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The Macro-Financial Implications of House Price-Indexed Mortgage Contracts

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September 2014

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The Macro-Financial Implications of House Price-Indexed Mortgage Contracts

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Sveriges Riksbank Working Paper Series

No. 287

September 2014

Abstract

A standard, no-recourse mortgage contract does not adjust when the value of the underlying collateral falls. Consequently, shocks that lower house prices may trigger one of the necessary conditions for default: negative equity. A common alternative contract attempts to prevent default by imposing full-recourse. This may cause individuals who believe they are likely to default to rent; however, it does not prevent those who buy from experiencing negative equity. I consider a contract that instead precludes negative equity by tying outstanding debt to an index of house prices. This is done in an incomplete markets model that is calibrated to match U.S. micro and macro data. I find that switching to the house-price indexed contract reduces the default rate from .72% to .11% and expands homeownership rates among the young and the poor, but pushes up the equilibrium minimum mortgage rate by 90 basis points. The volatility of net cashflows to financial intermediaries also increases slightly under the new contract.

JEL Classification: G21, E21, E43
Keywords: Default, Mortgages, Interest Rates, Heterogeneous Agents, Incomplete Markets

The views expressed in this paper are solely the responsibility of the author and should not be interpreted as reflecting the views of the Executive Board of Sveriges Riksbank.

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1 Introduction

A standard, no-recourse mortgage does not adjust its terms when the value of the underlying collateral changes. One consequence of this contract structure is that large reductions in house prices will cause households to have negative equity. Recent empirical work suggests that negative equity, coupled with unemployment and a weak asset position, leads to mortgage default.[1]

Consequently, a contract that adjusts with house prices to prevent negative equity will preclude default. This is accomplished by shifting the burden of the house price reduction to the lender. If house prices drop and a household is hit with an income shock simultaneously, she can sell, rather than defaulting. Under a standard contract, a household that experiences the same set of shocks can neither sell nor make payments, resulting in a breach of contract that initiates the foreclosure process.

In the following section, I setup an incomplete markets model in the style of Bewley (1983) and Aiyagari (1994) that features mortgage default. The model will not have aggregate uncertainty, as in Krusell and Smith (1998), but will emulate it in a stationary model by constructing regions that experience idiosyncratic shocks to housing productivity. This second tier of idiosyncratic shocks (above households, but below the aggregate economy) makes it possible to create localized credit crunches, as default probabilities and house price movements comove within a region. I then solve and simulate the model under two classes of contracts: 1) a standard, no-recourse mortgage contract; and 2) an alternative, house-price indexed (HPI) contract, which is constructed to eliminate negative equity.

2 The Model

2.1 Firms

The firm side of the economy consists of 1) a consumption goods producer who rents labor services; and 2) a region-specific technology that permits all households to transform the consumption good into housing units.

2.1.1 Consumption Goods

Consumption goods are produced using labor and are subject to decreasing returns:

$$Y_t = N_t^{\alpha}, \tag{1}$$

Firms maximize profits, yielding the factor price for labor, where N_t is the mass of employed workers:

$$w_t = \alpha N_t^{\alpha-1} \tag{2}$$

2.1.2 Housing Investment

The housing production specification is based on Glover, Heathcote, Krueger, and Rios-Rull (2011), but allows for regional heterogeneity. Agents in each region have access to a

[1] See Gerardi, Herkenhoff, Ohanian, and Willen (2013); Foote, Gerardi, and Willen (2008).

linear technology that transforms the consumption good into housing. If agent i in region m builds with c^h_{mit} units of the consumption good, it will yield ih^m_{mit} new units of housing:

$$ih^m_{mit} = c^h_{mit} e^{U_{mt}}, \tag{3}$$

where $U_{mt} = u_H + \rho_H U_{mt-1} + \epsilon_{mH}$, $\epsilon_H \sim N(0, \sigma_{mH})$. Total housing investment can be written as follows:

$$IH_t = \sum_{i \in I} \sum_{m \in M} c^h_{mit} e^{U_{mt}} \mu_{mi}, \tag{4}$$

where μ_{mi} is agent i in region m's mass and where IH_t denotes the aggregate. The housing stock evolves as follows:

$$H_{t+1} = H_t + IH_t - \delta_H H_t, \tag{5}$$

where δ_H is housing stock depreciation.

2.2 Households

Households work for T^W periods and then retire. An employed household that is age a and productivity type g at time t receives a wage, $w_t \eta_{ag}$, where η_{ag} is productivity weight of age cohort a and permanent productivity type g. Unemployed and retired agents receive a transfer payment from the government, x_t. Households pay an age and productivity-specific tax, Γ_{it}, which yields the following income process:

$$y_{it} = \begin{cases} w_t n_{a_{it}} - \Gamma_{at} & \text{if employed} \\ x_t & \text{if unemployed or retired} \end{cases} \tag{6}$$

Households consume two types of goods: 1) non-durable goods, which serve as the numeraire; and 2) service flows from housing, which are proportional to the size of the housing stock, h_{it}:

$$u(c_{it}, h_{it}) = \frac{c_{it}^{1-\sigma_c}}{1-\sigma_c} + \frac{h_{it}^{1-\sigma_h}}{1-\sigma_h} \tag{7}$$

Households also accumulate bank deposits, borrow in the form of collateralized mortgages, and choose whether or not to default on mortgage debt, yielding the following budget constraint:

$$\begin{aligned} c_{it} + \phi(h_{it}, h_{it-1}) + d_{it} + p^h_t h_{it} + m_{it} = y_{it} + (1+r)d_{it-1} + \\ p_{mt} h_{it-1}(1-\delta_H) + b_{it} \end{aligned} \tag{8}$$

Note that p^h_t is the relative price of housing, m_{it} is the mortgage payment, and b_{it} is the unpaid balance on the mortgage.

Households face a concave adjustment cost, $\phi(h_{it}, h_{it-1})$, which generates lumpy investment (i.e. infrequent moves). As in Iacoviello and Pavan (2011), there is a minimum house size, $\bar{h}$; and agents who cannot own have access to a small, fixed amount of non-housing shelter.

Additionally, I apply a novel constraint that makes holders of one-period mortgages behave as if they held long term debt:

$$b_{it}^H \leq \begin{cases} \lambda p_t^h h_{it} & \text{if } h_{it} - h_{it-1} > 0 \\ \lambda p_t^h h_{it} & \text{if } b_{it-1} < \lambda p_t h_{it} \ \& \ h_{it} = h_{it-1} \\ b_{it-1} & \text{otherwise,} \end{cases} \tag{9}$$

where $\lambda \in (0,1)$ denotes the maximum loan-to-value ratio.

The intent of this constraint is to achieve the following: 1) prevent spurious defaults that arise from one-period contracts with a collateral constraint; 2) permit mortgage equity withdrawal; and 3) allow negative equity.

I also borrow a constraint from Iacoviello and Pavan (2011) that limits borrowing to a fraction, γ, of discounted, remaining lifetime earnings:

$$b_{it}^I = \gamma E_t \sum_{j=t}^{T-a+j} \beta^{T-a+t} y_{ij} \tag{10}$$

The final constraint combines the previous two:

$$b_{it} \leq min\{b_{it}^H, b_{it}^I\} \tag{11}$$

That is, the maximum amount a household can borrow is the minimum implied by the two borrowing constraints.

Deposits yield the equilibrium interest rate, r, and borrowers pay an individual-specific mortgage rate, ξ_{it}, which depends on the contract structure. Defaulters forfeit their housing stock and are temporarily excluded from the mortgage market.

With the choice problem fully specified, we may collect the state variables, $z_{imt} = \{d_{it-1}, \psi_{it}, h_{it-1}, b_{it-1}, \epsilon_{it}, a_{it}, g_i, r, p_{mt}^h\}$ and the parameters $\Omega = \{\alpha, \sigma_h, \gamma, \lambda, \rho_{mU}, \sigma_{mU}, \delta_h\}$ to simplify notation. The dynamic programming problem (DPP) for the household, subject to equations 1-11, may be written as follows:

$$\begin{aligned} V_{it}(z_{it}; \Omega) = max_{\{c_{it}, d_{it}, k_{it}, h_{it}, b_{it}, \psi_{it}^d\}} u(c_{it}, h_{it}) + \\ \beta \sum_{\epsilon^{E\prime} \in \{1,0\}} Pr(U') Pr(\epsilon^{E\prime} | \epsilon^E) V_{it+1}(z_{it+1}; \Omega) \end{aligned} \tag{12}$$

2.3 The Financial Intermediary

The market for financial intermediation is perfectly competitive. All mortgages originated yield zero profits on average in equilibrium. Two equilibria are considered: one with the standard contract and another with the HPI contract.

2.3.1 Standard Mortgage Contract

We assume that the foreclosure process is costly and that financial intermediaries only recover a fraction, $\Lambda < 1$, of the outstanding debt from defaulters. Thus, a contract must be priced to satisfy the following condition:

$$(1+r)b_{it-1} = (1 - q_{it-1})(1 + \xi_{it})b_{it-1} + q_{it-1} b_{it-1} \Lambda \tag{13}$$

Here, q_{it-1} is the rational expectations probability of default. This implies the following, borrower-specific mortgage rate:

$$\xi_{it} = \frac{r + (1-\Lambda)q_{it-1}}{1-q_{it-1}} - 1 \tag{14}$$

The equilibrium interest rate on deposits, r, clears the mortgage market by equating aggregate savings and mortgage debt.

Using these assumptions, the intermediary sets the mortgage payment for household i, who obtained a loan in period t as follows:

$$m_{it} = (1 + \xi_{it})\, b_{it-1}, \tag{15}$$

If a household defaults, it repays neither principal nor interest on the mortgage.

2.3.2 HPI Contract

In the alternative contract, outstanding debt is indexed to the regional house price level. This contract specification eliminates one of the necessary conditions for default: negative equity. The mortgage payment is as follows:

$$m_{it} = (1 + \xi_{it}) min\{b_{it-1}, p_t^h b_{it-1}(1-\delta_h)\} \tag{16}$$

This contract requires the following condition to be satisfied:

$$(1 + r)b_{it-1} = (1 + \xi_{it}) min\{b_{it-1}, p_t^h h_{it-1}(1-\delta_h)\}$$

This can be rewritten to yield the individual-specific mortgage rate:

$$\xi_{it} = \frac{1+r}{min\left\{1, \frac{p^h b_{it-1}(1-\delta_h)}{b_{it-1}}\right\}} - 1 \tag{17}$$

Note that indexing only takes effect when house prices fall; and when it takes effect, it reduces the size of the payment and the amount of debt outstanding.

2.4 The Government

The government makes transfer payments to retired and unemployed individuals at a constant replacement ratio, ζ. It collects taxes from employed agents that are proportional to income; and maintains a balanced budget in all periods.

2.5 Aggregate Consistency Conditions

The economy is also subject to a set of standard aggregate consistency conditions. Additionally, the equilibrium interest rate must clear the mortgage market.

2.6 Calibration

The model's calibration is given in Table 1. The utility function was parameterized according to Chambers et. al (2009). The standard deviation for the housing productivity process applies only at the regional level, as there is no aggregate variation. The housing adjustment cost, housing depreciation rate, max lifetime borrowing parameter, and minimum house size is taken from Iacoviello and Pavan (2011). The within-cohort productivity range is calibrated to target an after-tax wage-GINI coefficient of 0.30. The quantity of non-housing shelter is used to calibrate the default rate for the standard contract. Additionally, micro data from the CPS is used to calibrate wage-age profiles.

Table 1: Model Calibration

	Param	Value
Housing utility curvature	σ_H	3
Cons. utility curvature	σ_C	1
Regional housing prod. persistence	ρ_H	.60
St. dev. housing prod.	σ_H	0.15
Within-cohort productivity range	-	[0.7,1.3]
Non-housing shelter	-	1.0 x W
Unemployment rate	-	6.1%
Housing depreciation rate	-	.05
Housing adjustment cost	-	.05
Max LTV ratio	λ	1.00
Max lifetime borrowing	γ	.35
Replacement ratio	ζ	.4
Min house size	$\underline{h}$	1.5 x W
Labor share	α	.67
Discount factor	β	.95
Housing recovered in foreclosure	Λ	0.70

3 Results

We will first consider the aggregate results for the model, given in Table 2. These were computed by averaging over 2,400,000 agent-periods of simulated data.

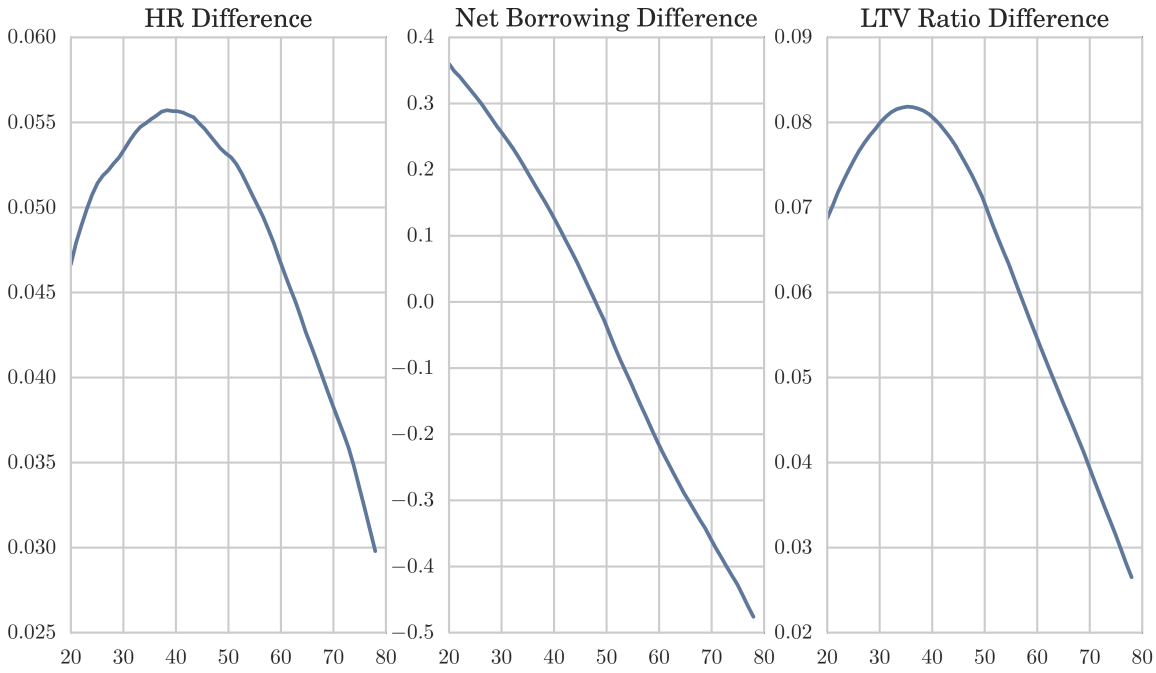
Table 2: Aggregate Differences Across Contracts

	Standard	Alternative	Difference
Default	0.72%	0.11%	0.61ppt
Consumption	0.527	0.558	5.88%
Borrowing	0.541	0.7962	47.19%
Mortgage Rate	1.0414%	1.0504%	90bp
LTV Ratio	86.30%	92.51%	6.21ppt

The switch from the standard to HPI contract reduces the default rate from 0.72% to 0.11%. It does not drop to zero, however, because some households are unable to repay both principal and interest, even if they can sell to repay principal. The switch also increases consumption by 5.88%, partly by reducing reliance on the costly foreclosure process. Borrowing increases, driven by lending to young and low income households, which is documented further in Figure 1. This pushes up the equilibrium interest rate by 90bp.

Next, we consider the differences in lifecycle profiles across contract types. Figure 1 uses the same simulated data, but does not aggregate across age. Notice that young households benefit disproportionately from the option to borrow more without increasing

Figure 1: Average Lifecycle Profile Differences



their probability of default or the associated risk premium on their mortgage. This induces a rise in the LTV ratio. Homeownership also disproportionately rises for low productivity households (not shown in the figure), who see a gain that is 10ppt higher than the corresponding rise for high productivity agents.

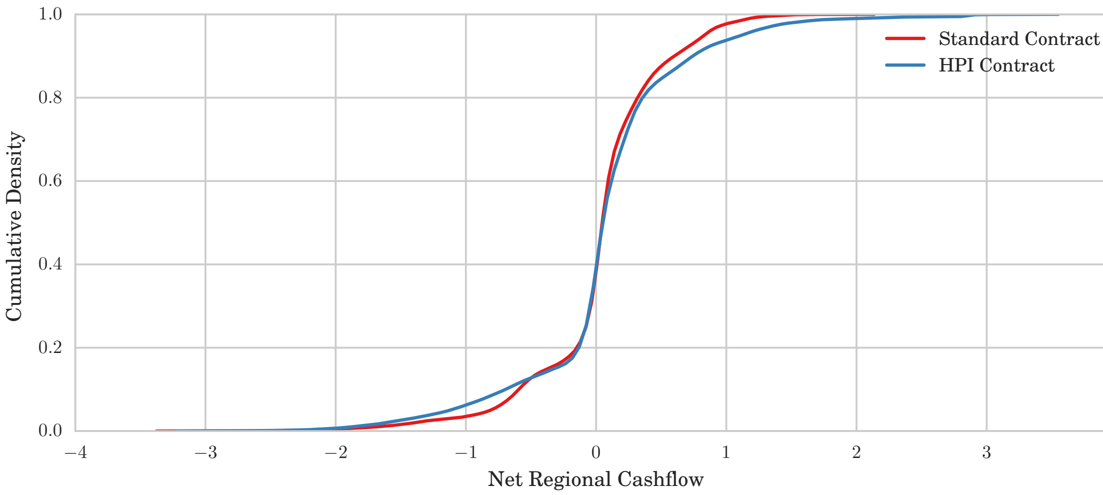
Figure 2 shows the simulated CDFs for net cashflows for each time-region pair. Each region receives a different sequence of exogenous shocks from the housing productivity process. This generates variation in the rate of default under the standard contract and variation in contract revaluation under the HPI contract. The HPI contract has a slightly higher mass in both tails, suggesting that it increases the regional dispersion of cashflows.

4 Conclusion

I use an incomplete markets model with mortgage default to study house price-indexed (HPI) mortgage contracts. When house prices fall, the amount of outstanding debt falls, precluding negative equity, which is a necessary condition for default. I find that switching to the HPI contract reduced the default rate in the model from .72% to .11%, but increased the equilibrium minimum mortgage rate by 90 basis points. The new contract also expanded homeownership in all age groups, but had a particularly pronounced impact on young and low income households.

Beyond the properties identified in this paper, the HPI contract has two additional benefits: first, it assigns clearer roles to originators and borrowers by incorporating more contingencies into the contract, rather than allowing those contingencies to result in a breach of contract. And second, it explicitly reassigns the need to forecast regional house prices from laypersons to financial institutions.

Figure 2: CDF of Financial Intermediary Net Cashflows



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