Housing and the Business Cycle

For obvious reasons, there has been considerable recent in the relationship among housing, credit markets, and the business cycles. To examine this issue, we will discuss the following paper:

Iacoviello, M. 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle." *American Economic Review*, 95(3): 739-764.

In this paper, housing serves three purposes.

1. It provides utility to households.

2. It is an input in production, capturing the role of commercial real estate.

3. It acts as collateral on secured loans.

The main result of the paper is that when negative demand shocks occur, the value of housing declines. This restricts access to credit (see #3), which then amplifies and propagates the shock. Note that this paper was published prior to the recent bursting of the housing bubble.

Motivational Econometrics

Figure 1 plots the estimated responses of a set of macroeconomic variables to random shocks to each variable. The set includes interest rates, inflation, output, and housing prices. Note the following:

1. When the interest rate exogenously increases, output declines. This as another estimate that shows that monetary policy matters.

2. An exogenous increase in inflation reduces real housing prices.

3. Exogenous increases in housing prices increase output and vice-versa. This suggests that the two variables interact with each other.

Iacoviello then sets out to develop a model that yields these results. We will follow what he describes as the "basic model." He also develops an extended ("full") model that yields similar results.

Model

A new feature (relative to Gali) is that there is more than one type of representative household. The first is referred to as the *patient household* because it has the higher discount factor. Its optimization problem is;

$$Max_{c_t',h_t',L_t',M_t'} \quad E_0 \sum_{t=0}^{\infty} \beta^t (lnc_t' + jlnh_t' - \frac{(L_t')^\eta}{\eta} + \chi ln(\frac{M_t'}{P_t}) \tag{1}$$

s.t.

$$c_t' + q_t \Delta h_t' + R_{t-1} b_{t-1}' / \pi_t = b_t' + w_t' L_t' + F_t + T_t' - \Delta M_t' / P_t \tag{2}$$

where $\pi_t = \frac{P_t}{P_{t-1}}$. Most of this setup is the same as Gali. Both the utility function and budget constraints , however, now include housing where j is the weight of housing in the utility function and q_t is the price of housing. Primes indicate variables for the patient household. Some variables, such as the price level and interest rate, are the same for all agents and thus do not carry a prime. F_t represents firm profits which are returned to the patient households that we assume own them.

For now, we assume that debt is not indexed to inflation. Hence the inclusion of $R_{t-1} b_{t-1}' / \pi_t$ in the budget constraint. The inclusion of inflation ensures that loans are subject to inflation risk.

Optimization yields the following first-order conditions:

$$\frac{1}{c_t'} = \beta E_t \left[\frac{R_t}{\pi_{t+1} c_{t+1}'} \right] \tag{3}$$

$$w_t' = (L_t')^{\eta-1} c_t' \tag{4}$$

$$\frac{q_t}{c_t'} = \frac{j}{h_t'} + \beta E_t \left[\frac{q_{t+1}}{c_{t+1}'} \right] \tag{5}$$

Equations (3) and (4) are the Euler Equation and labor supply rule. They are essentially the same as Gali Ch. 2. Equation (5) is the housing demand equation. It may be obtained through a thought experiment. Suppose that the household increases its housing stock by one very small unit in period t:

1. In period t, the household obtains additional utility equal to $\frac{j}{h_t'}$.

2. To pay for the extra housing, the household may reduce its consumption in period t by q_t units. This reduces household utility by $\frac{q_t}{c'_t}$.

3. In period $t+1$, the household can sell its extra housing unit for q_t. This yields utility equal to $betaE_t\left[\frac{q_{t+1}}{c'_{t+1}}\right]$.

4. Such a change leaves periods $t+2$ and beyond unaffected. It also cannot change utility, otherwise the household would not be optimizing. Equation (5) thus sets the costs and benefits of this hypothetical equal to each other.

In addition, there is also a money demand equation. But it is not used again so Iacoviello ignores it.

The other type of household is the representative entrepreneur (sometimes called impatient households). These agents use housing in order to produce a differentiated good. They use the following production function:

$$Y_t = A(h_{t-1})^{\nu}(L_t)^{1-\nu} \tag{6}$$

Entrepreneur's debt equals b_t. We now assume that, in order to borrow, entrepreneurs must use their housing (h_t) as collateral. We further assume that if entrepreneurs choose to default on their debt, lenders must pay a fraction of entreprenuer's collateral, $(1-m)E_t[q_{t+1}h_t]$, in order to recover the borrower's assets.

Because of the threat of default, lenders will never extend credit to the point where they expect it to be optimal for borrowers to default. The credit constraint thus takes the following form:

$$E_t[b_t R_t/\pi_{t+1}] \leq mE_t[q_{t+1}h_t] \tag{7}$$

The left hand side of (7) is outstanding debt in period $t+1$. The right hand side is the fraction of borrowers" assets that may be recovered. The parameter m thus reflects the efficiency of the recovery technology. If foreclosures are costless, then $m = 1$. If they are banned, then $m = 0$ and there is no credit.

The representative entrepreneur solves the following optimization problem:

$$Max_{c_t,h_t,L'_t}\ \ E_0\sum_{t=0}^{\infty}\gamma^t lnc_t \tag{8}$$

s.t. (7) and

$$\frac{Y_t}{X_t} + b_t = c_t + q_t \Delta h_t + R_{t-1} b_{t-1}/\pi_t + w_t^{'} L_t \tag{9}$$

whether $X_t = \frac{P_t}{P_t^w}$ and where P_t^w is the wholesale price that entrepreneurs obtain for their output.

Optimization may be done through the Lagrangian method. Doing so yields the following first-order conditions:

$$\frac{1}{c_t} = \beta E_t \left[\frac{R_t}{\pi_{t+1} c_{t+1}} \right] + \lambda_t R_t \tag{10}$$

$$\frac{q_t}{c_t} = E_t \left(\frac{\gamma}{c_{t+1}} (\nu \frac{Y_{t+1}}{X_{t+1} h_t} + q_{t+1}) + \lambda_t m \pi_{t+1} q - t + 1 \right) \tag{11}$$

$$w_t^{'} = (1 - \nu) Y_t / (X_t L_t) \tag{12}$$

where λ_t is the Lagrange multiplier.

Equation (10) is the Euler Equation, (11) is commercial housing demand, and (12) is labor demand. Note that there is only one type of labor and it is supplied by patient households and demanded by entrepreneurs.

The key assumption is that $\gamma < \beta$. It then follows that the entrepreneurs are less patient than the patient households and will therefore choose to borrow from the patient households to the point that the credit constraint is binding.

Before continuing, it is worth noting that default never actually occurs in the model. Instead, in equilibrium, entrepreneurs will always want to borrow more (to boost their current consumption at the expense of future consumption) but the threat of default prevents patient households from extending further credit.

The next step is to assume that a retail sector buys output at the wholesale price and converts to to a final good as in Gali Ch.3. By further assuming Calvo pricing, we obtain a New Keynesian Phillips Curve:

Finally, we assume that the monetary authority uses the following Taylor Rule:

$$\hat{R}_t = (1 - r_r)((1 + r_\pi)\pi_{t-1} + r_Y \hat{Y}_{t-1}) + r_r \hat{R}_{t-1} + \hat{e}_{r,t} \quad (13)$$

where hats indicate percentage deviations from the steady state.

Equation (13) has several differences from Taylor Rules seen elsewhere in class. First, it assumes a degree of monetary policy inertia (r_r). Second, it assumes that the monetary authority responds to lagged variables. Finally, it defines the response to inflation as $1 + r_\pi$ so that the Taylor Condition is satisfied for all $r_\pi > 0$. The paper is not about indeterminacy of equilibrium.

The resulting model contains 9 equations and 9 endogenous variables. To solve it, Iacoviello does the following:

1. He calibrates the model. He sets $j = 0.1$ and $\nu = 0.03$, This calibration results in 20% of steady state housing being used for commercial purposes which is consistent with the data. He sets $\beta = 0.99$, $\gamma = 0.98$, and $\theta = 0.75$. For monetary policy, he sets $r_r = 0.73$, $r_\pi = 0.27$, and $r_Y = 0$, which are estimated econometrically earlier in the paper. Table 1 on page 742 shows other calibrated values.

2. He uses Taylor Series expansions to linearly approximate the non linear model.

3. He uses the eigendecomposition to obtain saddle conditions.

Result 1: Impulse Response to a Demand Shock

Figure 2 reports the effects on output of an increase in the interest rate where $\hat{e}_{r,t} = 0.29$. Higher interest rates have three effects on output:

1. Those from Chapter 3 of Gali. These are the top line on the Figure. They result in a cumulative loss of output equal to 3.32% of steady state output.

2. When interest rates rise, (7) shows that the credit constraint tightens because entrepreneurs have larger debt payments. Iacoviello refers to this as the *collateral effect.* To isolate this effect, he temporarily assumes that debt is indexed to inflation by eliminating π_t from both budget constraints. The cumulative loss of output now equals 3.82%.

3. Inflation reduces the real value of debt. This is Fisher's debt-deflation effect. In this case, reduced demand leads to lower inflation which, all else equal, further reduces access to credit. With this effect in the model, the cumulative loss of output is 4.42%.

Effects #2 and #3 show that credit constraints collectively amplify and propagate the effects of demand shocks. Note, however, that the scope of this effect is fairly small, about one-third larger than the baseline model. Current research is examining under what conditions this figure might be increased.

Result 2: Impulse Response to a Supply Shock

Figure 4 plots the impact of an adverse supply shock in the model. As in the baseline New Keynesian Model, such a shock reduces output. The effect, however, is larger for indexed debt. This is because, in the absence of indexation, the resulting inflation reduces the real value of debt from debt-deflation, which then relaxes credit constraints.

Result 3: Response to Housing Price Shock

Figure 3 shows the effects of a temporary increase in housing prices caused by a temporary increase in the preference parameter j. Obviously, such a policy increases housing prices. In the model without credit effects ($m = 0$), this change causes households to substitute away from consumption and toward housing. This, however, does not match the data which shows that an exogenous increase in housing prices causes an increase in consumption.

If the collateral effect is big enough, simulated by a high value of m, then the relaxation of credit constraints allows households to increase both consumption and housing.

Result 4: Optimal Monetary Policy Response to Housing Prices

Iacoviello next allows the monetary authority to respond to housing prices by adding $r_q q_{t-1}$ to the policy rule. Figure 6 shows the range of policy outcomes both allowing for and not allowing asset price targeting. The frontiers are almost on top of each other, suggesting that the benefits of targeting housing prices are very small. He also finds that the Fed's estimated policy rule has not been particularly close to the set of potentially optimal policies.

It is far from clear that this result shows that there are no significant benefits to targeting asset prices. I offer two caveats.

1. For the model from Gali Ch. 3, it can be shown that household welfare depends only on the volatilties of the output gap and inflation. This model also includes housing in the utility function. It is thus likely that welfare depends on stabilizing housing quantities and it is plausible that aggressively targeting housing prices better allows the monetary authority to achieve this.

2. Recall the intuition behind aggressively responding to inflation in Ch. 3. of Gali, doing so eliminates the distortion of sticky prices. In this model, housing prices are fully flexible. Recent events. however, suggest that housing prices may also be sticky, especially in the downward direction. Adding such a distortion could easily change the implications of targeting housing prices.

Result #5: Debt indexation increases volatility

Figure 7 plots the policy frontier under debt indexation and without it. Surprisingly, the economy is more stable without indexation. This is because while indexation is stabilizing when demand shocks effect the economy (See Result #1), it is destabilizing when supply shocks affect the economy (See Result #2). But while monetary policy is effective at counteracting the former, it is less effective at offsetting the latter. So the destabiling effect in the presence of supply shocks makes indexation generally undesirable.

This result is counterintuitive to many. Indexation reduces inflation risk and would thus seem desirable. Yet the majority of debt in the United States is not indexed.

The previous analysis considers the stability of output itself. Because supply shocks affect both the natural rate of output and output, indexation is not as destabilizing to the output gap as it is to output. Figure 8 thus conducts the same analysis using the output gap instead of output. The result from Figure 7 is now generally reversed.