $|HPR_{i,t}|$ in the regression. The coefficient of the interaction term, γ, thus captures the linkage between house price depreciations and economic growth, relative to that between house price appreciations and economic growth. A positive value of γ suggests that house price depreciations are more positively associated with economic growth than house price appreciations.

We also include other explanatory variables (Λ) in the regressions. First, we control for the initial level of economic development proxied by *Log(InitialGDP)* as well as the growth of capital and labor, captured, respectively, by the annual log change in gross capital formation as a ratio to GDP (*Investment*) and the log change in unemployment rate (*Unemployment*). These variables account for growth in factor inputs influencing

output growth. Following the literature, we also control for *Inflation*, captured by the annual change in the log of consumer price index (CPI); the level of *TradeOpenness* of an economy, defined as the ratio of the exports plus imports to GDP; the ratio of government expenditure to GDP (*GovExp*), and bank credit to private sector as a ratio of GDP (*Credit*). All the level variables (*TradeOpenness, GovExp, and Credit*) are lagged by four quarters in the estimation. Also included in the regression is country and quarter fixed-effects, where Quarter takes the value of 1, 2, 3 or 4. The standard errors of the estimated coefficients allow for clustering of observations by quarter.

Using Equation (1) as the baseline specification, Table 2 reports estimation results of the relation between real GDP growth and house prices. Column 1 indicates that the economic growth is positively associated with house price returns. As we differentiate the house price returns into depreciation (*HPR* < 0) and appreciation (*HPR* > 0), we find that the association is highly non-linear: in absolute term, there is some evidence that both house price appreciations and depreciations are positively associated with economic growth. The result in column (2) suggests that a 1% house price appreciation is associated with 2.3 basis points increase in the economic growth, while the house price depreciation of the same size is positively associated with 1.7 basis points increase in the economic growth [the number 1.7 basis point is calculated as $|HPR| * (\gamma - \theta)$=1%*(4.00-2.26)].

Motivated by Mian, Sufi and Trebbi (2015), who show that large and moderate house price depreciations have asymmetric impacts on economic activity, we differentiate further the house price depreciations into large depreciations and moderate depreciations; i.e. whether the negative *HPR* is lower (that is, more negative) or higher than the median value of the negative *HPR*. Based on Table 1, a country-quarter housing price observation is considered a large depreciation if it drops by more than 9.4% over three years, and moderate depreciation otherwise. Interestingly, the estimation results in Table 2 columns (3) and (4) suggest that only

large depreciations are positively associated with the economic growth. More specifically, a large depreciation of 10% is associated with 14 basis points increase in the real GDP growth. In Appendix Table A2, we also differentiate the large appreciations with moderate appreciations, but find no evidence of an asymmetric relation with economic growth.

The association between economic growth and other controls are as expected and in line with previous studies; countries with lower initial GDP, more investment and less unemployment rate are found to have higher economic growth; less trade openness is associated with higher growth, which is in line with Yanikkaya, (2003); less financially developed economies are associated with higher economic growth, consistent with Alfaro, Chanda, Kalemli-Ozcan and Sayek (2004). Overall, the baseline estimation can explain about half of the variation in the growth rates across countries as suggested by the R-squared.

3.2. **Endogeneity Issues**

The ordinary least square (OLS) estimation results in Table 2 provide evidence that house price appreciations and large depreciations are positively associated with the real GDP growth. In this section, we address potential feedback from economic growth to housing prices; i.e. house price appreciates following strong economic growth. In addition, the relation observed from Table 2 may be spurious if we omit common variables that affect both house prices and economic growth. Both reverse causality and omitted variables could result in the OLS estimated coefficients being biased and inconsistent. To address these concerns, we employ an instrumental variable (IV) approach. We use the three-year cumulative change in the price-to-rent ratios, *PRR*, to instrument house price returns, *HPR*. Almeida, Campello, and Liu (2006) find price-to-rent ratio to be an important determinant of house prices. Further, it is plausible that price-to-rent ratios can affect the economic growth mostly through house prices. Therefore, the excluded instrument *PRR* should satisfy the relevance and exogenous criteria.

Together with the coefficient estimates from the first and second stage regressions, Table 3 reports the F-statistics and p-value of Endogeneity Test under the null hypothesis that *HPR* are exogenous: they clearly reject the null hypothesis at 1% significance level, supporting the use of IV approach. The endogenous regressor, *HPR*, as well as its interactions with large and moderate depreciation dummy variables are instrumented with *PRR* together with its interactions with the two depreciation dummy variables. Columns (1) - (3) provide the first-stage regressions, using two-stage least square (2sls) methods. It shows that the excluded instruments are significantly associated with *HPR* and the interaction terms. The under-identification test reports the Kleibergen-Paap rank LM statistic and its corresponding p-value under the null hypothesis that the instrumental variable is not relevant: it rejects the null hypothesis that the excluded instruments are not relevant at 5% significance level. The weak-identification test reports a Kleibergen-Paap rank Wald F-statistic of 7.5. Given that the Stock-Yogo weak ID test critical value at 10% maximum IV size is 7.03, the F-statistic rejects the null hypothesis that the IV is a weak instrument. These test statistics support our choices of the instruments.

Column (4) of Table 3 reports the second-stage estimation results. It shows that house price appreciations and large depreciations remain positively and significantly related to the real GDP growth. Moreover, coefficient estimates from the IV estimation is larger than that the estimates from OLS: 10% house price depreciation increases the real GDP growth by 30 basis points in the IV, compared to 14 basis points in the OLS regression. For moderate house price depreciation, the estimate has become negative and insignificant. In particular, an 8% depreciation in housing prices is associated with 35 basis point decline in real GDP growth [calculated as 8%*(6.44-2.07)]. Such a result is however not significant.

3.3. Cross-Sectional Heterogeneity

We next delve further into the cross-sectional differences in the relation between house valuations and

economic growth. Table 4 reports the second-stage estimation results based on the 2sls method, accounting for differences across countries with additional country-specific characteristics. All regressions are controlled for country and quarter fixed-effects. Across various specifications, the estimated coefficients of *HPR* and $|HPR|*D_{HPR<m}$ are both positive and statistically significant, while that of $|HPR|*D_{m<HPR<0}$ is negative but insignificant. The results are consistent with our earlier findings that house price appreciations and large house price depreciations are positively associated with economic growth. The estimated coefficients for other control variables included in Table 3 remain consistent (not reported for brevity).

Additional country-specific characteristics included in this set of estimation are in order. Columns (1) of Table 4 report the estimation results that account for institutional characteristics, measured by *CommonLaw* that equals to 1 if the country is in the common-law system as recorded in Lopez-de-Silanes, Shleifer and Vishny (1998), and zero otherwise. The estimated coefficient of the interaction term $|HPR|*D_{HPR<m}*CommonLaw$ is statistically significant and negative, suggesting that large house price depreciations is less associated with economic growth in common law legal framework than in civil law legal framework. In particular, a 10% depreciation in house prices is associated with 60 basis points increase in the real GDP growth in countries with civil law legal framework (the estimated coefficient of $|HPR|*D_{HPR<m}$ 7.98 minus the estimated coefficient of *HPR* 1.96, multiplied by the magnitude of depreciation 10%), but only related to 3 basis point increases of the real GDP growth in countries with common law legal framework [calculated as (7.98-1.96-5.71)*10%]. As the civil law systems tend to provide relatively weak legal protection for investors as compared to the common law systems (Porta, et al., 1998), our results seem to suggest a stronger relationship between larger house price depreciations and economic growth in countries with weaker safety nets.

Columns (2) and (3) report the regressions that account for the availability of mortgage insurance and personal bankruptcy law, respectively. The dummy *MI* takes a value of 1 if the government provides mortgage

insurance in country *i* at period *t*. The *PBL* is also a dummy that equals to 1 if there is personal bankruptcy law in country *i* at period *t*. Both interaction terms $|HPR|*D_{HPR<m}*MI$ and $|HPR|*D_{HPR<m}*PBL$ are statistically significant and negative, suggesting stronger relation between large depreciations and economic growth in countries that do not provide mortgage insurance or personal bankruptcy law. As the provision of mortgage insurance and personal bankruptcy law strengthens the cushion against large house price depreciations, the results support our previous argument that the relation between large depreciations and economic growth is stronger in countries with weaker safety nets.

Column (4) report results that account for housing policy, using the national requirement on maximum loan to value ratio (*LTV*), based on Almeida et al. (2004), as a proxy. The dummy variable $LTV_{<0.8}$ takes a value of 1 if the maximum *LTV* ratio is less than 80% (that is, the minimum down payment is more than 20%). The interaction term $|HPR|*D_{HPR<m}*LTV_{<0.8}$ is negative but not statistically significant. Column (5) explore whether the results differ between OECD and non-OECD countries. The interaction term $|HPR|*D_{HPR<m}*OECD$, where *OECD* is a dummy that equals to 1 for OECD countries, is positive but not statistically significant. Column (6) reports results that account for a concurrent banking crisis. The dummy variable *Crisis* equals to 1 if there is a banking crisis, as identified in Laeven and Valencia. (2013), and 0 otherwise. The interaction term $|HPR|*D_{HPR<m}*Crisis$ is statistically significant and negative, indicating that the positive relation between large depreciations and growth becomes weaker in the presence of the banking crises. In fact, when there is a banking crisis, the relation between large depreciations and economic growth becomes trivial and insignificant.

To summarize, the positive relation between large depreciations and economic growth is more pronounced in countries with civil-law legal systems, in countries without mortgage insurance or personal bankruptcy law, and in countries without a concurrent banking crisis.

3.4. Alternative Measures of Growth

To check for the robustness of our results, we use two alternative measures of economic growth: Per Capita GDP Growth (the change in log of annual GDP per capita) and Total Factor Productivity (TFP) growth (the Solow residual). Columns (1) and (3) provide estimation results based on OLS using, respectively, GDP per capita growth and TFP growth as the alternative dependent variables. All regressions control for country-specific time-varying characteristics as well as country and quarter fixed-effects (not reported). For both alternative measures of economic growth, our main results remain robust: both house price appreciations and large house price depreciations are positively related to economic growth. Columns (2) and (4) provide the second-stage estimation results based on 2sls. The under-identification tests reject the null hypothesis that the excluded instruments are not relevant at 5% significance level. The weak-identification tests reject the null hypothesis that the excluded instruments are weakly identified. Both tests support the use of price-to-rent ratio (*PRR*) and its interactions with depreciation dummies as the excluded instruments and their statistical relevance. The 2sls estimation results suggest that large depreciations are positively associated with growth in GDP per capita as well as TFP: we infer from the results that a 10% housing price depreciation is associated with 43 basis points growth in GDP per capita and 38 basis points growth in TFP.

Based on Table 3 and 5, Figure 1 summarizes the relation between different measures of economic growth and 1% marginal increment in house price appreciations, moderate depreciations, and large depreciations. Regardless of which growth measures are used, house appreciations and large depreciations are associated with higher economic growth.

3.5. Additional Controls

To mitigate the concern of spurious relation between house valuations and economic growth caused by omitted variables, we control for additional variables. Table 6 reports the second-stage result based on 2sls estimation. We find that including the lag of *HPR*, the lag of GDP growth, or both, does not affect our main

results. Throughout the various specifications, the estimated coefficient of *HPR* remains positive and statistically significant. The estimated coefficients of the interaction between |*HPR*| and large house price depreciation dummy remains positive and statistically significant. With the exception of column (6) when the one-quarter lagged *HPR* and real GDP growth are included, the estimated coefficient of $|HPR|* D_{HPR<m}$ is greater than that of *HPR*, further suggesting a positive linkage between large house price depreciations and economic growth.

3.6. Plausibly Exogenous IV

The results that both house price appreciations and large depreciations are positively related to economic growth are robust across different estimation methods, different measures of growth, and alternative specifications. Nonetheless, the excluded instrument *PRR* may still be imperfect, it may affect the economic growth directly or through channels other than house valuations that are neither documented in existing literature nor easily observable. We shall, therefore, take caution in interpreting the causality running from house valuations to economic growth.

To further check the robustness of the results, we take into considerations that the excluded IV may not satisfy the exogenous criteria. In particular, we verify the results using the methodology in Conley, Hansen and Rossi (2012), allowing the excluded IV to be not entirely exogenous. Table 7 reports the second stage estimation results under flexible (plausibly exogenous) conditions based on the union of confidence intervals approach. We find that our main findings on the association between house valuations and economic growth remain consistent for all three measures of economic growth. Specifically, a 10% house price appreciation is associated with 35, 29 and 22 basis points increase in real GDP growth, per capita GDP growth and TFP growth while a 10% house price depreciation is associated with 21, 33 and 18 basis points increase in the growth of real GDP, per capita GDP and TFP, respectively.

4. Implications on Economic Growth

According to Bracke (2013), the average duration of housing appreciations in a housing cycle, defined as the time interval between a trough and a peak, is 24.1 quarters or approximately 6 years, and the average duration of housing depreciations, defined as the time interval between a peak and a trough is 18.2 which is about 5 years. In our sample, the average size of house price appreciations and depreciations over three years are 17% and 11% respectively (see Table 1). If the housing market appreciates 17% per three years (or 5.4% per year) for the first 6 years, and then depreciates sharply at 11% per three years in the 5 years that follows, the total contribution of a typical housing cycle to GDP growth is about 3.8% based on the estimation results in Table 3.[2] Based on the 2sls estimation results in Table 5, such a housing cycle would be associated with 4.5% and 3.6% increment in GDP per capita growth and TFP growth. If the house price depreciates slowly, say at 4% per three years over the 5-year downturn periods, a typical housing cycle would have to be associated with 1%, 1.8% and 1.9% increase in the real GDP growth, GDP per capita growth and the TFP growth respectively.

Based on the estimation results, we calculate the contribution of housing price dynamics to economic outputs in terms of growth in GDP, GDP per capita, and TFP. In particular, for each country-quarter, we multiply *HPR* with the difference of the estimated coefficient of *HPR* and its two interaction terms $|HPR|*D_{HPR<m}$ and $|HPR|*D_{0<HPR<0}$ based on two-stage least square as reported in Table 3 and 5 to calculate the economic significance of the relation between house prices and economic growth. Table 8 presents the average annual association between housing valuations and economic growth for each country. Figure 2 illustrates the average

[2] It is calculated as [17%*2.07*6+11%*(5.06-2.07) *5]/100=3.76%, where 2.07 is the estimated coefficient of HPR and 5.06 is the estimated coefficient of $|HPR|*D_{HPR<m}$ in Table 3. The difference between 5.06 and 2.07 measures the relation between large depreciations and economic growth. More precise calculations that simulate the growth of housing prices and its cumulative association with growth yield similar results. For example, the compounded cumulative return is $(1+17\%*2.07/100)^6*(1+11\%*(5.06-2.07)/100)^5-1=3.82\%$.

relation between housing valuations and real GDP growth for each country. Such a relation is the strongest in Hong Kong, translating housing valuations into the economic growth of 6.7 to 81 basis points per year: in the absence of housing price cycles, the economic growth in Hong Kong would have been lower by 67 to 81 basis points per year. If cumulated over several years, this can have a significant implication on its long-term economic growth. On average, the housing price cycles add 26 to 35 basis points to economic growth annually. Note that, given our sample periods, the contribution of housing valuations to economic growth in German and Japan is negative, although the magnitude is comparatively small.

5. Discussion

It is intuitive that house price appreciations are positively related to the economic growth as they increase the consumption and investment both directly (captured by the inputs in the control variable) and indirectly (Mian, Gao and Sufi, 2013; Mian and Sufi, 2014; Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi, 2012; Chaney, Sraer and Thesmar, 2012). While large house price depreciations are associated with lower levels of consumption and investment that undermine economic growth, it can trigger financial and labour market restructuring that benefits growth. According to Borensztein and Lee (2002), credit is reallocated to more efficient firms after a crisis. One can, therefore, expect a credit market reshuffle that direct investment flows from real estate to more productive sectors following a sharp and deep correction in the housing market as captured by the large depreciations episodes, which improves the long-term economic growth. Moreover, in countries where zombie lending distorts capital allocation and depresses growth (Caballero, Hoshi and Kashyap, 2008), steep housing prices corrections may force zombie firms out of the market, which allows banks to lend more efficiently than committing loans to unproductive zombie firms. In this sense, large depreciations can be related to higher economic growth through improving banking efficiency. Finally, large depreciations can benefit economic growth through improving labor mobility. According to Donovan and Schnure (2011) and

Schulhofer-Wohl (2011), underwater mortgages provide greater incentive for households to relocate from a relatively poor to a better labor market, which improves labor mobility. Large depreciations that increase the number and magnitude of underwater mortgages, therefore, enhance labor mobility and subsequently economic growth.

6. Conclusion

Our empirical study suggests that house price appreciations are positively associated with economic growth, while the relation between house price depreciations and economic growth is highly non-linear, depending on country-specific characteristics. In the absence of concurrent banking crisis, large house price depreciations are positively associated with economic growth. We also find that the positive linkage between house price depreciations and economic growth is more pronounced in countries with relatively weak safety nets, the presence of a civil law system, provision of mortgage insurance and existence of personal bankruptcy law.

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Appendix Table A1. Data Sources and Definition.

VARIABLES	Definitions	Data Source
$HPR_{i,t}$	Log(house price$_t$)- Log(house price$_{t-12}$)	The Economist
$D_{HPRi,t<0}$	=1 if HPR$_{i,t}$<0 and =0 otherwise.	The Economist
$D_{HPRi,t<m}$	=1 if HPR$_{i,t}$<median(HPR<0) and =0 otherwise	The Economist
$D_{m<HPRi,t<0}$	=1 if 0>HPR$_{i,t}$>=median(HPR<0) and =0 otherwise	The Economist
$PRR_{i,t}$	Log(price-rent ratio$_t$) - Log(price-rent ratio$_{t-12}$)	The Economist
GDP Growth$_{i,t}$	Log(GDP$_t$) – Log(GDP $_{t-4}$)	IFS
Per Capita Growth$_{i,t}$	Log(GDP Per Capita$_t$) – Log(GDP Per Capita $_{t-4}$)	IFS
Log(initialGDP) $_{i,t}$	Log(GDP $_{t-4}$)	IFS
Log(initialPerCapita) $_{i,t}$	Log(GDP Per Capita $_{t-4}$)	IFS
Investment$_{i,t}$	Log(Gross capital formation$_t$/nominal GDP$_t$) – Log(Gross capital formation$_t$/nominal GDP$_{t-4}$)	IFS
Unemployment$_{i,t}$	Log(Unemployment Rate$_t$) - Log(Unemployment Rate$_{t-4}$)	IFS
Inflation$_{i,t}$	Log(CPI$_t$) - Log(CPI$_{t-4}$)	IFS
GovExp$_{i,t}$	Government expenditure$_t$/nominal GDP$_t$	IFS
TradeOpenness$_{i,t}$	(Export$_t$+Import$_t$)/nominal GDP$_t$	IFS
Credit$_{i,t}$	Domestic credit to private sector$_t$/nominal GDP$_t$	BIS
CommonLaw	=1 if the country adopts common law legal system and =0 otherwise	Porta, et al.(1998)
MI	=1 if the country provides mortgage insurance and =0 otherwise	Author's collection
PBL	=1 if there is a personal bankruptcy law in country i	Author's collection
LTV$_{<0.8}$	=1 if the maximum loan to value ratio in country i at quarter t is less than 80% and 0 otherwise.	Almeida, et al.(2004) and Author's collection
OECD	=1 if the country is a member of OECD at period t	http://www.oecd.org/
Crisis	=1 if there is a banking crisis in country i at quarter t	Laeven and Valencia (2013)

Appendix Table A2. Association of House Price Appreciations with Economic Growth

The table reports the second stage results by regressing output growth on house price return (HPR) and its interaction with large appreciation dummy $D_{HPR<ma}$ (equals to 1 if HPR is greater than the median value of all positive HPR and 0 otherwise, the default), moderate appreciation dummy $D_{0<HPR<ma}$ (equals to 1 if HPR is greater than 0 but less than the median value of all positive HPR), large depreciation dummy $D_{HPR<m}$ (equals to 1 if HPR is less than the median value of all negative HPR and 0 otherwise), and moderate depreciation dummy $D_{m<HPR<0}$ (equals to 1 if HPR is greater than the median value of all negative HPR but less than 0) The control variables other than HPR related terms are the same as in the estimation of Table 3 (not reported). Robust standard errors clustered by quarter are reported in parentheses, with the symbol ***, ** and * denote respectively the statistical significance levels at 1%, 5%, and 10%.

	GDP Growth	Per Capita Growth	TFP Growth
HPR	1.91	2.00	1.54
	(.28)***	(.32)***	(.34)***
$\|HPR\|*D_{m<HPR<0}$	1.42	2.49	4.81
	(2.89)	(2.00)	(2.53)*
$\|HPR\|* D_{HPR<m}$	6.24	5.00	5.30
	(.66)***	(.99)***	(1.03)***
$HPR*D_{0<HPR<ma}$	3.53	6.46	-2.12
	(10.95)	(10.78)	(9.24)
R-squared	.53	.54	.14
Observations (country-quarter)	1,808	1,856	1,856

Table 1. Summary Statistics.

HPR is the three-year cumulative house-price return, calculated as the change in log of real house-price over the past three years. Price/Rent is the annual growth rate of price rent ratio. GDP Growth is the growth rate of real GDP, calculated as the change in log of real GDP. Log(Initial GDP) and Log(Per Capita) are, respectively, the log of the real GDP and log of GDP per Capita. Capital Investment is the ratio of nominal gross capital formation to GDP. Unemployment is the change in log of unemployment rate. Inflation is the change in log of the CPI index. Government Expenditure is the nominal government consumption divided by GDP. Trade Openness is the sum of exports and imports to GDP. Credit is the domestic credit to private sector divided by GDP. Values about economic growth and housing price indicators except for price/rent are reported in percentage.

	Mean	St. Deviation	Min	Median	Max	N
Economic Growth						
GDP Growth	2.30	2.58	-9.77	2.52	13.97	1920
Per Capita Growth	1.64	2.58	-11.18	1.84	12.78	1872
TFP Growth	-0.05	1.83	-9.74	0.02	10.99	1920
House-Price Indicators						
House-Price Return (*HPR*)	0.07	0.18	-0.62	0.06	0.66	1920
House-Price Appreciation (*HPR*>0)	0.17	0.12	0.00	0.15	0.66	1212
House-Price Depreciation (*HPR*<0)	-0.11	0.10	-0.62	-0.08	0.00	708
Price/Rent Ratio (*PRR*)	0.01	0.08	-0.29	0.01	0.39	1860
Control Variables						
InitialGDP	5.48	1.68	2.64	5.25	9.65	1920
InitialPerCapita	-4.58	0.63	-5.54	-4.74	-3.01	1920
Investment	-0.01	0.06	-0.37	0.00	0.20	1920
Unemployment	0.01	0.17	-0.57	-0.02	0.94	1920
Inflation	0.03	0.02	-0.06	0.02	0.17	1920
GovExp	0.19	0.05	0.07	0.19	0.30	1920
TradeOpenness	0.81	0.67	0.16	0.60	4.74	1920
Credit	1.39	0.56	0.32	1.28	3.46	1920

Table 2. House-Price Adjustment and Economic Growth.

This table reports the ordinary least square estimation results based on Eq. (1). The dependent variable is the growth rate of real GDP measured in 2005 USD; calculated as the change in log real GDP, scaled by 100. HPR is the three-year change in log real house-price, scaled by 100. $D_{HPR<0}$ is a dummy variable, equals to one if HPR is negative, and zero otherwise. $D_{HPR<m}$ is a dummy variable identifying episodes of large depreciation in house-price, equals to one if HPR is lower than median of HPR depreciation, and zero otherwise. $D_{m\leq HPR<0}$ is a dummy that equals to one if the HPR is higher or equal to the median of HPR depreciation, and zero otherwise. Log(initial GDP) is the log of real GDP, lagged by one year. Capital Investment is the change in log of nominal gross capital formation to GDP. Unemployment is the change in log of unemployment rate. Inflation is the change in log of CPI index. Government Expenditure is the nominal government consumption divided by the nominal GDP. Trade Openness is the sum of exports and imports to nominal GDP. Credit is the domestic credit to private sector divided by GDP. Accompanying the estimation results, robust standard errors clustered by quarter are reported in parentheses. All regressions control for country and quarter fixed-effects, with symbol ***, ** and * denoting, respectively, statistical significance levels at 1%, 5%, and 10%.

	(1)	(2)	(3)	(4)
HPR	1.70	2.26	2.26	2.63
	(.21)***	(.41)**	(.41)**	(.28)***
$\|HPR\|*D_{HPR<0}$		4.00		
		(.64)***		
$\|HPR\|*D_{HPR<m}$			3.63	4.03
			(.84)**	(.76)**
$\|HPR\|*D_{m<HPR<0}$			6.37	
			(2.76)	
log(initialGDP)	-1.91	-2.04	-2.03	-1.98
	(.09)***	(.09)***	(.09)***	(.10)***
Investment	12.79	12.65	12.61	12.78
	(.92)***	(.94)***	(.95)***	(.91)***
Unemployment	-5.16	-5.12	-5.13	-5.10
	(.28)***	(.27)***	(.26)***	(.28)***
Inflation	-2.36	-2.39	-2.44	-2.31
	(1.99)	(1.95)	(1.92)	(1.93)
GovExp	1.84	3.95	3.78	3.18
	(2.15)	(1.87)	(1.75)	(2.13)
TradeOpenness	-.80	-.66	-.67	-.69
	(.12)***	(.14)**	(.14)**	(.14)**
Credit	-.25	-.32	-.32	-.34
	(.10)*	(.11)*	(.11)*	(.11)*
Constant	13.27	13.62	13.61	13.34
	(.15)***	(.15)***	(.19)***	(.22)***
All Depreciation		1.73		
t-statistics		4.57		
Large Depreciation			1.37	1.40
t-statistics			2.46	2.45
Moderate Depreciation			4.11	
t-statistics			1.74	
R-squared	.53	.54	.54	.54
Observations (country-quarter)	1,920	1,920	1,920	1,920

Table 3. Instrumental-Variables Estimation.

Table 3 reports the Instrumental-Variables (IV) estimation results based on Eq. (1). The instrument variables are PRR, the log change of Price/Rent ratio over the past three years, and its interaction with $D_{m\leq HPR<0}$ and $D_{HPR<m}$, where $D_{m\leq HPR<0}$ equals to one if HPR is higher or equal to the median of HPR depreciation and $D_{HPR<m}$, equals to one if HPR is lower than median of HPR depreciation. Columns (1)-(2) provide the first-stage regressions, while column (3) provides the second-stage estimation results, using 2sls methods. All regressions are controlled for country and quarter fixed-effects. Robust standard errors clustered by quarter are reported in parentheses. The under-identification test reports the Kleibergen-Paap rank LM statistic and its corresponding p-value under the null hypothesis that the instrumental variable is relevant. The weak identification test reports the Kleibergen-Paap rank Wald F-statistic. Note that the Stock-Yogo weak ID tests' critical values at 10% maximum IV size are 7.03. Endogeneity Test reports the F-statistics and p-value under the null hypothesis that instrumented variables are exogenous. The symbol ***, ** and * denote, respectively, the statistical significance levels at 1%, 5%, and 10%.

	First Stage			Second Stage
	HPR	$\|HPR\|* D_{m<HPR<0}$	$\|HPR\|*D_{HPR<m}$	GDP Growth
HPR				2.07
				(.19)***
$\|HPR\|* D_{m<HPR<0}$				-6.44
				(10.75)
$\|HPR\|*D_{HPR<m}$				5.06
				(1.10)***
PRR	.73	.00	.00	
	(.01)***	(.00)**	(.00)***	
PRR $*D_{m<HPR<0}$	-.51	.00	.21	
	(.07)***	(.03)	(.04)**	
$PRR*D_{HPR<m}$	-.17	.53	.01	
	(.03)***	(.02)***	(.00)***	
log(initialGDP)	-.00	-.01	.00	-2.02
	(.00)	(.00)***	(.00)*	(.09)***
Investment	.06	.07	-.01	13.46
	(.01)***	(.01)***	(.01)	(.75)***
Unemployment	.01	.02	.00	-5.02
	(.01)	(.00)**	(.00)	(.27)***
Inflation	.85	.32	.02	-1.20
	(.03)***	(.02)***	(.00)**	(1.76)
GovExp	-.39	-.03	-.02	3.43
	(.05)***	(.03)	(.02)	(1.97)*
TradeOpenness	.06	.04	.00	-.59
	(.00)***	(.00)***	(.00)	(.10)***
Credit	-.01	-.01	-.00	-.36
	(.00)***	(.00)***	(.00)*	(.07)***
Constant	.10	.04	-.01	13.56
	(.02)***	(.00)***	(.00)*	(.17)***
Large Depreciation / t-statistics				2.99 / 2.66
Under Identification Test / p-value				3.72 / .05
Weak Identification Test				7.50
Endogeneity Test / p-value				79.26 / .00
R squared	.91	.90	.78	.54
Observations (country-quarter)	1,856	1,856	1,856	1,856

Table 4. Cross-sectional differences in large house-price adjustment.

The table reports the two-stage least-square estimation results by including the interaction between large price depreciations with country characteristics. The *CommonLaw* is a dummy that equals to 1 if the country belongs to the common law system. MI is a dummy that takes the value of 1 if the government provides mortgage insurance at period t. $LTV_{<0.8}$ is a dummy that equals to 1 if the maximum loan to value ratio is less than 80%. *PBL* is a dummy that equals to 1 if there is Personal Bankruptcy Law in that country at period t. *OECD* is a dummy that equals to 1 if the country is a member of OECD. *Crisis* is a dummy that equals to 1 if there is a banking crisis in the country at period t. All regressions are controlled for country and quarter fixed-effects. The control variables are the same as in the estimation of Table 3 (not reported). Robust standard errors clustered by quarter are reported in parentheses, with the symbol ***, ** and * denote respectively the statistical significance levels at 1%, 5%, and 10%.

	(1)	(2)	(3)	(4)	(5)	(6)
HPR	1.96	2.06	2.06	2.03	2.04	2.12
	(.20)***	(.19)***	(.19)***	(.19)***	(.20)***	(.19)***
$\|HPR\|* D_{m<HPR<0}$	-4.76	-6.2	-6.5	-6.03	-6.37	-6.55
	(11.40)	(10.80)	(10.55)	(11.21)	(10.81)	(10.84)
$\|HPR\|*D_{HPR<m}$	7.98	5.33	5.15	7.03	3.93	5.92
	(1.52)***	(1.15)***	(.92)***	(1.17)***	(1.00)***	(1.30)***
$\|HPR\|*D_{HPR<m}$ *CommonLaw*	-5.71					
	(1.22)***					
*MI		-1.78				
		(.58)***				
*PBL			-4.77			
			(.51)***			
$*LTV_{<0.8}$				-0.14		
				(0.46)		
*OECD					1.19	
					(0.73)	
* *Crisis*						-3.07
						(.58)***
Large Depreciation	6.01	3.28	3.08	5	1.89	3.80
t-statistics	3.78	2.77	3.17	4.11	2.04	2.93
R-squared	0.54	0.54	0.54	0.54	0.54	0.54
Observations	1,856	1,856	1,856	1,856	1,856	1,856

Table 5. Alternative Measures of Economic Growth.

We use GDP Per Capita Growth (measured as the change in log of GDP per capita) and Total Factor Productivity growth (measured by the residual in the country-specific regression of real GDP growth rate on capital investment and labor). Columns (1) and (3) provide the estimation results based on OLS. Columns (2) and (4) provide the results based on two-stage least square. All regressions are controlled for country and quarter fixed-effects. The under-identification test reports the Kleibergen-Paap rank LM statistic and its corresponding p-value under the null hypothesis that the instrumental variable is relevant. The weak-identification test reports the Kleibergen-Paap rank Wald F-statistic. The Stock-Yogo weak-ID test critical values at 10% maximum IV size are 7.03. Robust standard errors clustered by quarter are reported in parentheses, with the symbol ***, ** and * denote respectively the statistical significance levels at 1%, 5%. and 10%.

	Per Capita Growth		TFP Growth	
	OLS	2SLS	OLS	2SLS
HPR	2.27	2.09	1.83	1.55
	(.47)**	(.22)***	(.30)***	(.20)***
$\|HPR\|* D_{m<HPR<0}$	4.04	-3.37	2.78	2.09
	(.47)***	(10.94)	(.82)**	(9.15)
$\|HPR\|*D_{HPR<m}$	6.26	6.42	7.29	5.31
	(3.06)	(.71)***	(3.14)	(1.10)***
Large Depreciation	1.77	4.33	.95	3.76
t-statistics	8.77	5.66	1.39	2.97
Under-Identification Test		3.79		3.71
p-value		.05		.05
Weak-Identification Test		7.87		7.31
R-squared	.52	.53	.14	.13
Observations	1,872	1,808	1,920	1,856

Table 6. Additional Control Variables

The table reports the second stage results by including the lagged variables of housing price return (HPR) and real GDP growth. The dependent variable is real GDP growth. All regressions are controlled for country and quarter fixed-effects. The control variables are the same as in the estimation of Table 3 (not reported). Robust standard errors clustered by quarter are reported in parentheses, with the symbol ***, ** and * denote respectively the statistical significance levels at 1%, 5%, and 10%.

	(1)	(2)	(3)	(4)	(5)	(6)
HPR	3.33	4.89	2.16	1.52	3.40	4.76
	(.43)***	(2.33)**	(.20)***	(.24)***	(.45)***	(1.72)***
$\|HPR\|* D_{m<HPR<0}$	- 6.37	- 6.06	- 6.19	- 11.33	- 6.13	- 10.90
	(11.36)	(10.53)	(9.84)	(13.66)	(10.40)	(13.54)
$\|HPR\|*D_{HPR<m}$	4.89	4.92	4.68	2.27	4.50	2.10
	(1.06)***	(1.04)***	(1.04)***	(.85)***	(.99)***	(.79)***
L4.HPR	-1.51				-1.49	
	(.42)***				(.43)***	
L.HPR		-2.90				-3.33
		(2.30)				(1.90)*
L4.GDP Growth			-.09		-.10	
			(.01)***		(.01)***	
L.GDP Growth				.60		.60
				(.05)***		(.05)***
R-squared	.54	.54	.55	.71	.55	.72
Observations	1,844	1,853	1,856	1,856	1,844	1,853

Table 7. Plausibly Exogenous IV.

The table reports the second stage estimation results under flexible (plausibly exogenous) conditions based on Conley et al (2012)'s union of confidence intervals approach. All regressions are controlled for country and quarter fixed-effects. The control variables are the same as in the estimation of Table 3 (not reported). Robust standard errors clustered by quarter are reported in parentheses, with the symbol ***, ** and * denote respectively the statistical significance levels at 1%, 5%, and 10%.

	GDP Growth	Per Capita Growth	TFP Growth
HPR	3.52	2.90	2.22
	(.34)***	(.34)***	(.28)***
$\|HPR\|* D_{m<HPR<0}$	-9.84	-6.47	0.21
	(4.78)***	(4.70)***	(2.47)
$\|HPR\|*D_{HPR<m}$	5.64	6.23	4.00
	(.85)***	(.91)***	(.48)***

Table 8: Average Contribution of Housing Cycles to Economic Growth. This table reports the average annual contribution of housing price return (HPR) to the growth in GDP, GDP per capita and total factor productivity (TFP) country by country. For each country in each quarter, the contribution of HPR to the growth is calculated by multiplying HPR with the difference of the estimated coefficient of HPR and its two interaction terms based on two-stage least square as reported in Table 3 and 5. All numbers are reported in percentages.

		Contribution of Housing Cycles to Growth in		
	HPR	GDP	GDP per capita	TFP
Australia	8.35	0.11	0.14	0.15
Austria	3.64	0.04	0.07	0.09
Belgium	6.88	0.30	0.35	0.29
Britain	5.81	0.29	0.38	0.35
Canada	6.35	0.13	0.18	0.19
Denmark	3.75	0.40	0.50	0.42
France	6.48	0.10	0.17	0.20
Germany	-0.69	-0.13	-0.05	0.08
Hong Kong	9.93	0.67	0.81	0.67
Ireland	7.87	0.41	0.50	0.43
Italy	2.93	0.27	0.38	0.36
Japan	-0.47	-0.05	0.07	0.18
Netherlands	4.98	0.38	0.47	0.40
New Zealand	6.63	0.22	0.29	0.27
South Africa	2.67	0.35	0.48	0.44
Spain	7.78	0.38	0.48	0.42
Sweden	4.15	0.35	0.43	0.37
Switzerland	2.72	0.20	0.25	0.22
United States	0.64	0.18	0.30	0.32
Total	5.47	0.26	0.35	0.32

Figure 1. Summary of Associations with Growth. The graph plots the association of 1% increase in house price appreciation, moderate house price depreciation, and large house price depreciation with GDP growth, GDP per capita growth, and total factor productivity (TFP) growth in basis points.

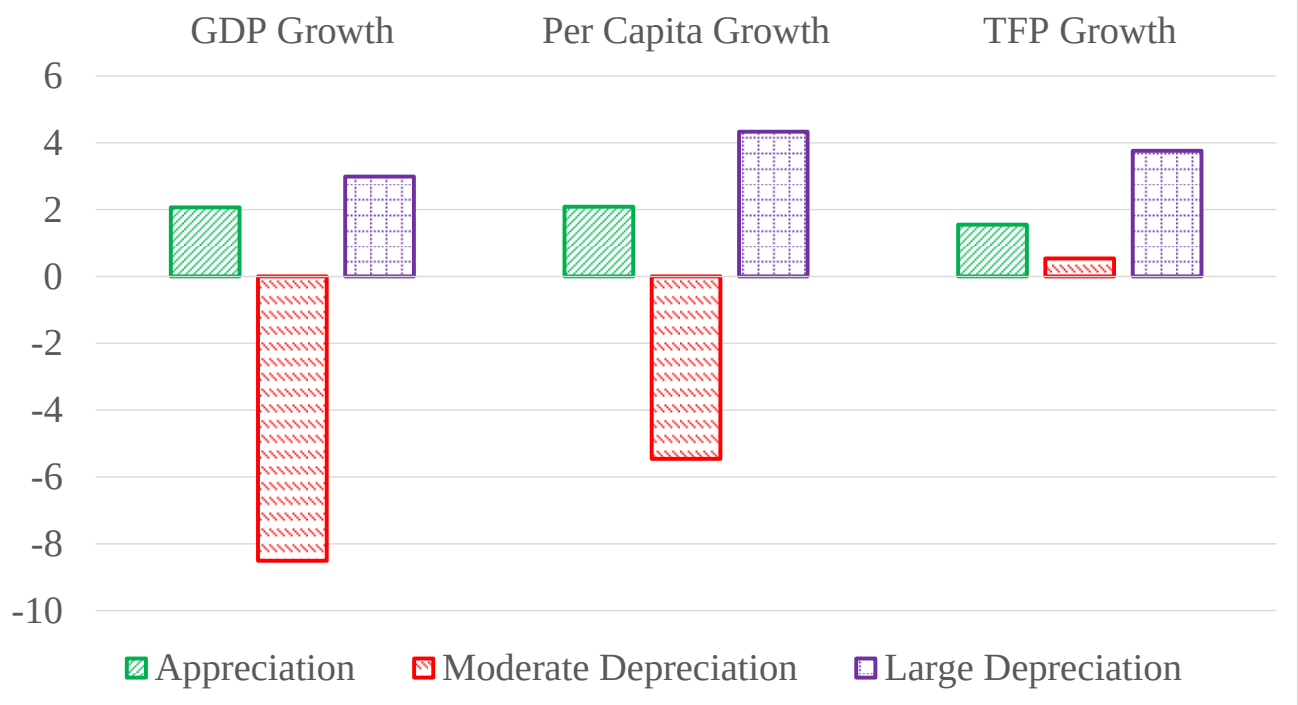

Figure 2. Contribution of housing price variation to GDP Growth (%).