Depreciation: a Dangerous Affair

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Abstract

Statutory fiscal depreciation of real estates is typically higher than their realistic expected life. This would imply that markets would value buildings more than their social fundamental value. I prove that this allows house price bubbles to emerge and open the door to sudden crashes, even in an economy with fully rational and forward-looking individuals, and no credit market imperfections. I also provide a simple "rule-of-thumb" method to calculate the highest bubble-free depreciation rate. With standard parameters, it turns out that the usual annual 5% fiscal depreciation can prevent house price bubbles only by a very close shave.

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"*A lot of my write-off was depreciation..I pay tax and I pay federal tax too. But I have a write-off, a lot of it is depreciation, which is a wonderful charge. I love depreciation.*" Donald Trump, October 9, 2016.

1 Introduction

When a firm buys a building it is entitled to deduct parts of its value from taxes at rates which are supposed to approximate the actual economic depreciation rate of the building. However fiscal schedules are often the result of political compromise and sometimes accused to be too generous to real estate holders willing to minimize their income taxes. For example, according to the federal *Modified Accelerated Cost-Recovery System* (MACRS) introduced by the US Tax Reform Act of 1986, businesses may recover investments in buildings through depreciation deductions up to a substantial amount: typically a house is assumed to be depreciated in 27.5 years, but the owner can opt for accelerated depreciation, so short as to 5 years. On the other hand, estimated depreciation rates for buildings are notoriously much smaller - running from 0.36% per year (Leigh, 1980), to 2.5% per year (Harding, Rosenthal, and Sirmans, 2007). Similarly long housing life expectancies are used in the literature - 1% in Cocco (2005), 1.5% in Diaz and Luengo-Prago (2008), and Maggiori, Stroebel, and Weber (2015). Hence, with the fiscal depreciation rules actually in place, the governments could actually be subsidizing house prices. This paper proves theoretically that this is sufficient to render a rational house price bubble sustainable. Moreover, this allows for self-fulfilling prophecies to generate house price bubble collapses even in an otherwise very stable economy.

The rest of this study is organized as follows. Section 2 sets up a simple stylized house price model. Section 3 characterizes and proves the existence of rational bubbles and sunspot equilibria in this model. The final section concludes.

2 A Simple Model of House Prices

Let us assume that infinitely lived families - identical and with constant population normalized to 1 - choose consumption, savings and investment by maximizing their intertemporal utility functional represented by

$$E_0 \sum_{j=0}^{\infty} \beta^j \frac{c_{t+j}^{1-\sigma} - 1}{1-\sigma}$$

where time $t = 0, 1, ...$ is unbounded and discrete, $\sigma > 0$ is the inverse of the intertemporal elasticity of substitution, $\beta = \frac{1}{1+\rho}$ is the subjective discount factor, with subjective interest rate $\rho > 0$. Individuals produce income w_t per unit time. The market for interfamily consumption loan is open, and r_t is its real rate of return between period t and $t+1$. Family wealth, denoted a_t, grows according to:

$$a_{t+1} = a_t r_t + w_t - c_t - \tau_t,$$

where τ_t is percapita lump-sum taxation. We will allow the representative household's income, which is this economy's GDP, to grow at constant exogenous rate $\gamma \geq 0$.The associated

Euler equation is:

$$c_t^{-\sigma} = E_t \left[\beta c_{t+1}^{-\sigma} (1 + r_t) \right], \tag{1}$$

where E_t is the expectation as of time t.

Financial intermediaries - called "banks", and operating at zero cost - perfectly diversify individual savings into "houses", which are in limited supply H. In every period each bank buys a house and sells it to other banks in next period: hence the current stock of houses gets rolled over in every period.[1] We assume that the price of a house paid by a bank, $p_t \geq 0$, is refunded in a fraction $\theta \in [0; 1]$ per period by the government. Parameter θ is exogenously set by the legislation on the depreciation of physical investment. For simplicity, we will assume balanced government budget, with lump sum taxes financing the fiscal depreciation of the buildings:

$$\tau_t = \theta H p_t.$$

Hence non-distortionary taxation is fully compensated by trasfers and do not interphere with our assumed intertemporal wealth constraint.

I will assume for simplicity that real estates are unproductive and irreproducible assets. Hence any positive price would be a bubble. An extension would complicate notation, but would imply that the bubble would be the difference between the price of the asset and the expected present value of the rents it generates.[2]

2.1 Bubble-free Equilibrium

Our very simple economy always admits a general equilibrium without bubbles.

A bubble-free equilibrium is a sequence of consumption $\{c_t\}_{t=0}^{\infty}$ and real interest rates $\{r_t\}_{t=0}^{\infty}$, house prices $\{p_t\}_{t=0}^{\infty}$, and taxes $\{\tau_t\}_{t=0}^{\infty}$, such that $p_t = 0 = \tau_t$, $c_t = w_t = (1+\gamma)^t w_0$, for all $t = 0, 1, 2, ...$, and eq. (1) holds. As a consequence, eq. (1) determines a constant real interest rate

$$r_t = (1 + \gamma)^{\sigma} \beta^{-1} - 1 \equiv \bar{r}. \tag{2}$$

Hence in this simple economy the bubble-free equilibrium exists, is unique, and it is along a balanced growth path.

2.2 Bubbly Equilibrium

In this section I will characterize the stationary rational bubble equilibrium of our simple economy. I will now look for the possibility of bubbles with constant probability $\lambda \in [0; 1[$ of bursting each period. Since financial intermediaries, perfectly competing and risk neutral, view real estate investment as equivalent to consumption loans, they will invest in estates only if the expected returns between the activities are equalized, that is only if:

[1] This allows banks to update their fiscal depreciation to higher levels during a house price bubble.

[2] Our model is purposefully very stylized, but it could be complicated in several directions. For a useful survey of recent housing macroeconomics, see Piazzesi and Schneider (2016).

$$\frac{p_{t+1}(1-\lambda)}{p_t(1-\theta)} = 1 + r_t. \tag{3}$$

Since there is a probability λ of bursting each period, the probability of the bubble lasting more than an arbitrary number T of periods is $(1-\lambda)^T > 0$. For a housing bubble to be stationary it is necessary that the price of the asset grows at the same rate as the real GDP until it bursts. Hence we will look for an equilibrium in which, conditionally on the bubble not having burst until period t, the following holds:

$$\frac{p_{t+1}}{p_t} = \begin{cases} 1+\gamma, & \text{with probability } \lambda, \text{ and} \\ 0, & \text{with probability } 1-\lambda. \end{cases} \tag{4}$$

This guarantees that the value of the stock of estates does not become unboundedly higher than GDP in any state of nature.

Also in a stationary (balanced growth path) bubbly equilibrium, percapita consumption will grow at the same rate as GDP, that is

$$\frac{c_{t+1}}{c_t} = 1 + \gamma. \tag{5}$$

Therefore, since eq. (5) and the Euler equation (1) hold simulaneously, yielding:

$$1 + r_t = (1+\gamma)^{\sigma} (1+\rho). \tag{6}$$

Combining eq.s (3), (4), and (6), provided the bubble has not burst until period t, we have:

$$\lambda = 1 - \frac{(1+\rho)(1-\theta)}{(1+\gamma)^{1-\sigma}} \equiv \lambda^*(\rho, \sigma, \gamma, \theta). \tag{7}$$

Notice that $\lambda^*(\rho, \sigma, \gamma, \theta)$ gives the equilibrium probability of the bubble bursting as a function of the subjective interest rate, the elasticity of intertemporal substitution, the economy's growth rate, and the fiscal depreciation rate. From (5) we see that λ^* is non-negative if and only if:

$$\theta \geq 1 - \frac{(1+\gamma)^{1-\sigma}}{1+\rho} \equiv \theta_{\min}(\rho, \sigma, \gamma). \tag{8}$$

The threshold level, $\theta_{\min}$, of fiscal depreciation for the existence of a stationary rational real estate bubble with constant probability of exploding is positive, because the convergence of representative agent utility restricts parameters to $1 + \rho > (1+\gamma)^{1-\sigma}$. Therefore if government forced the fiscal amortization rate to be low enough the real estate bubble would not exist in this economy. Existence becomes possible only if the government allows for a level of θ at least as large as $\theta_{\min}$. Interestingly, the higher θ the higher the probability of the bubble collapsing each period. Therefore we can conclude with the following:

Proposition 1. *A stationary rational house price bubble equilibrium exists if and only if the fiscal depreciation rate θ is above a minimum level $\theta_{\min}$. The higher the allowed depreciation rate the higher the probability per year of a house price bubble crash.*

Notice that the crash probability is an example of a rational stationary sunspot equilibrium (Cass and Shell, 1983), that would not emerge in this economy (see, Tirole 1982) if the government did not introduce a fiscal depreciation rate.

With a standard unit elasticity of intertemporal substitution traditional in real business cycle literature, $\sigma = 1$, and the canonical subjective rate of time preference $\rho = 5\%$, the minimum yearly amortization needed to generate a bubble would be $\theta_{\min} = \frac{\rho}{1+\rho} = 0.048$. This, according to eq. (8), predicts the possibility of a house price bubble starting, with associated probability of bursting - eq. (7) - equal to $\lambda^*(\rho, \sigma, \gamma, \theta) = 1 - (1 + \rho)(1 - \theta) = 0.00002$. Despite the simplicity of our analysis, it seems that the usual 20 years fiscal depreciation is roughly borderline, and potentially able to generate a very long-lasting house price bubble. Using instead the 5 year lower bound of MACRS would imply a house price bubble expected to be crashing every 6 years and three months.

2.2.1 House finite lives

Our very simple framework can be extended in several realistic directions. One is to assume that each house has a finite expected life. We can model this by assuming a positive annual house crash rate, denoted $\delta > 0$. According to the literature, $\delta = 0.01$ is realistic, and it implies a 100 year expected life of the house. This would modify our eq. (3) to

$$\frac{p_{t+1}(1-\lambda)(1-\delta)}{p_t(1-\theta)} = 1 + r_t, \tag{9}$$

and, after the same steps as in the previous section, lead us to the following modified version of eq. (7):

$$\lambda = 1 - \frac{(1+\rho)(1-\theta)}{(1+\gamma)^{1-\sigma}(1-\delta)} \equiv \lambda^*(\rho, \sigma, \gamma, \theta, \delta). \tag{10}$$

Therefore the new expression for eq. (8) would be:

$$\theta \geq 1 - \frac{(1+\gamma)^{1-\sigma}(1-\delta)}{1+\rho} \equiv \theta_{\min}(\rho, \sigma, \gamma, \delta). \tag{11}$$

Using the previous numerical example for the other parameters, we obtain $\theta_{\min} = 1 - \frac{1-\delta}{1+\rho} = 1 - 99/105 = 0.0571$.

Quite interestingly, our very simple numerical analysis delivers a minimum annual fiscal depreciation rate required for a bubble to emerge that is slightly higher than 5% per year. This suggests that the standard fiscal depreciation rate of 5% per year would be the best rounding of the upper bound for a rational house price bubble not to emerge! According to my simple model, it seems that legislators adopting that simple accountancy rule could have been amazingly cautiosly generous towards the estate investors. However, the simple model of this paper also shows that they should be very careful not to increase it any further, if the wish to avoid house price bubbles. For example, MACRS, with its five year allowance, would open the door to rational house price bubbles of expected duration of about 8 years and 8 months.

3 Conclusion

This paper has shown that in a rational world in which real estate price bubbles would not exist, governments could induce the emergence of house price bubbles by allowing estate owners to fiscally depreciate their real estates at a rate higher than the actual physical depreciation of the estate. Moreover, the very existence of such house price bubbles allows for a probability of their crash. Finally, the crash probability is increasing in the fiscal depreciation rate.

A very simple rule of thumb numerical excercise has shown that the standard fiscal accounting practice of allowing for a 5% annual depreciation rate is the most generous fiscal depreciation able to safeguard the economies from house price bubbles.

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