Economics in a Changing World

Proceedings of the Tenth World Congress of the International Economic Association, Moscow

Congress Editor: Anthony B. Atkinson

Volume 3
PUBLIC POLICY AND ECONOMIC ORGANIZATION

Edited by

Dieter Bös

150th YEAR
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St. Martin's Press

10 The Dynamics of Housing Prices: An International Perspective[1]

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1 INTRODUCTION

Housing prices increased dramatically in many countries during the 1980s. Those increases accentuated differences across countries in the levels of housing prices. They have also attracted attention to the dynamics of housing prices more generally. In the USA the phenomenal price increases, some of which have been attributed to 'bubbles'.[1] in some regions and states during the mid- to late 1980s, have given way to price declines. The bubbles seem to have been burst throughout the USA from the North-Eastern states to the South and to California. Yet, as Poterba notes (Poterba, 1991, p. 178), housing prices do not appear to have declined as much as one would have expected if price increases were indeed due to bubbles and related phenomena.

Another interesting phenomenon that has attracted some attention is the fact that foreign investors, especially Japanese, borrowed heavily against real estate assets in their own countries in order to invest in assets in the USA, including real estate assets as well. Since real estate competes for finance with other investments, it is natural that the real estate boom would be related to more general investment or stock market booms. There seems to be virtually no formal analysis of these phenomena.

It is of particular interest to consider potential dependence in the dynamics of housing prices across different countries. In a financially integrated world economy, with the rate of return being determined internationally, one would expect prices of housing assets in different countries to move in concert with one another. The dual role of housing as an asset and a durable good providing shelter does have consequences for the long run equilibrium value of the capital stock. Housing markets are different from other asset markets in the sense that transactions costs and the non-equivalence between residential and owner-occupied housing impose frictions for arbitrage. This paper proposes a basic analytical model that may be used to examine the dynamics of housing prices in an international perspective. It involves a simple two overlapping-generations model with two sectors, one of which is producing a tradeable good and and the other housing, whose services are consumed only domestically. The choice of an overlapping-generations model is simply for ease of exposition. The model adopts a dynamic specific factors structure in the style of Eaton (1987, 1988). Housing is a produced durable and claims to it may be traded internationally. For symmetry, we allow for capital and land also to be traded internationally. With respect to land, in particular, which is a non-reproducible factor, we know from Eaton's work (Eaton, 1988) that its ownership by foreigners affects conventional wisdom in non-trivial ways.[2]

The dynamics of the model with foreign ownership of housing in addition to that of capital and land, discussed in Sections 3 and 4 below, are interesting in their own right. In addition the model allows further exploration of the importance of bubbles. Since bubbles have allegedly been detected in housing markets in various countries and regions of the USA, conditions which might rule out the existence of price bubbles on housing assets are of special importance. This is also important in view of the attention this topic is receiving at the present time in the empirical literature. An interesting result of Rhee (1991), itself a correction of Tirole (1985), overturned the conventional wisdom, invoked quite frequently and especially by macro theorists: that is, the presence of a fixed (that is, non-reproducible) factor of production (such as land) was thought to exclude the possibility of bubbles in the economy. We investigate this further in the present paper.

This study is to the best of our knowledge the first one to emphasize housing price dynamics in an international context. It is not, however, the first to take up the dynamics of housing prices as such. The work by Poterba (1984) has been decisive in explaining the complicated dynamics that might affect housing markets. In such models prices are sensitive to shocks in the short run because investment adjusts only sluggishly owing to adjustment costs.

After a discussion in Section 2 of some facts about the movements of housing prices internationally, we present the basic behavioural model in Section 3, and explore its dynamic properties in Section 4. The possibility of bubbles in land and housing prices is also explored there. Then in Section 5 we analyse a related model where the demand side is also affected by inertia due to the costs of moving from one dwelling to another. We use that model to study the dynamics of housing prices in the short run and to obtain predictions about the relationship between price volatility and the pattern of residential mobility across countries. Section 6 offers some brief conclusions.

2 FACTS ABOUT HOUSING PRICES IN AN INTERNATIONAL PERSPECTIVE

Poterba (1991) considers the traditional determinants of housing prices. He argues that the conventional view that real user costs, which were low during the 1970s, are an important determinant of housing prices is found wanting when confronted with data from the 1980s for the USA. Real user costs of housing increased during the 1970s but housing prices did not fall sufficiently. On the other hand, evidence from a large cross-section of cities provides support neither for the demography-based explanation for housing price dynamics, suggested for example by Mankiw and Weil (1989), nor for the real user cost theory. Variations in housing price appreciation do seem to be forecastable, which argues against the existence of arbitrage in housing markets. Finally, from some limited international evidence he takes up,[3] Poterba concludes that housing prices can be quite unstable even during relatively short periods, and may be subject to speculative bubbles.[4]

For the United States the most rapid increase was one of 20 per cent from 1976 to 1979. In contrast real house prices rose by 32 per cent in Canada between 1971 and 1973, by 37 per cent in the Netherlands between 1976 and 1978 and by 52 per cent in the United

Kingdom between 1971 and 1973. The most rapid decreases were 5 per cent for the USA (1981–3), 14 per cent for Canada (1977–9), 38 per cent for the Netherlands (1979–82) and 25 per cent for the United Kingdom (1974–7). Corresponding numbers for Sweden were +29 per cent (1986–9) and −31 per cent (1979–83).

Muellbauer (1992) emphasises the differences in housing market dynamics between Germany and the United Kingdom. Other evidence presented by Cutler *et al.* (1991) suggests that excess returns[5] to housing prices in the USA are positively autocorrelated at an annual frequency. This picture conforms to that for many other assets.[6]

An international comparison of returns to various assets during the 1980s is particularly interesting. From data reported by the Bank for International Settlements in a number of its annual reports (1986, 1989, 1990, 1991, 1992) we note a substantial correlation of house prices across countries, at least during the 1980s when capital markets became better integrated. During the earlier part of the decade, house prices fell in real terms in most countries or grew considerably more slowly than prices of financial assets like equities and bonds. During 1980–85, real price changes of houses sold in the USA, the United Kingdom and Italy fluctuated around an average of −1 per cent, 0.5 per cent and 0.5 per cent respectively. Whereas for the United States those fluctuations varied from a maximum of 2 per cent and a minimum of −3 per cent only, they were much wider in the United Kingdom: 6 per cent to −8 per cent respectively; and even more wide for Italy: 13 per cent to −9 per cent. Average real rates of return implied by the price of new houses sold in Germany, France and Canada similarly registered 0.5 per cent, −2.1 per cent and −4.1 per cent respectively, during that same period, with fluctuations being most pronounced for Germany and Canada. Japan, where urban land prices grew at an average of 3.7 per cent, was an exception. In contrast equities and bonds performed consistently much better during that same period.

The performance of housing in the second half of the 1980s all but made up for the lacklustre performance in the first half. Specifically, growth in urban land prices accelerated in Japan, with commercial properties leading the way and registering phenomenal increases. Housing prices moved upwards in most industrialized countries, but especially in North America and Western Europe. This housing boom exhibited substantial correlation across most countries, for example the USA, the United Kingdom, Canada, Australia, Sweden, France, Norway and Italy.

The performance since 1990 shows a sharp slowdown in growth or actual decline in real estate prices, thus completing a picture of a 'boom-to-bust' cycle in international housing markets. Urban land prices actually fell in Japan, for the first time in seventeen years and only the second time since the Second World War (Bank for International Settlements, 1992, p. 139). The overall picture does indeed tempt us to consider the extent of the internationalization of the housing cycle, making it more pressing to pursue a formal analysis of the dynamics of housing prices in an international perspective. In Section 5 below we offer some additional data, in order to contrast with varying patterns of residential mobility internationally.

3 THE MODEL

We assume an economy with a constant endowment of land, in amount T, and a constant labour force L. We allow for a growing labour force in Section 4.3 below. Without loss of generality, we shall set the quantity of land equal to 1. The model integrates housing into a specific factors model in the style of Eaton's. We assume two domestic sectors. Sector 1 produces a homogeneous output, using capital (K) invested in the previous period, K_{1t}, and labour employed in the current period, L_{1t}, according to a production function:[7]

$$Q_{1t} = F(K_{1t}, L_{1t}) \tag{1}$$

$F(\cdot)$ is assumed to yield output net of depreciation of capital,[8] satisfies the standard properties, and is homogeneous of degree one. Thus the producers operating in sector 1 hire capital and labour in competitive markets and earn zero profits at equilibrium. The output of sector 1 may be used for consumption and investment.

Sector 2 produces new housing stock, using capital and land, according to a production function:

$$Q_{2t} = G(K_{2t}, T_{2t}) \tag{2}$$

$G(\cdot)$ satisfies the standard properties and is homogeneous of degree one. Housing producers hire capital and land in competitive markets to produce housing. Once produced, new housing is added to the surviving housing stock in the following period. Once installed, housing stock is homogeneous and depreciates at a constant rate δ per period. Capital used in housing production depreciates fully. Land does not depreciate.

The model contains three assets, which may be used for transferring purchasing power over time: capital, land and housing. The difference between land and the other two is that land is non-reproducible. A novelty of the model is that foreign investment in all three of these factors is allowed. Let K^f_{t+1}, T^f_{t+1} and H^f_{t+1} be the respective amounts of foreign investment in those three factors, available at the beginning of period $t + 1$. The assumption of foreign holdings in housing, in particular, is made in response to some of the important stylized facts discussed in the introduction. It also simplifies the model considerably by allowing rather naturally for holdings of housing stock for consumption purposes to differ from those for investment purposes (Henderson and Ioannides, 1983).

The behaviour of individuals may be described as follows. Individuals live for two periods. Those born in period t work only when young, supplying their labour inelastically (one unit each), and consume output in both periods, in quantities c^y_t and c^o_{t+1}, respectively. We simplify the housing decision by assuming that housing is consumed only in the second period.[9] Let χ_{t+1} be the quantity of housing stock rented by a member of the generation born in period t during the second period of its life. The typical household's utility function is:

$$u = U(c^y_t, c^o_{t+1}; \chi_{t+1}) \tag{3}$$

Let k_{t+1}, ℓ_{t+1} and h_{t+1} be the holdings of assets acquired by a member of generation t when young, that is holdings of capital, land, and housing, respectively. Let w_t, r_t, q_t and x_t be the wage rate, rate of interest, price of land and price of housing stock, respectively. And let π_t and ρ_t be the rental rates of land and housing, respectively. All prices are defined in terms of the numeraire commodity, the output of sector 1.

An individual's decisions about how much to consume when young and old and how much housing to rent satisfy a lifetime budget constraint which, for convenience, may be written in two parts, as follows. Individuals save by investing in holdings[10] of capital, land and housing:

$$c^y_t = w_t - k_{t+1} - q_t \ell_{t+1} - x_t h_{t+1} \tag{5'}$$

They use the total returns from their investments in the second period of their lives to pay for consumption of housing and of the non-housing consumption good:

$$c^o_{t+1} + \rho_{t+1}\chi_{t+1} = (1 + r_{t+1})k_{t+1} + (q_{t+1} + \pi_{t+1})\ell_{t+1} + [\rho_{t+1} + (1 - \delta)x_{t+1}]h_{t+1} \tag{6'}$$

The determination of the consumption bundle may be analytically simplified as follows. In equilibrium, the returns to all assets are equalized.[11] Consequently by defining

$$s_t \equiv k_{t+1} + q_t\ell_{t+1} + x_t h_{t+1} \tag{4}$$

we may rewrite (5′) and (6′) above as follows:

$$c^y_t = w_t - s_t \tag{5}$$

$$c^o_{t+1} + \rho_{t+1}\chi_{t+1} = (1 + r_{t+1})s_t \tag{6}$$

We are now ready to close the model. Individuals maximize utility (3) subject to budget constraints (4) to (6) by choosing c^y_t, s_t, c^o_{t+1}, and χ_{t+1}.

Equilibrium in the market for capital is characterized as follows. The total supply of capital is equal to the demand for capital for investment purposes:

$$K_{t+1} = Lk_{t+1} + K^f_{t+1} \tag{7}$$

The total supply of capital is equal to the demand for capital for production purposes by the two sectors:

$$K_{t+1} = K_{1t+1} + K_{2t+1} \tag{8}$$

Equilibrium in the market for land is characterized as follows. The total supply of land, which has been normalized to 1, is equal to the demand for land for production purposes, which comes only from the housing producing sector (sector 2), $T_{2t} = T_t$. The total supply of land is equal to the demand for investment purposes. The demand for investment purposes has a domestic component $L\ell_{t+1}$ and a foreign component T^f_{t+1}. So for equilibrium we have:

$$1 = T_{t+1} = L\ell_{t+1} + T^f_{t+1} \tag{9}$$

Negative values for K^f_{t+1} and T^f_{t+1} imply net ownership of these assets abroad by nationals.

The supply of housing stock in every period satisfies:

$$H_{t+1} = Q_{2t} + (1 - \delta)H_t \tag{10}$$

This is the housing accumulation equation. Equilibrium in the market for housing stock for investment purposes implies:

$$H_{t+1} = L\, h_{t+1} + H^f_{t+1} \tag{11}$$

Equations (10) and (11) determine the price of housing stock x_t. Equilibrium in the market for housing stock for consumption purposes implies:

$$H_{t+1} = L\, \chi(w_t, r_{t+1}, \rho_{t+1}) \tag{12}$$

where $\chi(\cdot)$ is obtained from the solution for χ_{t+1} to the lifetime utility maximization problem.[12] Equations (10) and (12) determine the rental rate for housing stock, the price of housing services, ρ_{t+1}, in terms of the quantity of housing stock and its price in period t, H_t and x_t, respectively.

Employing the definition of savings (4) and substituting from the asset market equilibrium conditions (7), (9), and (11) we see that total asset values equal the sum of domestic and foreign savings:

$$K_{t+1} = Ls(w_t; r_{t+1}, \rho_{t+1}) - q_t - x_t H_{t+1} + \Phi_t \tag{13}$$

where $s(\cdot)$ is obtained from the solution to the individual's lifetime utility maximization problem and Φ denotes net foreign investment defined as

$$\Phi_t \equiv K^f_{t+1} + q_t T^f_{t+1} + x_t H^f_{t+1} \tag{14}$$

Further, in asset market equilibrium, the rates of return on investment in land and housing must equal the market interest rates; these yield, respectively,

$$q_t = \frac{\pi_{t+1} + q_{t+1}}{1 + r_{t+1}} \tag{15}$$

$$x_t = \frac{\rho_{t+1} + (1 - \delta)x_{t+1}}{1 + r_{t+1}} \tag{16}$$

Standard marginal productivity conditions determine the wage rate w_t, the rental rate for land π_t, and the rate of interest (rental rate of capital, net of depreciation) r_t. The rate of interest is equal to the marginal productivity of capital in both sectors. That is:

$$w_t = \frac{\partial F(K_{1t}, L_t)}{\partial L_t} \tag{17}$$

$$\pi_t = x_t \frac{\partial G(K_{2t}, T_t)}{\partial T_t} \tag{18}$$

$$r_t = \frac{\partial F(K_{1t}, L_t)}{\partial K_{1t}} \tag{19a}$$

$$r_t = x_t \frac{\partial G(K_{2t}, T_t)}{\partial K_{2t}} \tag{19b}$$

In analysing the equilibrium of the model we assume that we are dealing with a small open economy where the rate of interest r_t is exogenously given from the world market and equal to $\bar{r}_t$. For simplicity we treat the interest rate as constant, $\bar{r}_t = \bar{r}$, although this is not an essential assumption.

The factor demand conditions (17) and (19a), evaluated at the exogenously given supply of labour, determine $K_1(\bar{r})$ and $w(\bar{r})$. Similarly conditions (18) and (19b) determine the capital stock and the rental rate of land as functions of the price of housing stock, which is determined elsewhere in the model: $K_2(x_t, \bar{r})$ and $\pi(K_2(x_t, \bar{r}))$.

The remainder of the equilibrium conditions are determined by a set of three dynamic equations, the accumulation equation for housing (10) and the two forward-looking asset demand equations (15) and (16). In analysing this system we note that the rental rate of housing may be expressed from the equilibrium condition in the housing market, by inverting (12):

$$\rho_{t+1} \equiv R(H_{t+1}, w(\bar{r}), \bar{r})$$

Furthermore it is convenient to write the output of the housing producing sector at equilibrium in terms of prices only:

$$g(x_t, \bar{r}) \equiv G(K_2(x_t, \bar{r}), 1)$$

We may now rewrite the dynamic system as:

$$H_{t+1} = g(x_t, \bar{r}) + (1 - \delta)H_t \tag{20}$$

$$q_t = \frac{\pi(x_{t+1}, \bar{r}) + q_{t+1}}{1 + \bar{r}} \tag{21'}$$

$$x_t = \frac{R(H_{t+1}, w(\bar{r}), \bar{r}) + (1 - \delta)x_{t+1}}{1 + \bar{r}} \tag{22'}$$

The system of equations (20), (21′) and (22′) yields the evolution of H, q and x over time, given initial conditions. Given this solution, the factor demand condition (19b) determines K_2. Since K_1 is already determined as a function of $\bar{r}$, this means that the path for K is determined. Finally the amount of foreign investment Φ is given from (14).

4 DYNAMICS

Dynamic equilibrium in this model is subject to the basic indeterminacy of equilibrium in overlapping-generations models. The equilibrium conditions do not yield initial conditions for q_t and x_t. Given initial conditions for capital and the housing stock, K_0 and H_0, and with arbitrary initial values for the price of land and housing, we may solve equations (20), (21′) and (22′) for the values of the state variables in period 1 and successive periods.[13]

When the rate of interest is endogenous, the dynamic system is fully simultaneous, exhibits no block structure and is thus very complicated to analyse. This is one reason for examining the case of an exogenous rate of interest in some detail. We then return to the general case in order to examine the possibility of bubbles.

4.1 Dynamics with an Exogenous Rate of Interest

The dynamic analysis is simplified by substituting for H_{t+1} from (20) in (22′) and from (22′) in (21′). After solving for q_{t+1} and x_{t+1} we obtain the counterparts of (21′) and (22′):

$$q_{t+1} = (1+\bar{r})q_t - \pi\left[\frac{1+\bar{r}}{1-\delta}x_t - \frac{1}{1-\delta}R[g(x_t, \bar{r}) + (1-\delta)H_t, \bar{r}], \bar{r}\right] \tag{21}$$

$$x_{t+1} = \frac{1+\bar{r}}{1-\delta}x_t - \frac{1}{1-\delta}R[g(x_t, \bar{r}) + (1-\delta)H_t, \bar{r}] \tag{22}$$

By linearizing around the steady state in the standard fashion we obtain a linear system of first order difference equations in terms of the deviations of the endogenous variables (H_t, q_t, x_t) from their steady state values:

$$\begin{bmatrix} \Delta H_{t+1} \\ \Delta q_{t+1} \\ \Delta x_{t+1} \end{bmatrix} = \begin{bmatrix} 1-\delta & 0 & g_x \\ \pi_x R_H & 1+\bar{r} & -\dfrac{1+\bar{r}-g_x R_H}{1-\delta}\pi_x \\ -R_H & 0 & \dfrac{1}{1-\delta}(1+\bar{r}-g_x R_H) \end{bmatrix} \begin{bmatrix} \Delta H_t \\ \Delta q_t \\ \Delta x_t \end{bmatrix} \tag{23}$$

All entries in the right-hand side of (23) are evaluated at the steady state values of all variables. The characteristic equation corresponding to the above system is

$$(1+\bar{r}-\lambda)\left[\lambda^2 - \left[1-\delta+\frac{1}{1-\delta}(1+\bar{r}-R_H g_x)\right]\lambda + 1 + \bar{r}\right] = 0 \tag{24}$$

Equation (24) has three distinct roots, the eigenvalues of the system (23). One is equal to $1 + \bar{r}$ and thus positive and greater than 1. The other two are given by the roots of the quadratic equation:

$$\lambda_{2,3} = \frac{1}{2}\left(1 - \delta + \frac{1}{1-\delta}(1 + \bar{r} - R_H g_x)\right) \pm \frac{1}{2}\left[\left(1 - \delta + \frac{1}{1-\delta}(1 + \bar{r} - R_H g_x)\right)^2 - 4(1 + \bar{r})\right]^{\frac{1}{2}}$$

The roots of equation (24) are always real and both are positive.[14] One of these roots is greater than 1 and the other is less than 1. We conclude that the system exhibits saddlepoint stability.

4.2 Properties of the Steady State Equilibrium

The system of equations (20), (21′), and (22′) in the steady state yield:

$$\delta H^* = g(x^*, \bar{r}) \tag{25}$$

$$\bar{r}q^* = \pi(x^*, K_2(x^*, \bar{r})) \tag{26}$$

$$(\bar{r} + \delta)x^* = R(H^*, w(\bar{r}), \bar{r}) \tag{27}$$

Equations (25) and (27) give conditions for producers and consumers to be at equilibrium. They are represented in Figure 10.1 by the curves PP and DD, which jointly determine H^* and x^* as functions of the world market rate of interest. The equilibrium price of land follows recursively from (26).

We may refer to Figure 10.1 to illustrate how steady state equilibrium is affected by an increase in the world interest rate. Such an increase may be represented by a shift to the right of the PP locus to $P'P'$. At a higher interest rate producers will hire less capital and supply less housing at given house prices. The effect on the DD curve as it shifts to $D'D'$ is ambiguous, however. We explore that by differentiating (27) to get:

$$\frac{dx^*}{d\bar{r}} = \frac{1}{\bar{r} + \delta}\left(\frac{\partial R}{\partial \bar{r}} - x^*\right)$$

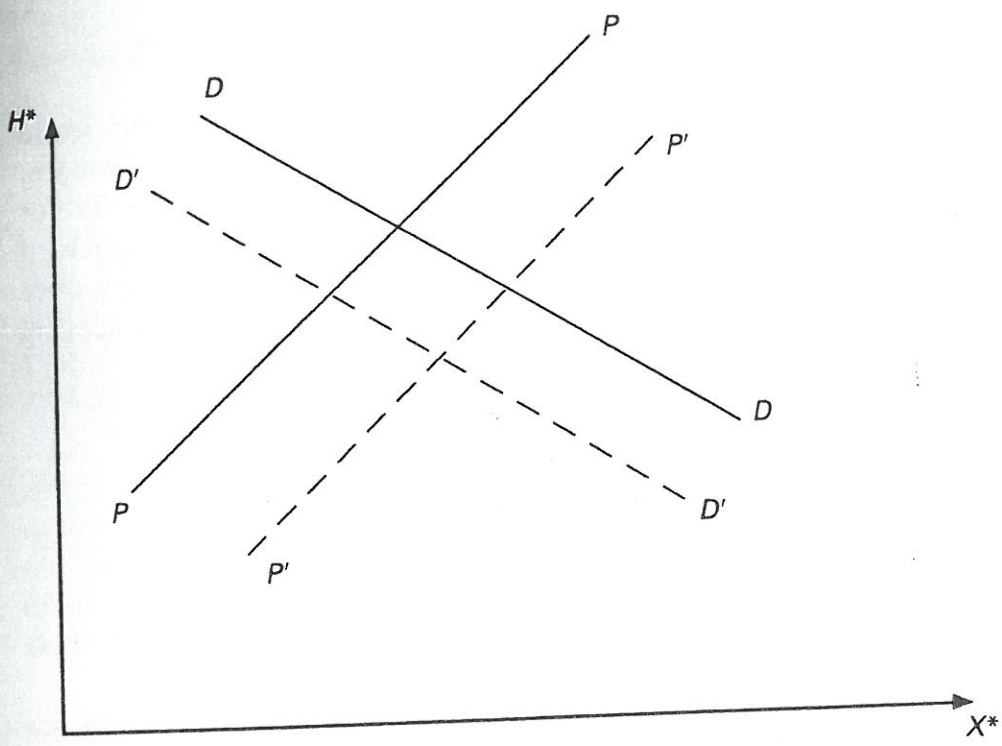

Figure 10.1 Steady state equilibrium

where

$$\frac{\partial R}{\partial \tilde{r}} = -\frac{(\partial \chi / \partial w \times \partial w / \partial r) + \partial \chi / \partial \tilde{r}}{\partial \chi / \partial \rho}$$

Since $\frac{\partial \chi}{\partial w} > 0$, $\frac{\partial w}{\partial \tilde{r}} < 0$, $\frac{\partial \chi}{\partial \tilde{r}} > 0$ and $\frac{\partial \chi}{\partial \rho} < 0$, the sign of $\frac{\partial R}{\partial \tilde{r}}$ is ambiguous. Rents may go either up or down, depending on the relative strength of two factors. On the one hand, an increase in $\tilde{r}$ lowers the discounted price of housing and increases housing demand; this tends to increase rents. On the other hand, an increase in $\tilde{r}$ lowers wages and hence has a negative income effect on housing demand. If the negative income effect is sufficiently strong, then the net effect on the house price x^*, given H^*, is unambiguously negative. Finally we note that the effect on the land price q^* is ambiguous. If the effect on x^* is sufficiently small, then the effect on q^* is clearly negative.

4.3 The Possibility of Bubbles in Land and Housing Prices

The evidence from various housing markets around the world suggests the possibility of housing price bubbles (Meese and Wallace, 1991). The housing market is a popular source of examples for bubbles. Consider, for example, the following scenario (Blanchard and Watson, 1982). In a steady state equilibrium, the housing price should be equal to the present value of the infinite stream of housing services that a unit of housing makes possible. A deterministic bubble in this market would take the form of the housing price exceeding this fundamental value. Such a higher price for housing would cause housing construction to exceed depreciation of the housing stock, with rents falling below their original steady state value. The fall in rents would cause the fundamental price of housing to decrease. At the same time, the increase in housing price would cause increases in the price of land. If land supply was entirely inelastic, then the bubble on housing would be entirely reflected in land prices.

We show below that, at least in a closed economy version of our model, this scenario is not exactly possible in long run equilibrium. Such a bubble, if it starts, must burst. We see that, whereas a bubble on the asset price of land is possible, this is not the case on the asset price of housing. These results depend on some of our specific assumptions, namely that housing is produced with land and capital under constant returns to scale. A bubble on the asset price of housing would cause, as we shall see, the per capita value of housing stock held in portfolios to become infinitely large. In contrast, this is not the case for land. The per capita amount of land held in portfolios tends to zero. If the share of land in housing production does not vanish asymptotically, then indeed a bubble on the price of land but not on that of housing is perfectly possible in long-run equilibrium. This result confirms the importance of the reconsideration of conventional wisdom on this matter by Rhee (1991).

Let prices q_t and x_t be decomposed into a fundamental component and a bubble component:

$$q_t \stackrel{def}{=} \psi_t^q + \beta_t^q$$

$$x_t \stackrel{def}{=} \psi_t^x + \beta_t^x$$

The fundamental components must be particular solutions of the difference equations (15) and (16), which we rewrite here in the standard form:

$$q_{t+1} = (1 + r_{t+1})q_t - \pi_{t+1} \tag{15'}$$

$$x_{t+1} = \frac{1 + r_{t+1}}{1 - \delta} x_t - \frac{1}{1 - \delta} \rho_{t+1} \tag{16'}$$

The bubble components must satisfy the respective homogeneous equations. Therefore, if bubbles exist, they must grow at the equilib- rium rate of interest. To make the problem meaningful we assume that the economy is growing and that the rate of interest is endogen- ous. We also assume for convenience that the economy is closed.

Let population grow at a constant rate η: $L_t = L_0(1 + \eta)^t$. The constancy of land implies that the amount of land held by a young person in period t, ℓ_{t+1} satisfies $T_t = L_t\ell_{t+1} = 1$, and evolves over time according to $\ell_{t+2} = \frac{1}{1+\eta}\ell_{t+1}$. The fundamental law of motion for this economy is (13), which we rewrite in our new notation as follows:

$$L_t q_t + L_t x_t h_{t+1} + L_{t+1} k_{t+1} = L_t s(w_t; r_{t+1}, \rho_{t+1}) \tag{28}$$

The question of existence of a 'bubbly' equilibrium reduces to whether (28) admits a steady state equilibrium at which the rate of interest is equal to the rate of population growth, and the steady state (total) capital–labour ratio k_b and 'aggregate bubble' $\hat{b}$ satisfy:

$$(1 + \eta)\hat{k}_b + \hat{b} = S(\hat{w}; \eta, \hat{\rho})$$

We now take up the issue of whether such an equilibrium exists, and if it exists, whether $\hat{b}$ contains both land and housing. If a bubbly equilibrium exists, then $\hat{b} = \lim_{t\to\infty} \psi_t^q \ell_{t+1} + \beta_t^q \ell_{t+1}\, \psi_t^x h_{t+1} + \beta_t^x h_{t+1}$. It is straightforward to see that the component of the aggregate bubble that corresponds to a bubble on housing would tend to ∞. That is, at the steady state, with $\ell_t \to 0$, the amount of housing produced per capita is equal to $G(k_{2b}, 0)$. If this is non-zero, which would indeed be the case with a constant elasticity of substitution (CES) production function $G(K, T) \equiv (K^{\sigma_h} + T^{\sigma_h})1/\sigma^h\ 0 \leq \sigma_h \leq 1$, then so is the total amount of housing stock per capita. Therefore there cannot be a bubble on the asset price of housing.

The case of land is quite different, on the other hand, because ℓ_t tends to 0 as $t \to \infty$. This makes the fundamental component of the aggregate bubble tend to 0. As for the bubble component, a non-zero value is possible provided that the share of land in the production of housing does not vanish as the amount of land per capita vanishes.

This follows directly from Rhee (1991) and may be demonstrated easily by means of a CES production function like the one invoked above. In that case, $\lim_{t\to\infty} \beta_t \ell_{t+1} = \beta_0 L_0$. Specifically for the CES example above, it suffices to assume that $0 \geq \sigma_h$.

This result clearly depends on the assumption that housing production exhibits homogeneity of degree one. Otherwise, if it exhibited decreasing returns to scale, then housing per capita would tend to zero in long-run equilibrium and a bubble on housing could in principle be sustained. This case requires a major revision of our basic framework and will not be pursued further here.

5 DYNAMICS AND TRANSACTIONS COSTS

In previous sections we have dealt with the long-run tendencies of house prices. In particular we assumed housing demand to adjust instantaneously to changes in market prices. But households can only alter their housing consumption by moving, and moving entails large transactions costs. Hence, when prices or other economic factors change, most households will not adjust their housing consumption. Only if the change is big enough will they find it worthwhile to move, given the transactions costs. This suggests that in analysing price determination it is important to recognize that prices are set to equate supply and demand from those households that actually trade in the market. Taking this into account should be important in understanding what drives housing prices in the short run. We pursue this here by means of a model of short-run dynamics that emphasizes mobility[15] by heterogeneous households.

The degree of mobility varies across countries. Americans move much more often than most others. The annual mobility rate for US home owners between 50 and 60 years of age is 10 per cent, while the corresponding number for Germany is as low as 2.5 per cent (Börsch-Supan, 1992). Only 2 per cent of all Japanese and 4.5 per cent of all Swedish home owners move in any year (Seko, 1992; Edin and Englund, 1991). Relating these differences to the differences in price volatility noted in Section 2 suggests that there may be a negative correlation. The model considered in this section explains why this may be so.

We now sketch a partial equilibrium model that allows us to throw some light on the relation between transactions costs and price volatility. The model is related to the standard asset price model employed by Poterba (1984), Mankiw and Weil (1989) and others to study house prices. It departs from that model in assuming an overlapping structure of households living for two periods and having the choice of whether or not to move between the first and second period of their life.

Consider a household living for two periods and consuming housing (h^y, h^o) and other goods (c^y, c^o) in both periods of life. The budget constraint is given by

$$p_t h^y + \zeta p_{t+1} h^o + c^y + \zeta c^o = w - \alpha \tag{29}$$

where $\alpha = 0$ if $h^y = h^o$. Here ζ is equal to the discount factor $\frac{1}{1+r}$, w is lifetime endowment and α is transactions costs. We do not take a stand as to whether transactions costs are a fixed sum or whether they are related to the amount of housing consumed in the first or second period.[16] The prices of housing consumption p_t are user costs, defined by

$$p_t = x_t + \zeta(1 - \delta)x_{t+1} \tag{30}$$

It is easy to recognize that the choice of whether to move or not depends on the transactions costs α. That is, there exists a critical value α^* such that the household moves if $\alpha < \alpha^*$, and stays in the same house in both periods otherwise. The critical value depends on the utility gain from moving, which is related to the relative preferences for housing consumption when young and old and on relative prices, p_t and ζp_{t+1}.

In a population of heterogeneous households transactions costs and preferences will vary. This implies that at any set of prices a fraction ξ will choose to move and a fraction $(1 - \xi)$ will choose to stay. In general these fractions depend on relative prices. Assume that prices are such that the marginal household, which is indifferent between moving and staying, would choose $h^o > h^y$ if it were to move. Then the effect of an increase in the first period price, p_t, would be to increase the fraction of movers ξ, whereas an increase in the second period price ζp_{t+1} has the opposite effect.

The discussion above refers to the problem of a young household making its optimal lifetime plan. Our model is one of perfect foresight, but we will in standard comparative-static fashion consider the effects of sudden unforeseen changes. This leads to the problem of replanning in the middle of life; under what conditions would a household that planned to be a mover (stayer) reverse its plans, if prices turned out to be different from those originally anticipated? This is an interesting issue which we will pursue further in another paper. For now we conjecture that such replanning will not occur as a result of marginal price changes.[17]

Let us now regard the market equilibrium in an economy of overlapping generations facing the decision problem outlined above. L_t denotes the size of a generation born at t, and H_t is the demand per household. There are three categories of households acting in the market: young movers (*ym*), stayers (*s*) and old movers (*om*). In this economy the equilibrium prices are determined not by equating the *stock* of housing supplied with some measure of the aggregate demand for housing, but by equating the *flow* of demand by the young generation and old movers to the supply coming from old movers, and from old houses put on the market by the retiring generation and from new investment, I_t. Investment is assumed to be an increasing function of the market price of houses. The condition for market equilibrium is

$$\begin{aligned} & L_t \xi_t H_t^{ym} + L_{t-1} \xi_{t-1} H_{t-1,\,t}^{om} + L_t(1 - \xi_t) H_t^s \\ & = L_{t-1}(1 - \delta) \xi_{t-1} H_{t-1}^{ym} + L_{t-2}(1 - \delta) \xi_{t-2} H_{t-2,\,t-1}^{om} \\ & \quad + L_{t-2}(1 - \delta)^2 (1 - \xi_{t-2}) H_{t-2}^s + I_t \end{aligned} \tag{31}$$

Here subscripts refer to the date when relevant decisions were taken with double subscripts indicating that second period demand for movers depends on decisions taken both when young and when middle-aged. This equilibrium depends on decisions taken back in period $t - 2$ and while looking two periods ahead until $t + 2$. Assuming perfect foresight it is hence described by a fourth order difference equation.

In order to come to grips with the price dynamics we now make two simplifying assumptions. First, the proportion of movers and stayers is fixed over time. This may be justified by strong idiosyncratic preferences that divide the population into two distinct groups where no households are marginal with respect to moving or staying.[18] Second, there are no cross-price effects. Income and substitution effects cancel exactly as under a logarithmic utility function. The local dynamic properties may then be obtained by linearizing around the stationary solution for a constant population. It can be shown that two of the characteristic roots corresponding to the resulting equation

Table 10.1 The dynamic response of the market price of houses to a demographic shock at time t (percentage deviation from steady-state values)

	Period					
	t	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$
$H^{ym}=0.8$; $H^{om}=1.2$						
$\xi=0.25$	+2.91	+0.59	−1.53	−0.08	−0.05	−0.02
$\xi=0.50$	+2.74	+1.06	−1.68	−0.14	−0.06	−0.02
$\xi=0.75$	+2.62	+1.45	−1.77	−0.23	−0.05	−0.02
$H^{ym}=1.2$; $H^{om}=0.8$						
$\xi=0.25$	+3.20	+0.09	−1.32	−0.07	−0.09	−0.05
$\xi=0.50$	+3.26	+0.18	−1.35	−0.14	−0.08	−0.08
$\xi=0.75$	+3.33	+0.26	−1.38	−0.20	−0.06	−0.06

are outside and two are inside the unit circle. Hence the equilibrium is a saddle point.

We now ask how the price sensitivity to shocks depends on transactions costs as reflected in the share of movers. To investigate this we look at a demographic shock where it is learned at time t that the size of generation t is 20 per cent larger than all previous and following generations. We solve for the stable adjustment path by multiple shooting methods. Some numerical results are given in Table 10.1. These are based on the assumption that demand price elasticities are unity for all categories of households while the supply elasticity is five, values which are in line with those previously used in the literature. There is little firm knowledge, however, particularly about the supply elasticity. A lower value would obviously give a larger price response; lowering the supply elasticity to three would increase the initial price response by approximately 50 per cent.

Several patterns emerge from Table 10.1. First, we find that there are strong 'echo' effects. The price in the initial period is around 3 per cent above its long-run value, but the price in period $t+2$ is around 1.5 per cent below. The reason is of course that the initial price rise is accompanied by increased building and a larger housing stock, but that demand from $t+2$ and onwards falls back to its initial value. Second, it matters whether mover demand typically is larger in the first or second period of life. The upper section of the table reports the empirically more plausible case where demand from the old is larger (by 50 per cent) than demand from the young. This gives an immediate price response which is some 20 per cent lower than in the opposite case where the young demand more housing, reported in the lower section. The reason is simply that the immediate demand shock is smaller in the former case. On the other hand, the price impact in period $t + 1$, when the larger generation is middle-aged, is larger in the upper section, where middle-age demand exceeds young demand, than it is in the lower section. Third, we see that the fraction of movers in the population matters. In the upper section of Table 10.1, where movers move to larger houses, the initial price response is some 10 per cent larger in the case of a majority of stayers, $\xi = 0.25$, than with a majority of movers, $\xi = 0.75$. The reason is that with many stayers there are fewer households that react immediately to the higher housing prices by lowering their demand, thereby mitigating the price increases.

We conclude that accounting for transactions costs and the fact that most households should not be expected to react at all to price changes has potential effects on the degree of price volatility. Quantitatively the effects do not appear to be all that large. Nevertheless they suggest that countries with low mobility should exhibit high price volatility, just as seems to be the case empirically.

6 CONCLUSIONS

During the late 1980s the world economy experienced a considerable amount of foreign investment in real estate-related assets. At the same time economists have been paying considerably more attention to the consequences for the dynamics of exchange rates of international movements of assets. It may even be said that economists may have rediscovered that asset movements are a key determinant of exchange rates.

In view of these observations the present paper proposes a model for the dynamics of housing prices. Both long run and short run dynamics are examined. They correspond neatly to two senses in which an international perspective is invoked by the paper. One is that foreign investment is allowed in all assets of the economy, that is physical capital, land and housing. We examine the long-run dynamics of such an economy. The importance of the saddle point property of long-run equilibrium is reaffirmed. We then consider the possibility of bubbles on land and housing prices. We show that, whereas under the right conditions a bubble on the asset price of land is possible, this is not the case with the asset price of housing.

The second perspective emphasizes potential consequences of international differences in patterns of residential mobility. We show that allowing for transactions costs and for the fact that housing demand does not adjust instantaneously to changes in prices affects the degree of price volatility. Even though the underlying effect does not appear to be quantitatively important, it does nonetheless suggest that countries with low mobility should exhibit high price volatility. This appears to be in accordance with casual empiricism.

Notes

1. The authors are grateful to Dieter Bös for comments and corrections, to Philippe Weil for useful references, to Rita Maurice for editorial assistance and to Linda Dobkins for excellent research assistance.
2. For example, Eaton (1988) shows that a permanent increase in net foreign investment can reduce steady state welfare if a consequence is higher land prices.
3. Poterba uses data for real house prices for Canada, 1950–89, for the United Kingdom, 1970–91, and for the Netherlands, 1965–85.
4. See also Case and Shiller (1988) and Meese and Wallace (1991).
5. Excess returns are defined as $R_t = \ell n \frac{P_t}{P_{t-1}} - \ell n(1 + i_{US\,t})$, where P_t are constant-quality house prices and $i_{US\,t}$ is the nominal rate in US Treasury bills. This calculation abstracts from economic fundamentals for housing.
6. Cutler *et al.* (1991) list four regularities in asset returns: first, asset returns are positively serially correlated at high frequencies; second, returns are negatively serially correlated at lower frequencies; third, there is a tendency towards fundamental reversion in asset prices; fourth, when short term interest rates are high, the excess returns on other assets are low.
7. It would be straightforward to augment the model and allow for land to be used in production by sector 1.
8. This is equivalent to writing gross output minus capital depreciation.
9. This may be justified since housing consumption reaches a peak late in the life cycle.
10. Note that the time subscripts for asset holding refer to the period in which they yield returns.
11. See equations (14) and (15) below.
12. We think it is necessary to impose the restriction $H^f_{t+1} \geq 0$. That is, housing services may not be imported, but foreigners may own claims to the domestic housing stock. Equations (11) and (12) imply that the investment demand for housing may not exceed the consumption demand, in the terminology of Henderson and Ioannides (1983).
13. This fundamental indeterminacy was first noted by Calvo (1978), who also considered specifically the case of land. Azariadis (1991) provides the latest and clearest statement on this issue.

14. The discriminant may be written as $\left(\frac{1+\bar{r}}{1-\delta}\right)^2 - 2R_H g_x \left(\frac{1+\bar{r}}{1-\delta} + 1\right)$.
15. Mobility is also emphasized by Hardman and Ioannides (1991), who solve for the frequency of moves by finitely lived households in continuous time and analyse the steady state of an infinite overlapping-generations model.
16. Different specifications of transactions costs are studied in Englund (1986).
17. Some intuition in support of this conjecture is as follows. Consider a household that was originally indifferent between being a mover and a stayer but that chose to be a mover and purchased a relatively small house h^y anticipating to move to a larger house h^o. In the middle of life it turns out that p_{t+1} is slightly higher than anticipated. Had the household known about this it would have chosen to be a stayer and to consume $\bar{h}(h^y < \bar{h} < h^o)$ in both periods. But the household being in a position of already having chosen a low quantity h^y, the stayer alternative is less attractive than it would otherwise be, because it implies a second period housing consumption far below the desired level. This intuitive argument may be formalized for this and other possible cases. It leads us to conclude that as long as we are considering the impact of small changes we are entitled to disregard the possibility that households change their plans in mid-life.
18. Taking the endogeneity of the fraction of movers into account turns out to have little quantitative impact.

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