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Abstract:
This paper analyzes the costs of housing crises in terms of GDP growth and the economic conditions under which crises are particularly costly. Housing crises are often followed by recessions that are longer than other recessions. According to empirical estimates, a housing crisis reduces the GDP growth rate in the following year on average by two percentage points and has still a considerable negative impact in the second year. One important channel through which the effect of housing crises is passed on seems to be the banking sector. In addition, our results suggest that negative wealth effects possibly cause further reductions in GDP.

Keywords: Housing crisis, Panel Data

JEL classification: E21, E32, C23

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1 Introduction

The severe recessions of 2008/2009 in almost all industrialized countries renewed interest in the analysis of economic crises. Since these recessions were mainly perceived to be triggered by a financial crisis, the literature initiated by the work of Reinhart and Rogoff (2008) usually focuses on the consequences of financial crises.[1] However, the recession in the United States was preceded by a boom and bust cycle in the housing market. Other countries, such as the United Kingdom or Spain, also experienced a boom and bust cycle in their housing markets. Therefore, it is necessary to build not only on the experience of historical financial crises but also on the experience of historical housing crises to gain further insights into the behavior of an economy during and after the time of severe economic decline. Claessens et al. (2008) and Jannsen (2010) analyze the consequences of housing crises on the economy and document that housing crises usually lead to long-lasting and deep recessions (see also IMF 2003). However, these studies conduct non-parametric analysis and do not deal with the links between the housing market and overall economic activity, through which a housing crisis leads to recessions, or with what economic conditions cause a housing crises to have higher costs.

Several links between the housing market and general economic activity exist. Wealth effect's that describe a positive relationship between the wealth of private households and their consumption activity constitute a first possible. Since housing wealth usually accounts for the bulk of the overall wealth of private households, fluctuations in house prices should influence private consumption. Case et al. (2005) find for the United States and a set of industrialized countries that housing wealth, of all the classes of household wealth, is the most important determinant of private consumption. Using micro data, the studies of Bostic et al. (2009) and of Gan (2010) also find a close link between housing wealth and consumption in the United States and Hong Kong. Accordingly, the negative impact of a housing crisis which is usually defined as an exceptional strong decline of house prices might relate to a negative wealth effect. However, the link between consumption and housing is not confirmed by all studies. The relation between housing wealth and private consumption seems to be less pronounced especially in most European countries (see, e.g., European Commission 2008).[2]

A second possible link between the housing market and economic activity discussed in the lit-

[1] Overall, these papers conclude that financial crises lead to particularly long-lasting and deep recessions (Reinhart and Rogoff 2009a and 2009b, IMF 2009a, Cecchetti et al. 2009) and to permanent output losses (Cerra and Saxena 2008, IMF 2009b, Furceri and Mourougane 2009).

[2] While the empirical evidence for a general link between housing wealth and consumption is mixed, Buiter (2010) generally denies the existence of housing wealth effects, based on theoretical arguments, since home buyers are negatively affected by increases in house prices.

erature is a direct link via the construction sector. In general, according to Tobin's q, residential investment should decrease when the worth of the housing stock decreases relative to its construction costs. Therefore, housing crises should be accompanied by a considerable decrease in residential investment as construction costs presumably do not decline as strong as house prices. Leamer (2007) stresses the close relation between residential investment and overall economic activity for the United States, where residential investment typically leads the business cycle. Further, he observes that sales of new homes are much more volatile than real house prices and he argues that the housing sector follows a volume cycle rather than a price cycle.[3] When house prices start to fall, large volume adjustments might be necessary to stop prices from falling further. Therefore, during housing crises, economic activity should be damped considerably by depressed construction activity. Ghent and Owyang (2010) challenge the link between residential investment and the business cycle by investigating regional data for the United States spanning from 1984 to 2008. On a regional basis, they find no close link between housing permits – as a measure of construction activity – and GDP, but on a nationwide level they do find such a link. The authors conclude that other links between housing and economic activity should exist and argue that their findings might point to the importance of wealth effects. Girouard and Böndal (2001) analyze the importance of both of the described links between housing and economic activity for a panel of OECD countries. They find strong evidence for the importance of wealth effects and somewhat weaker evidence for the importance of construction activity. Note that the two described links between the housing market and economic activity so far have been investigated only in general, but not during housing crises.

Additionally, there is at least one further possible link that might be of *particular* importance during housing crises, namely a link via the banking sector. Activity in the housing market, i.e., construction or purchases of houses, usually goes hand in hand with a high degree of leverage financed by the banking sector. Since houses usually serve as collateral for this leverage, a sharp decrease in house prices occurring during house crises deteriorates collateral considerably, which could mark the beginning of a banking crisis, as noted by Kaminsky and Reinhart (1999). Related to this, Reinhart and Rogoff (2008) show that exceptional severe banking crises have been accompanied by a boom-and-bust cycle in the housing market (see also Leaven and Valencia 2008). Banking crises have been proved to have severe consequences for overall economic activity. Therefore, it seems reasonable that housing crises that spread over to the banking sector are more severe than housing crises that do not.

In order to investigate the circumstances making housing crises particularly costly, we assess in

[3]Even though large price adjustments in houses during housing crises are observed, there is a priori no reason that this relationship should not hold during such crises.

our model cross terms between the housing crisis indicator and proxies capturing the relevance of the three described links between the housing market and economic activity. To estimate the relevance of the link via the construction sector, we consider a cross term of the housing crisis indicator and the change of residential investment relative to GDP in the year of the peak at the housing market.[4] If the boom-bust of housing investment would be the main driver we argue that a high acceleration during the boom should be an indicator for the resulting costs of the bust. Thus, one underlying assumption is that housing crises are particularly costly when an oversized construction sector needs rescaling. To assess the relevance of the wealth effect, we use a cross term of the housing crisis indicator and the share of homeowners. Thereby, we assume that the more people in a country own housing wealth, the more house price declines dampen private consumption. In contrast, in countries where housing wealth is more concentrated to relatively few people or houses are more often owned by firms or communities, the wealth effect should be less important during housing crises. An implicit assumption behind this is that the housing wealth elasticity of private consumption diminishes with increasing wealth. Therefore, a higher homeownership rate might translate into a stronger aggregate wealth effect. For a robustness check of the importance of the wealth effect, we also use the change of private consumption relative to GDP in the cross term, which is more symmetric to our proxy for measuring the relevance of the construction sector. We test for the relevance of the link via the banking sector by using an indicator taking value one when a housing crisis was accompanied by a banking crisis and zero otherwise. Thereby, we are able to test directly whether stress at the banking sector worsens the effect of a housing crisis.[5]

To measure the costs of housing crises, we deviate from the existing literature in using a parametric framework rather than a nonparametric framework. We apply a *differences-in-differences* specification incorporating structures for latent heterogeneity and serial correlation. The robustness of results is checked against potential endogeneity of crises via an extended panel treatment model with random coefficients. Also alternative crisis definitions are assessed yielding similar results. By including control variables into our model that capture influences on GDP growth other than the crises, we are able to provide parameter estimates capturing the direct impact of defined crisis events on economic growth. Since growth persistence in terms of positive first-order autocorrelation

[4]Besides the specification with the year-to-year change in the year of the peak we also consider specifications that monitor the change of housing for three years before the peak. Further, we also considered levels as well as Hodrick-Prescott filtered gaps. All specifications reveal similar results.

[5]Measuring the costs of housing crises in terms of loss in GDP growth is a common approach in the literature (see, e.g., Claessens et al. 2008), but not the only one. Other approaches include adding up the difference between the hypothetical potential output path and observed GDP as long as observed GDP is below the hypothetical potential output (Boyd et al. 2005).

is identified, the parameter estimates do not reflect costs in terms of cumulated output losses to the full extent.[6]

We find that the costs of housing crises on average amount to roughly 2 percent of GDP in the first year after crisis occurrence and an additional 1.5 percent in the second year after the crisis. A housing crisis that is accompanied by a banking crisis leads to a loss of GDP that is 1.4 percent higher in the first year after crisis and for which an extensive prolongation of reduced growth can be observed even in the second year after crisis. We find limited evidence for the importance of wealth effects. While countries with a higher homeownership rate suffer, on average, a higher loss of GDP during a housing crisis, specifications that control for the effect of the homeownership rate do not explain the variation in observed growth significantly better than models that include only the crisis dummies. Our results are robust against alternative crisis definitions and no evidence for selection bias is found. However, the only weak evidence in favor of housing wealth effects does not deny their importance. As Aron et al. (2006) and Aron et al. (2010) argue, financial institutions play an important role for wealth effects. Such institutions have been developed mainly in recent years, see IMF (2008). The sample data used for the empirical analysis mainly covers housing crises from periods where less developed financial institutions prevailed. Thus, during the current housing crises in the US or the UK, wealth effects may have played an important role. Finally, we find no evidence for a special role of the construction sector.

The paper proceeds as follows. Section 2 describes the data set applied in this analysis as well as the methodology used to define a housing crisis. Section 3 reassesses the relationship between housing crises and recessions. Section 4 presents the panel model and our results, while robustness checks are presented in Section 5. Section 6 summarizes our results and concludes.

2 Data Description

Our data set includes data for 15 industrial countries.[7] In addition to real house prices taken from a database of the Bank of International Settlements, house prices for France (Existing Houses & Apartments, I.N.S.E.E.), the United States (House Price Index - All Transactions, Office of Federal

[6]An assessment of overall cumulated output losses could be based on a simulation study involving assumptions concerning dynamic interactions between all of the (presumably weak) exogenous regressors. See Aßmann (2008) for an application in the context of current account reversals and currency crises.

[7]These are: Australia, Belgium, Canada, Denmark, Finland, France, Great Britain, Ireland, Japan, The Netherlands, Norway, Spain, Sweden, Switzerland, and The United States. For Germany house prices are not available on a quarterly basis. Thus, Germany is only considered when using a annual timing methodology for housing crisis as a robustness check.

Housing Enterprise), as well as land prices for Japan (Nationwide Land Price Index, Japan Real Estate Institute) deflated by consumer prices, were taken from the national statistical agencies. Data for GDP, residential investment, private consumption, short- and long-run interest rates, and the inflation rate based on consumer prices from 1970 to 2007 were taken, when available, from the OECD Economic Outlook Database. Residential investment for Spain and Switzerland was taken from Quarterly National Accounts from the OECD. The homeownership rates were collected from several national and international sources: mainly from the United Nations Economic Commission for Europe, the European Mortgage Federation, and national statistical offices.[8]

Following Ahearne et al. (2005) and IMF (2003), we identify housing crises as turning points in real house prices followed by large price declines, i.e., a housing crisis is defined as a peak in house prices within a rolling window of eight years, followed by a price decline of at least 7.5 percent *(baseline definition)*.[9] Using quarterly data for real house prices between 1970 and 2004, we can identify 23 housing crises in our data set.[10] The starting year of a housing crisis is defined as the year that includes the quarter of the price peak. Besides for France and for Belgium, we identify for each country in our sample at least one housing crisis (Table 1). Most of the housing crises cluster within certain time periods, namely between 1973 and 1976, between 1979 and 1981, and between 1989 and 1991. When considering further explaining variables, which are not all available for all countries and the whole time span under consideration in the regression analysis, only 18 of the identified housing crises can be used for inference on the (unbalanced) panel model. The starting year of a housing crisis is defined as the year that includes the quarter of the price peak. Nevertheless, since our identification method is rather ad hoc, we provide robustness checks of our results using the identification method from Ahearne et al. (2005) *(loose definition)* which yield similar findings.[11]

[8]The homeownership rate was not available for several countries for each single year between 1970 and 2004. In these cases, the time series were interpolated, which is a straightforward approach, given that the homeownership rate usually changes very smoothly over time.

[9]In doing so, we deviate slightly from the approach used in Ahearne et al. (2005), which identifies the beginning of housing crises as price peaks within a rolling window of six years. However, since we are more interested in housing crises than in cyclical house price movements, we impose a restriction on the minimum size of the following price decline.

[10]While in general, it is not obvious whether the identification of housing crises on a quarterly or an annual basis is more appropriate, for our baseline results we use the identification on a quarterly basis, because it allows a more timely identification of the crises and we use the quarterly for the empirical investigation in section 3. For a robustness check we also use a corresponding identification method based on annual data, see Appendix for the results. Due to the identification with annual data Germany can be included into the analysis. The main results stay the same.

[11]A tight crisis definition as applied by IMF (2003) reduces the number of housing crises such that a econometric analysis, especially regarding the cross terms, is rarely meaningful anymore. However, concerning the crisis dummies results are in line with the other crisis definitions.

Banking crises are usually identified as historical episodes with bank runs or closures of relevant financial institutions. We rely on the chronology of banking crises published in Reinhard and Rogoff (2009a), and thus have 15 banking crises in our sample. We define a housing crisis as being accompanied by a banking crisis if the banking crisis starts at least two years before the housing crisis and at most two years after the housing crisis. According to this definition, 8 out of 23 housing crisis were accompanied by a banking crisis. While it is not straightforward and beyond the scope of this paper to reveal the causality between these housing crises and banking crises, it turns out that none of these 8 housing crises started after the respective banking crises. Specifically, two housing crises started in the same year as the banking crisis, 3 housing crises started one year before the banking crisis, and three housing crises started two years before the banking crisis. Therefore, for most of the housing crises accompanied by a banking crisis, house prices already started to fall before the banking crisis began. This is at least descriptive evidence that it is not likely that the housing crises in our sample are systematically triggered by banking crises.

3 Housing crises and recessions

There is broad evidence in the literature that a housing crisis usually goes hand in hand with a slowdown of economic activity (see, e.g., IMF 2003). In particular, Leamer (2007) points at the close link between housing crises and the business cycle in the US, and Jannsen (2010) shows the impact of housing crises on the business cycle on an international level. We broaden this evidence by analyzing the link between housing crises and recessions. In 15 out of the 23 cases a recession started within one year after the start of the housing crises.[12] Recessions are defined according to the Bry-Boschan algorithm for quarterly GDP data. The Bry-Boschan algorithm identifies peaks and troughs via analyzing several moving averages of the log level series. The algorithm identifies a peak (trough) when the moving averages of the following period are lower (higher) and the corresponding business cycle phases comply with some conditions concerning the minimum duration of business cycles.[13] Overall, the data set contains 45 recessions. To check whether this seemingly connection is not just a random phenomenon, we perform a simulation exercise to derive a distribution for the number of recessions that are connected to housing crises. In the simulation, we assume that the occurrence of the 23 housing crises is random and not correlated to the recessions. We generate 10,000 random draws. In each draw, 23 housing crises are distributed on a sample of the same size as the original one. The drawn set of housing crises thereby has to fulfill some conditions to be accepted as a draw for the distribution: a minimum distance between two crises is assumed for

[12] The dates of housing crises and recessions respectively are given in Table (1).

[13] For further details, see Bry and Boschan (1971), and for the quarterly version, Watson (1994).

example. Otherwise, an unrealistic case can occur in which housing crises start in consecutive years, which is not observed in the data.[14] The random draws of the housing crises are then connected with the observed recessions and the number of joint housing crises and recessions is calculated as for the original sample. In the 10,000 random draws, the event that 15 housing crises or more are followed by a recession virtually never occurred, which thus provides evidence for a clear relation between housing crises and recessions.

We further assess this relation by comparing the properties of a recession following a housing crises and those without a housing crisis, see Table (2). We do not find differences between both types of recessions according to the mean growth rate of GDP during a recession. The mean growth rate is slightly higher in recessions with a housing crisis but the differences are not significant according to the common levels. However, we do find evidence that recessions with housing crises last longer, namely 5.5 quarters on average, compared to 4 quarters in a recession without housing crisis, see Table (2). We conclude that recessions are often preceded by housing crises and that recessions preceded by housing crises lead to longer lasting output reductions than other recessions.

In the following section we discuss a parametric approach to grasp the costs of housing crises and to ask which circumstances might be particularly adverse.

4 Costs of housing crises

To assess the costs of a housing crisis in terms of output growth, we set up a *differences-in-differences* specification (see Bertrand et al. 2007). The model for GDP growth takes the form

$$y_{i,t} = \alpha_0^{(i)} + \alpha_1^{(i)} y_{i,t-1} + \beta^{(i)} X_{i,t-1} + \sum_{j=1}^{2} \gamma_j I_{i,t-j} + \sum_{j=1}^{2} \delta_j I_{i,t-j} \times Z_{i,t-j} + u_{i,t}, \qquad (1)$$

where $y_{i,t}$ represents the GDP growth of country i in year t. The variable $I_{i,t-j}$ indicates whether a housing crisis started in the year before or two years before. In a second term, the crisis indicator is multiplied by the variable $Z_{i,t-j}$ to assess what economic conditions increase the costs of housing crises. To assess such conditions, we use a proxy measure of the impact of housing prices on consumption, namely the homeownership rate, a measure for the impact on construction, namely the change of the share of housing investment in real GDP, *and a measure for the impact of stress in the banking sector, namely a banking crisis dummy variable.* Furthermore, lagged GDP growth and additional standard control variables, namely short and long term interest rates and inflation rates, represented by $X_{i,t-1}$, are included to capture other influences on GDP growth. We specify

[14] Note that due to these restrictions (dependency structure) a typical χ^2-test is not applicable.

the error term $u_{i,t}$ as an moving average process of order one,

$$u_{i,t} = \rho e_{i,t-1} + e_{i,t} \quad \text{with} \quad e_{i,t} \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma^2) \tag{2}$$

allowing for serial dependence within the unobserved component. To take possible heteroscedasticity in the panel into account, a random coefficient approach is specified. Analysis reveals that the consideration of a random coefficient for the persistence term α_1 and the coefficient for the long term interest rates is sufficient to control for heteroscedasticity in the panel. Thus, we assume that $\alpha_1^{(i)}$ is a random variable following a normal distribution with parameters μ_{α_1} and σ_{α_1}, and for one of the β, we assume that it follows a normal distribution with parameters μ_{β_3} and σ_{β_3}, while all other parameters are constant in i. Estimation of this basic *differences-in-differences* specification is done via the maximum likelihood method (Beck and Katz 2007).

The estimated effects of specified crisis events using the *differences-in-differences* specification are given in Table (3). Robustness checks concerning possible endogeneity and definition and timing methodology of the crises are provided in Section 5. We estimate the (unbalanced) panel model in Equation (1) in several specifications with respect to the crisis dummies and cross terms, thus conditioning on a given set of control variables. Note, that all models with contemporaneous impacts of housing crises and cross terms were not preferred according to likelihood ratio tests and are thus not reported. Specification I takes into account the crisis indicators only and no cross terms. A housing crisis has a significant impact on growth in both years after its occurrence. In the first year, the growth rate is dampened by 2.0 percentage points and in the second year by an additional negative impact of 1.5 percentage points. Specifications II through V all control for a single additional cross term. In specification II, the cross term of the change in the share of housing investment and the crisis indicator is added, but no significant impact is revealed. Thus, we find no evidence that a boom-bust cycle in the construction sector is the main driver of costs induced by housing crises. In specification III, the homeownership rate cross term is included and turns out to be highly significant. However, it does not improve the model fit according to Akaike's information criteria (AIC).[15] The cross term including the change in the share of consumption (specification IV) does not provide any improvement of the model fit. In specification V, we include an additional dummy that identifies housing crises accompanied by banking crises. Again the overall fit is not improved by this specification, compared to specification I. However, the additional inclusion of a two period lagged banking crisis cross term in specification VI provides a significantly better model fit compared to specification V. According to this specification, a housing crisis depresses growth by 1.5 percentage points in the first year after its occurrence and has an additional impact of -0.8

[15] t-values might be misleading, as the joint inclusion of cross terms and dummies induces the problem of multi-collinearity.

percentage points in the second year after. If a banking crisis accompanies the housing crisis, the first year effect amounts to -2.9 percentage points and the recession is substantially prolonged with an additional dampening effect of -2.6 percentage points. The best of all considered specifications is specification VII, where compared to specification VI, the first year dummy for the housing crisis is replaced by the cross term with the homeownership rate. The impact of the homeownership rate is lower when controlling for banking crises than in specification III, which might indicate that the homeownership rate is not a pure proxy for wealth effects. Collateral effects may interact. Our model specifications provide evidence that certain economic conditions potentially worsen the effect of a housing crisis on economic growth.

Overall, given that banking crises induce a substantial additional reduction of GDP growth and the disability of all other cross terms to provide additional explanatory power, we conclude that the banking sector is a channel that is important in transmitting the housing crisis to overall economic activity. Non-performing loans and loss in value of collaterals as a consequence of falling house prices seem to loop back to the economy with the banks' balance sheets. A connection between housing wealth and output via consumption seems comparably less important. However, this study mainly captures housing crises in the 1970s and 1980s. Financial tools that enable house owners to transmit wealth increases into additional consumption were less developed than they are today.[16] No special impact of the size of the construction sector could be found.

5 Robustness checks

Empirical results given in Table (3) are conditional on the crisis definition, i.e., dating with quarterly data and assuming a minimum price decline of 7.5 percent *(baseline crisis definition)*. Three kinds of robustness checks are considered. Results on the robustness checks are presented, see Tables (4), (5) and (6). The first robustness check considers a dating of housing crisis based on annual price data, which allows also to include Germany, see Table (4). As a next robustness check, we apply the definition of Ahearne et al. (2005) *(loose crisis definition)* thereby varying the minimum price decline needed to identify a housing crisis. This leads to 26 identified housing crises. Results for both quarterly and annual timing methodology are given in Table (5) and Table (6) respectively. The main results are merely unchanged when applying the loose crisis definition or the dating based on annual data. The effect of banking crises are even a bit more pronounced in the latter case.

Finally, all specifications including those considered as robustness checks are checked against the

[16] Aron et al. (2006) and Aron et al. (2010) point at the importance of the development status of the credit channel for the link between housing prices and consumption.

possible endogeneity or selection bias. Factors causing the occurrence of a housing crisis may be correlated with unobserved factors influencing growth. This correlation leads when ignored to biased parameter estimates. Although we find no contemporaneous effect of the crisis, endogeneity of the crisis indicators may be problematic due to autocorrelated errors. Thus, the model in equation (1) is enhanced with a second equation,

$$\delta^*_{i,t} = \xi^{(i)} Q_{i,t} + \epsilon_{i,t}, \tag{3}$$

where $\xi^{(i)}$ comprise individual specific random coefficients. In addition to lagged growth, short interest rates, long interest rates, inflation and the consumption ratio are included in $Q_{i,t}$. The analysis suggests that this variable is connected to a random coefficient. $\epsilon_{i,t}$ denotes an autoregressive process of order one, i.e., $\epsilon_{i,t} = \varphi\epsilon_{i,t-1} + v_{i,t}$. Further, v_{it} and e_{it} (error in Equation 1) are modeled as bivariate normal with contemporaneous correlation ψ. This serial correlation structure in the errors implies a possible dependence of growth on all past shocks in the crisis equation, while the process for crises depends on past growth via the inclusion of lagged growth rates. Thus, even when no contemporaneous crisis dummy is included, a treatment model might be needed. For a more detailed description of the implied correlation structure and estimation thereof, see Aßmann (2008). Our model is closely related to treatment framework established in the seminal work of Heckman (1979). Estimation is performed using the maximum likelihood method, where the corresponding likelihood function involves high dimensional integrals. Hence, a simulation-based estimator is used based on the GHK importance sampling proposed by Geweke (1989), Hajivassiliou (1990), and Keane (1992). To ensure numerical precision of the likelihood evaluations, a set of common random numbers with a size of 500 has been found sufficient. Overall, likelihood ratio test statistics given in the last column of Tables (3) and (4)-(6) suggest that no selection mechanism or endogeneity of crisis is present in the data set and different crisis definitions.

6 Conclusion

This paper provides evidence for a close link between housing crises and severe contractions of overall production at the level of industrialized countries. Housing crises are often followed by recessions that are longer than other recessions. Using a panel study, we assessed the costs of housing crises. They diminish GDP growth in the following year by about 2 percentage points on average and have an additional detrimental effect of roughly 1.5 percentage points in the second year after the outbreak of the housing crisis. We could not observe any significant contemporaneous effects of housing crises.

The economic conditions that may lead to particular costly housing crises are analyzed via several cross terms. We find no evidence that a high increase in the share of housing investment prior to a crisis has a particular impact. Thus, we conclude that a housing crises does not simply indicate a boom-bust cycle in the construction sector. A detrimental wealth effect does not seem to be the driver of costs, since we find no evidence for a boom-bust in consumption either. However, there is some evidence that a higher rate of homeownership increases costs. This may indicate an asymmetric behavior. While homeowners might feel a loss in wealth due to decreasing house prices, potential home buyers do not translate decreased prices into a positive wealth effect in times of economic stress or even recessions. Due to multicollinearity, this result should be interpreted with care. Finally, we analyzed the growth effect of housing crises that are connected to banking crises. A joint occurrence of a banking and housing crisis increases costs. While the difference between housing crises with and without banking crises is rather moderate in the first year, banking crises play a major role in the second year after the house price peak. We conclude that the effect of housing crises on the banking sector seems to be an important channel on output.

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Tables

Table 1: Timing of Housing crises and Recessions

	Housing crises	Recessions
JP	1973, 1991	1973, 1993, 1997, 2001
FR		1974, 1992
US	1979	1973, 1980, 1981, 1990
UK	1973, 1980, 1989	1973, 1974, 1979, 1990
CN	1976, 1981, 1989	1981, 1990
ES	1991	1978, 1980, 1992
AU	1974, 1981, 1989	1974, 1981, 1990
NL	1978	1974, 1979, 2003
BG		1974, 1980, 1992
SD	1979, 1990	1970, 1976, 1980, 1990
SW	1973, 1989	1974, 1981, 1990, 1991, 2002
DK	1979, 1986	1973, 1979, 1986, 1992, 2003
NW	1987	1988
FN	1989	1975, 1990
IR	1979	1982, 1985

Notes: The figures denoted the year a housing crisis or a recession started in according to the timing methods described in the text.

Table 2: Mean growth rates and duration in recessions

	with housing crisis	without housing crisis	t-value of difference	p-value
mean quarterly growth rate	-0.689	-0.631	-1.569	0.124
duration in quarters	5.467	4.000	5.159	0.000

Table 3: Costs of housing crises: Baseline crisis definition and quarterly timing methodology

		I	*II*	*III*	*IV*	*V*	*VI*	*VII*
α_0	constant	2.5743	2.5362	2.5513	2.5726	2.4930	2.4239	2.4245
		5.6217	5.5942	5.7721	5.6131	5.5387	5.3942	6.2077
μ_{α_1}	Δ GDP(t-1)	0.1699	0.1745	0.1686	0.1692	0.1849	0.1914	0.1866
		1.7829	1.7835	1.7887	1.8770	1.7543	1.8319	2.0296
σ_{α_1}		0.1390	0.1387	0.1391	0.1401	0.1366	0.1333	0.1365
		3.3824	3.3168	3.2335	3.3250	3.1622	2.4915	2.8739
β_1	short interests (t-1)	-0.2970	-0.3028	-0.2976	-0.2939	-0.2888	-0.2872	-0.2899
		-5.6735	-5.7657	-5.5674	-5.6513	-5.2760	-5.2646	-5.3057
β_2	inflation (t-1)	-0.0171	-0.0181	-0.0165	-0.0158	-0.0180	-0.0320	-0.0303
		-0.4763	-0.5271	-0.4857	-0.4374	-0.4865	-0.9190	-0.8771
μ_{β_3}	long interests (t-1)	0.2645	0.2730	0.2673	0.2612	0.2619	0.2738	0.2779
		3.8032	4.2965	3.9958	3.7781	3.9251	3.8211	4.1387
σ_{β_3}		0.0395	0.0384	0.0437	0.0383	0.0390	0.0428	0.0460
		1.4220	1.4696	1.6543	1.1262	1.5169	1.4503	1.5845
γ_1	crisis (t-1)	-2.0353	-1.9748	0.0026	-1.9794	-1.6955	-1.5486	
		-5.0922	-4.9753	0.0039	-4.9923	-3.2568	-3.1623	
$\delta_1^{(1)}$	crisis $\times$ Δ shi (t-1)		-0.5293					
			-0.9931					
$\delta_1^{(2)}$	crisis $\times$ hor (t-1)			-3.4631				-2.7665
				-3.3676				-3.2061
$\delta_1^{(3)}$	crisis $\times$ Δ cr (t-1)				0.4821			
					0.7577			
$\delta_1^{(4)}$	crisis $\times$ bc (t-1)					-0.9667	-1.3674	-0.7914
						-1.1333	-1.7526	-1.6328
γ_2	crisis (t-2)	-1.4714	-1.4519	-1.4849	-1.4711	-1.4640	-0.7712	-1.1907
		-3.7458	-3.6728	-3.4162	-3.5443	-3.5862	-1.4795	-1.6080
$\delta_2^{(1)}$	crisis $\times$ bc (t-2)						-1.8274	-1.8370
							-2.2960	-2.1096
ρ		0.2303	0.2238	0.2241	0.2317	0.2101	0.1889	0.1890
		2.6885	2.4994	2.6430	2.8093	2.2429	1.8666	2.2206
σ		1.6368	1.6361	1.6323	1.6362	1.6344	1.6215	1.6194
		34.2816	32.4375	32.9248	33.2248	33.3580	33.0352	34.3187
Log Likelihood		-968.5	-968.0	-967.8	-968.1	-967.6	-964.7	-964.4
AIC		1.9809	1.9840	1.9836	1.9843	1.9833	1.9815	1.9807
$\mathcal{LR}$-test Treatment[a]		0.96	1.05	0.99	1.11	0.89	0.32	0.23

Notes: Δ shi: change in share of housing investment; hor: rate of homeownership; Δ cr: change in consumption ratio; bc: banking crisis. [a]:The probit part of the treatment model yields a log likelihood of -76.2 if estimated separately. The probit model contains the following list of regressors: lagged growth, short interest rates, long interest rates, inflation and consumption ratio.

Table 4: Costs of housing crises: Baseline crisis definition and annual timing methodology

		I	*II*	*III*	*IV*	*V*	*VI*	*VII*
α_0	constant	2.4202 6.1725	2.3359 6.0371	2.3820 5.5823	2.3638 5.8139	2.2791 5.3292	2.3477 5.8721	2.3306 5.3832
μ_{α_1}	Δ GDP(t-1)	0.2012 2.4924	0.2228 2.6108	0.2095 2.3781	0.2148 2.6053	0.2351 2.5304	0.2086 2.3638	0.2108 2.4626
σ_{α_1}		0.1256 2.9005	0.1244 3.2085	0.1251 3.5513	0.1263 3.7633	0.1214 2.9770	0.1282 2.8397	0.1277 2.8090
β_1	short interests (t-1)	−0.2843 −5.9152	−0.2759 −5.0125	−0.2825 −5.1675	−0.2800 −5.2646	−0.2728 −4.8855	−0.2813 −5.3968	−0.2836 −5.3226
β_2	inflation (t-1)	−0.0070 −0.2073	−0.0123 −0.3494	−0.0070 −0.2207	−0.0086 −0.2587	−0.0121 −0.3467	−0.0234 −0.6723	−0.0225 −0.6315
μ_{β_3}	long interests (t-1)	0.2471 3.4862	0.2463 3.7694	0.2476 3.7055	0.2466 3.5380	0.2462 3.4565	0.2599 3.7163	0.2630 3.5915
σ_{β_3}		0.0361 1.1886	0.0328 1.1535	0.0398 1.5514	0.0348 1.3411	0.0354 1.3963	0.0444 1.4847	0.0464 1.8775
γ_1	crisis (t-1)	−1.7950 −5.1107	−1.9273 −4.9811	0.0778 0.1167	−6.2939 −1.5721	−1.3934 −2.7388	−1.2495 −2.4807	
$\delta_1^{(1)}$	crisis × Δ shi (t-1)		−0.7958 −1.7459					
$\delta_1^{(2)}$	crisis × hor (t-1)			−3.2493 −2.9195				−2.2453 −2.8838
$\delta_1^{(3)}$	crisis × Δ cr (t-1)				0.0804 1.1253			
$\delta_1^{(4)}$	crisis × bc (t-1)					−1.3115 −1.4699	−1.6423 −1.8701	−0.8069 −1.8793
γ_2	crisis (t-2)	−1.3441 −3.9114	−1.3436 −3.4691	−1.3642 −3.8059	−1.3504 −3.5919	−1.3596 −3.6334	−0.8055 −1.7054	−1.5143 −2.0200
$\delta_2^{(1)}$	crisis × bc (t-2)						−1.7264 −2.2367	−1.7478 −2.1406
ρ		0.2177 2.9276	0.1937 2.2645	0.2040 2.1862	0.1998 2.5467	0.1758 1.8760	0.1940 2.4781	0.1886 2.1107
σ		1.6149 29.7087	1.6122 31.7383	1.6112 31.3625	1.6132 30.4562	1.6103 30.2033	1.5956 31.9179	1.5928 33.3109
Log Likelihood		-1012.3	-1010.8	-1011.6	-1012.2	-1010.6	-1007.7	-1007.4
AIC		1.9626	1.9635	1.9651	1.9662	1.9632	1.9615	1.9609
$\mathcal{LR}$-test Treatment[a]		0.63	0.65	0.60	0.78	0.42	0.67	0.60

Notes: Δ shi: change in share of housing investment; hor: rate of homeownership; Δ cr: change in consumption ratio; bc: banking crisis. [a]:The probit part of the treatment model yields a log likelihood of -86.4 if estimated separately. The probit model contains the following list of regressors: lagged growth, short interest rates, long interest rates, inflation and consumption ratio.

Table 5: Costs of housing crises - Loose crisis definition and quarterly timing methodology

		I	*II*	*III*	*IV*	*V*	*VI*	*VII*
α_0	constant	2.5267	2.5262	2.5305	2.5178	2.4437	2.3823	2.3818
		5.4042	5.4023	5.9948	5.8240	5.5199	5.6204	4.9623
μ_{α_1}	Δ GDP(t-1)	0.1802	0.1802	0.1722	0.1823	0.1998	0.2007	0.1965
		1.8075	1.8081	1.6806	1.9335	1.9236	2.1835	1.9364
σ_{α_1}		0.1402	0.1402	0.1454	0.1410	0.1364	0.1373	0.1400
		3.4473	3.4479	3.2913	3.3673	2.8310	3.1109	3.3539
β_1	short interests (t-1)	−0.2848	−0.2848	−0.2864	−0.2815	−0.2757	−0.2759	−0.2768
		−5.5615	−5.5618	−4.9667	−5.4719	−4.7809	−4.9169	−5.2077
β_2	inflation (t-1)	−0.0200	−0.0200	−0.0209	−0.0202	−0.0217	−0.0321	−0.0325
		−0.5871	−0.5874	−0.5932	−0.5891	−0.6009	−0.9115	−0.9824
μ_{β_3}	long interests (t-1)	0.2592	0.2592	0.2633	0.2569	0.2556	0.2688	0.2715
		3.8031	3.8041	3.7992	3.6771	3.6029	3.8010	3.9724
σ_{β_3}		0.0410	0.0410	0.0478	0.0393	0.0395	0.0435	0.0462
		1.4459	1.4460	1.8420	1.2967	1.4272	1.6472	1.6442
γ_1	crisis (t-1)	−2.1289	−2.1286	1.0189	−2.0860	−1.8678	−1.7492	
		−5.6563	−5.6555	1.5697	−5.2568	−3.6487	−3.6554	
$\delta_1^{(1)}$	crisis $\times$ Δ shi (t-1)		−0.2283					
			−0.2267					
$\delta_1^{(2)}$	crisis $\times$ hor (t-1)			−5.2409				−3.0863
				−5.1185				−3.8677
$\delta_1^{(3)}$	crisis $\times$ Δ cr (t-1)				0.4647			
					0.7493			
$\delta_1^{(4)}$	crisis (t-1) $\times$ bc					−0.8540	−1.2147	−1.0365
						−0.9302	−1.4716	−1.3779
γ_2	crisis (t-2)	−1.4773	−1.4770	−1.5043	−1.4743	−1.4608	−0.8645	−0.8986
		−3.6641	−3.6635	−3.7627	−3.7975	−3.8619	−1.7251	−1.8652
$\delta_2^{(1)}$	crisis (t-2) $\times$ bc						−1.7597	−1.7679
							−2.1549	−2.0498
ρ		0.2154	0.2153	0.2176	0.2167	0.1924	0.1767	0.1775
		2.2266	2.2252	2.2099	2.5125	1.8855	1.9327	1.7636
σ		1.6267	1.6267	1.6176	1.6257	1.6251	1.6138	1.6077
		31.8834	31.8836	29.1939	29.4515	31.7388	33.9514	34.2050
Log Likelihood		-965.8	-965.8	-964.3	-965.5	-965.1	-962.3	-961.2
AIC		1.9757	1.9797	1.9766	1.9791	1.9783	1.9765	1.9744
$\mathcal{LR}$-test Treatment[a]		1.86	2.60	1.96	2.08	1.90	1.97	1.99

Notes: Δ shi: change in share of housing investment; hor: rate of homeownership; Δ cr: change in consumption ratio; bc: banking crisis. [a]:The probit part of the treatment model yields a log likelihood of -81.0 if estimated separately. The probit model contains the following list of regressors: lagged growth, short interest rates, long interest rates, inflation and consumption ratio.

Table 6: Costs of housing crises - Loose crisis definition and annual timing methodology

		I	II	III	IV	V	VI	VII
α_0	constant	2.3685	2.3679	2.3060	2.3936	2.2167	2.2590	2.2397
		6.0143	5.4680	5.0898	5.6665	5.1042	4.7873	5.4308
μ_{α_1}	Δ GDP(t-1)	0.2134	0.2132	0.2249	0.2085	0.2490	0.2304	0.2344
		2.4947	2.4963	2.5158	2.3419	2.5733	2.4526	2.4975
σ_{α_1}		0.1263	0.1262	0.1283	0.1289	0.1216	0.1258	0.1275
		3.3503	3.0536	3.4829	3.0784	3.0866	3.1050	3.3737
β_1	short interests (t-1)	−0.2702	−0.2702	−0.2655	−0.2708	−0.2581	−0.2630	−0.2615
		−5.1481	−4.9573	−4.6866	−4.9253	−4.6349	−4.8568	−4.8584
β_2	inflation (t-1)	−0.0122	−0.0121	−0.0133	−0.0117	−0.0161	−0.0241	−0.0249
		−0.3504	−0.3543	−0.4228	−0.3554	−0.4899	−0.6980	−0.7374
μ_{β_3}	long interests (t-1)	0.2440	0.2440	0.2446	0.2426	0.2428	0.2523	0.2541
		3.6704	3.3252	3.2915	3.5956	3.6066	3.4338	3.6508
σ_{β_3}		0.0429	0.0424	0.0477	0.0417	0.0405	0.0456	0.0480
		2.0361	1.4239	1.6794	1.7226	1.5420	1.6709	1.7301
γ_1	crisis (t-1)	−1.8273	−1.8289	0.9147	−1.7730	−1.5022	−1.4043	
		−5.6518	−6.1313	1.2187	−5.1354	−3.8252	−3.2270	
$\delta_1^{(1)}$	crisis × Δ shi (t-1)		−0.4893					
			−0.4839					
$\delta_1^{(2)}$	crisis × hor (t-1)			−4.7087				−2.5463
				−3.6871				−3.3345
$\delta_1^{(3)}$	crisis × Δ cr (t-1)				0.3025			
					1.1324			
$\delta_1^{(2)}$	crisis × bc (t-1)					−1.3165	−1.5870	−1.4383
						−1.6513	−1.8854	−1.8860
γ_2	crisis (t-2)	−1.4264	−1.4258	−1.4530	−1.4175	−1.4396	−1.0359	−1.0528
		−4.3439	−4.2743	−4.2724	−4.3984	−4.3679	−2.5227	−2.6777
$\delta_2^{(1)}$	crisis × bc (t-2)						−1.5328	−1.5574
							−1.6165	−1.8594
ρ		0.2018	0.2025	0.1814	0.2109	0.1534	0.1651	0.1606
		2.6006	2.2670	1.8172	2.1407	1.5478	1.6507	1.8872
σ		1.5994	1.6006	1.5920	1.5977	1.5953	1.5830	1.5792
		31.6827	30.8858	30.4045	29.4919	30.4184	32.7127	30.9168
Log Likelihood		-1008.6	-1007.8	-1007.0	-1007.9	-1006.7	-1004.1	-1003.1
AIC		1.9556	1.9578	1.9564	1.9581	1.9558	1.9546	1.9528
$\mathcal{LR}$-test Treatment[a]		1.63	1.54	2.52	2.47	2.44	2.56	2.62

Notes: Δ shi: change in share of housing investment; hor: rate of homeownership; Δ cr: change in consumption ratio; bc: banking crisis. [a]:The probit part of the treatment model yields a log likelihood of -100.0 if estimated separately. The probit model contains the following list of regressors: lagged growth, short interest rates, long interest rates, inflation and consumption ratio.