Impact of a Land Price Fall When Labor Markets are Incomplete*

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April 2013

Abstract

In this paper, I explore the impact of a fall in land prices in a class of *incomplete labor markets models.* These models drop the usual equilibrium restriction that households optimally choose their level of labor supply, and instead treat the path of nominal wages as exogenous. I show that in incomplete labor markets models with overlapping generations or credit constraints, a fall in the price of land generates an inefficient decline in employment if the nominal interest

*First Version: October 2011. The paper was originally titled "Incomplete Labor Markets." I thank Bernabe Lopez-Martin for excellent research assistance, and Paco Buera, Jonathan Heathcote, Robert E. Lucas, Jr., Lee Ohanian, Jenni Schoppers, Sam Schulhofer-Wohl, and participants in the Christiano-Eichenbaum Dynamic Macroeconomics Group for useful comments. The views expressed in this paper are not necessarily shared by others in the Federal Reserve System or on the Federal Open Market Committee.

rate does not fall sufficiently. The low employment means that, in these kinds of models, interventions like debt-financed increases in government spending are Pareto improving.

1 Introduction

In this paper, I explore the theoretical properties of what I term *incomplete labor markets* models. I use this terminology because, as in (now conventional) incomplete markets models of financial markets, I restrict the ability of agents within the model to engage in all mutually beneficial exchanges. In incomplete financial markets models, agents cannot make all possible trades of state-contingent and date-contingent claims to consumption. In incomplete labor markets models, households are not able to offer to supply more labor for firms at a lower wage. More specifically, when I define the equilibrium conditions of an incomplete labor markets model, I drop the usual equilibrium condition that households choose their labor supply so as to maximize utility. I replace this condition with an exogenously specified path for nominal wages.

I consider the impact of a permanent fall in land prices in incomplete and complete labor markets models with overlapping generations or (equivalently) credit constraints. As will become clear, the fall in land prices can be generated by either fundamental or non-fundamental shocks. I assume that households are willing to supply labor inelastically, up to some maximal amount, and that the nominal interest rate is under the control of a policymaker. I show that, even if the policymaker leaves the nominal interest rate unchanged, the fall in land prices has no impact on employment or output if labor markets are complete. However, in the incomplete labor markets model, the land price fall leads to a permanent fall in both employment and output if the nominal interest rate is not lowered sufficiently.

Why does the completeness of labor markets matter for the impact of the land price decline? Regardless of the completeness of labor markets, the fall in the price of land reduces the demand for consumption at any given real interest rate. In incomplete labor markets, the expected inflation rate is pinned down by competition in the goods market and the exogenous path of nominal wages. If the policymaker does not change the nominal interest rate after the land price decline, the real interest rate will not change. The fall in consumption demand at that interest rate translates into less consumption, less output, and less employment.

The situation is quite different if labor markets are complete. Labor supply is inelastic. Hence, if firms are ever failing to demand all available work time, then households will bid down their current wages relative to anticipated future wages. Because of competition in the goods market, current prices fall relative to anticipated future prices. Households sell bonds in order to buy goods at their currently low prices, and that drives up firms' labor demand. This off-equilibrium process continues until firms do indeed demand all available work time. The decline in consumption demand manifests itself as an increase in the growth rate of wages, an increase in the expected inflation rate, and a fall in the real interest rate. There is no decline in employment or output.

Interventionist policies are not beneficial in a complete labor markets model, but can be beneficial when labor markets are incomplete. For example, a short-term, debt-financed increase in government spending raises employment and output permanently and is Pareto improving. Lowering the real interest rate sufficiently can also lead to a Pareto-improving increase in employment and output. Perhaps more surprisingly, within these models, any government intervention that reduces the private demand for saving can generate an increase in employment. Thus, in these models, the government can raise current employment by committing to raise future (lump-sum) taxes so as to provide Social Security and Medicare payments for the currently young.

I see my paper as highly related to recent work by Hall (2011a, 2011b). My contribution over Hall's is that my analysis provides a tighter connection between changes in asset values and the ultimate impact of those changes on labor markets. In this sense, my paper tries to answer Ohanian's (2010) call for further research that builds connections between financial market shocks and labor market distortions.[1]

In incomplete labor markets models, nominal wages are exogenous, but product prices are fully flexible, which means in turn that real wages al-

[1]See Farmer (2011) and Heathcote and Perri (2012) for alternative approaches that place less emphasis on the role of monetary policy.

ways adjust so as to equal the marginal product of labor. Hence, incomplete labor markets models are entirely distinct from models with *real* wage rigidities (such as those described in Shimer (2012) and Michaillat (2012)). In incomplete labor markets models, productivity shocks do not give rise to labor market inefficiencies, but consumption demand shocks do. In models with real wage rigidities, consumption demand shocks don't give rise to labor market inefficiencies, but productivity shocks do.

Incomplete labor markets models are similar to New Keynesian models, in the sense that adverse demand shocks do give rise to labor market inefficiencies. However, incomplete labor markets models provide a more explicit model of the link between changes in asset prices and changes in the demand for consumption. As well, product prices are flexible in an incomplete labor markets model, whereas price stickiness is the hallmark of New Keynesian modeling.[2]

2 A Benchmark Model

Consider an overlapping generations economy, in which all agents live two periods. Each cohort has a unit measure of agents. The initial old agents are each endowed with one unit of land. A unit of land pays off 1 unit of land services in every period. An agent born in period 1 and thereafter is

[2] Note that in their seminal analysis of New Keynesian models, Christiano, Eichenbaum, and Evans (2005) find that price rigidities are considerably less important than wage rigidities in understanding the business cycle properties of U.S. macroeconomic data.

endowed with one unit of time. When young, the agent can produce An units of consumption with n units of time. Old agents are unproductive.

An agent born in period 1, or thereafter, has a utility function of the form:

$$u(c_y) + \beta u(c_o + \theta d_o)$$

Here, c_y represents consumption of goods when young, c_o is consumption of goods when old, and d_o is land services consumed when old. I assume that $u', -u''$ are both positive. The agents supply labor inelastically. The parameter θ is common across all agents and represents how much they value land. The initial old prefer more consumption to less.

In period $t \geq 1$, the government pays off its obligations by selling one-period nominal bonds with face value $\overline{b}P_{t+1}$ units of consumption (where P_{t+1} is the price level in period $(t+1)$) and by levying a constant lump-sum tax τ^* units of consumption on young agents. The bonds pay a fixed nominal interest rate R. The initial old each own government debt that pays off $\overline{b}$ units of consumption. At each date, agents can trade consumption for land and bonds.

At this point, I will define two notions of steady-state equilibrium. In both, product markets are competitive and prices are fully flexible. The two notions differ, though, in terms of the structure of labor markets. In the first, wages are fully flexible. In the second, the wage path is exogenously fixed.

2.1 Complete Labor Markets Equilibrium

Given the real level of government debt $\overline{b}$ and a nominal interest rate R, I define a (steady-state) complete labor markets equilibrium in this economy to be a specification of a price path $\{P_t\}_{t=1}^{\infty} = \{P_0(1+\pi)^t\}_{t=1}^{\infty}$, a wage path $\{W_t\}_{t=1}^{\infty} = \{W_0(1+\pi_W)^t\}_{t=1}^{\infty}$, a real land price p_L, and quantities $(c_y^*, c_o^*, n^*, \tau^*)$ such that:

1. Households optimize at each date t:

$$\begin{aligned}(c_y^*, c_o^*, n^*, L^*, b^*) \quad \in \quad & \arg\max_{(c_y, c_o, L, n, b)} u(c_y) + \beta u(c_o + \theta L) \\ & s.t.\ P_t c_y + p_L P_t L + \frac{b P_{t+1}}{1+R} = W_t n - \tau^* P_t \\ & s.t.\ P_{t+1} c_o = p_L P_{t+1} L + b P_{t+1} \\ & s.t.\ c_y, c_o, L, b, n, 1-n \geq 0\end{aligned}$$

2. Firms optimize at each date:

$$n^* \in \arg\max_{n \geq 0} A P_t n - W_t n$$

3. Markets clear:

$$\begin{aligned}& c_y^* + c_o^* = A n^* \\ & L^* = 1 \\ & b^* = \overline{b}\end{aligned}$$

This is a rather vanilla overlapping generations model. Given $\bar{b}$ and R, the complete labor markets equilibrium $(c_y^*, c_o^*, n^*, P_0, \pi, \pi_W, \tau^*, p_L)$ is characterized by the following conditions:

$$W_0 = AP_0 \tag{1}$$

$$\pi = \pi_W \tag{2}$$

$$n^* = 1 \tag{3}$$

$$u'(c_y^*) = \beta\frac{(1+R)}{(1+\pi)}u'(c_o^* + \theta) \tag{4}$$

$$\tau^* = \bar{b}[\frac{R-\pi}{1+R}] \tag{5}$$

$$c_y^* = A - p_L - \bar{b} \tag{6}$$

$$c_o^* = p_L + \bar{b} \tag{7}$$

$$p_L = \frac{\theta(1+\pi)}{(R-\pi)} \tag{8}$$

Firms earn zero profits in equilibrium, and so the rate of wage inflation must equal the rate of inflation. Since the real wage is positive, households find it optimal to set $n^* = 1$. The inflation rate π is determined so that households are marginally indifferent between consumption when young and old. The land price p_L is simply the present value of the perpetual stream of services generated by land.

2.2 Incomplete Labor Markets Equilibrium

Given the constant real level of government debt $\overline{b}$, an exogenous wage path $\{\overline{W}_t\}_{t=1}^{\infty} = \{\overline{W}_0(1+\overline{\pi}_W)^t\}_{t=1}^{\infty}$, and an interest rate R, I define a steady-state incomplete labor markets equilibrium in this economy to be a price path $\{P_t\}_{t=1}^{\infty} \equiv \{P_0(1+\pi)^t\}_{t=1}^{\infty}$, a real land price p_L, and quantities $(c_y^*, c_o^*, n^*, \tau^*)$ such that:

1. Households optimize with respect to consumption, land, and bonds:

$$
\begin{aligned}
(c_y^*, c_o^*, L^*, b^*) \in \; & \arg\max_{(c_y, c_o, L, b)} u(c_y) + \beta u(c_o + \theta L) \\
& s.t. \; P_t c_y + p_L P_t L + \frac{b P_{t+1}}{1+R} = \overline{W}_t n^* - P_t \tau^* \\
& s.t. \; P_{t+1} c_o = P_{t+1} p_L L + b P_{t+1} \\
& s.t. \; c_y, c_o, L, b \geq 0
\end{aligned}
$$

2. Firms maximize profits:

$$
n^* \in \arg\max_{n \geq 0} A P_t n - \overline{W}_t n
$$

3. Markets clear:

$$
\begin{aligned}
& c_y^* + c_o^* = A n^* \\
& L^* = 1 \\
& b^* = \overline{b}
\end{aligned}
$$

In this incomplete labor markets equilibrium, households do not optimize with respect to n, because they cannot offer to work at a wage less than $\overline{W}_t$ in period t. In this version of equilibrium, $1 - n^*$ units of time do not get used.

Given $R, \bar{b}$, and $\overline{W}$, an incomplete labor markets equilibrium $(c_y^*, c_o^*, n^*, P_0, \pi, \tau^*, p_L)$ is defined by the equations:

$$P_0 = \overline{W}_0/A \tag{9}$$

$$\pi = \pi_W \tag{10}$$

$$\pi_W = \overline{\pi}_W \tag{11}$$

$$u'(c_y^*) = \beta \frac{(1+R)}{1+\pi} u'(c_o^* + \theta) \tag{12}$$

$$\tau^* = \bar{b} \frac{R - \pi}{1+R} \tag{13}$$

$$c_y^* = An^* - p_L - \bar{b} \tag{14}$$

$$c_o^* = p_L + \bar{b} \tag{15}$$

$$p_L = \theta \frac{1+\pi}{R-\pi} \tag{16}$$

These equations are the same as the ones defining the complete labor markets equilibrium, except that I've dropped the household's labor supply decision $n^* = 1$ and replaced it with the condition that $\pi_W = \overline{\pi}_W$ for all t.

2.3 Comparative Statics

In this subsection, I analyze the impact of changes in exogenous variables within the two notions of equilibrium. It is useful to note that because land is an asset that pays off θ in every period, R must be greater than π (positive real interest rates) in either notion of equilibrium. It follows that:

$$u'(c_y^*) > \beta u'(c_o^* + \theta)$$

Both notions of equilibrium are dynamically efficient, and that means that young households are "over-saving" relative to the natural rate of interest (equal to the population growth rate of zero). In the next section, I expand the analysis to include models with dynamically inefficient equilibria.

2.3.1 Complete Labor Markets Equilibrium

In a complete labor markets equilibrium with a lower value of θ, the inflation rate π has to rise so as to satisfy the household's intertemporal Euler equation:

$$u'(A - \frac{\theta(1+\pi)}{R-\pi} - \bar{b}) = \beta\frac{(1+R)}{(1+\pi)}u'(\frac{\theta(1+R)}{R-\pi} + \bar{b})$$

Thus, if people don't like land services as much, their demand for bonds rises (so as to better fund their retirements). If the real supply of bonds is fixed at $\bar{b}$, then bond prices rise and the real interest rate falls. In equilibrium, the young end up consuming more.

In a complete labor markets equilibrium with a higher value of $\bar{b}$, the inflation rate π has to fall so as to satisfy the household's intertemporal Euler equation. Intuitively, with more bonds available to save for retirement, the real interest rate rises.

In a complete labor markets equilibrium with a higher value of A, the consumption of both young and old households rises. There is a fall in the real interest rate and a rise in the inflation rate, as young households demand more bonds.

Finally, if the policymaker increases R, then π also rises sufficiently so as to keep $(1+R)/(1+\pi)$ unchanged. There is no impact on the consumptions of either young or old agents.

Because of the simplicity of the model, these steady-state calculations are actually informative about transitions. Suppose there is an unanticipated permanent fall in θ in period t. That fall in θ will make the price of land fall immediately. The old agents are worse off.

Should the government make up for the losses of the old by selling more bonds in that period and then transferring the proceeds to the old? The old in period t will be made better off by the government's doing so. However, the government needs to pay off its obligations by rolling over this higher level of debt. Because the complete labor markets equilibrium is dynamically efficient, all future generations are made worse off with the higher level of government debt.

2.3.2 Incomplete Labor Markets Equilibrium

In an incomplete markets equilibrium, the key equation that pins down equilibrium quantities is the household's intertemporal Euler equation:

$$u'(An^* - \frac{\theta(1+\overline{\pi}_W)}{R-\overline{\pi}_W} - \overline{b}) = \beta\frac{(1+R)}{(1+\overline{\pi}_W)}u'(\frac{\theta(1+R)}{R-\overline{\pi}_W} + \overline{b})$$

Thus, in an incomplete labor markets equilibrium with a lower value of θ, the value of n^* has to fall so as to satisfy the household's intertemporal Euler equation. Intuitively, when θ falls, the price of land falls, and old households have to consume less. With a fixed real interest rate (given by $(R-\overline{\pi}_W)$), the young households also consume less. Total output falls, and all households are worse off in the steady state.

In an incomplete labor markets equilibrium with a higher value of $\overline{b}$, the value of n has to rise so as to satisfy the household's intertemporal Euler equation. Intuitively, with a higher value of $\overline{b}$, old households can consume more. Given the fixed value of R, young households also consume more.

In an incomplete labor markets equilibrium with a higher value of A, the value of n^* has to fall to satisfy the household's intertemporal Euler equation. An increase in productivity has no impact on output and lowers employment.

What happens if R falls in an incomplete labor markets equilibrium? We can see that n^* has to rise to satisfy the household's intertemporal Euler equation. In other words, lower values of the nominal interest rate lead to higher steady-state output.[3]

3 Land Price Declines in Other Incomplete Labor Markets Models

The basic logic in the last section was simple. In both models, I considered the impact of a fall in the price of land. The fall in the price of land shrank the outside supply of assets. In a complete labor markets model, the decline in the supply of outside assets led the real interest rate to fall through an increase in the rate of wage inflation. People saved less and consumed more when young. However, total output remained unchanged. In an incomplete labor markets model, the wage inflation rate is exogenous. Through competition in the product market, the exogenous wage inflation rate pins down the rate of inflation itself. Hence, the real interest rate falls only if the government adjusts the nominal interest rate downward. Without that downward adjustment, people view current consumption as being too expensive and demand little of it. Equilibrium consumption and output both fall.

In this section, I discuss how this basic logic can be extended to four other kinds of incomplete labor markets models. First, I allow for the possibility of diminishing returns in labor by endowing the young agents with a (perishable) fixed factor of production. Next, I add capital to the over-

[3] Given that n^* is capped at one in this economy, there is no incomplete labor markets equilibrium if $\overline{\pi}_W$ is larger than the complete labor markets equilibrium inflation rate.

lapping generations version of the incomplete labor markets model discussed above. Then I consider the case of a bursting bubble in land prices. Finally, I examine the implications of a fall in land prices in an incomplete labor markets model with infinitely lived agents who face borrowing constraints. This last analysis builds on Woodford's (1986) classic equivalence result between overlapping generations economies and economies with infinitely lived finance-constrained agents. I simplify the notation by assuming that the exogenous wage inflation rate equals zero, although this assumption is not essential.

3.1 Adding Diminishing Returns to Labor

In this subsection, I change the earlier model so that the young agents are endowed with one unit of a fixed factor to production that disappears when they are old. Firms produce $F(n, a)$ units of consumption from n units of labor and a units of the fixed factor, where F is a constant returns-to-scale production function. They rent the fixed factor from the young in a competitive market.

Given a nominal interest rate R, a fixed wage $\overline{W}$, and a real debt level $\overline{b}$, I define an incomplete labor markets (steady-state) equilibrium in this economy with a fixed factor to be a constant price level P, a real land price p_L, a real factor rental rate r, and quantities $(c_y^*, c_o^*, n^*, k^*, \tau^*, b^*, a^*)$ such that:

1. Households optimize with respect to consumption, land, bonds, and

factor rental:

$$
\begin{aligned}
(c_y^*, c_o^*, L^*, b^*, a^*) \quad \in \quad & \arg \max_{(c_y, c_o, L, b, a)} u(c_y) + \beta u(c_o + \theta L) \\
& s.t. \; P[c_y + p_L L + \frac{b}{1+R}] = \overline{W} n^* - P\tau^* + Pra \\
& s.t. \; Pc_o = Pp_L L + bP \\
& s.t. \; c_y, c_o, L, b, a, 1 - a \geq 0
\end{aligned}
$$

2. Firms maximize profits:

$$
(n^*, a^*) \in \arg \max_{n, a \geq 0} PF(n, a) - \overline{W} n - Pra
$$

3. Markets clear:

$$
\begin{aligned}
& c_y^* + c_o^* = F(n^*, 1) \\
& L^* = 1 \\
& b^* = \overline{b}
\end{aligned}
$$

Given R and $\overline{b}$, an incomplete labor markets equilibrium $(c_y^*, c_o^*, n^*, P, r, \tau^*, P_L, b^*, a^*)$

is defined by the equations:

$$\overline{W} = PF_n(n^*, a^*) \tag{17}$$

$$r = F_a(n^*, a^*) \tag{18}$$

$$a^* = 1 \tag{19}$$

$$u'(c_y^*) = \beta(1+R)u'(c_o^* + \theta) \tag{20}$$

$$\tau^* = \frac{\bar{b}R}{1+R} \tag{21}$$

$$c_y^* = \overline{W}n^*/P - p_L - \bar{b} + r \tag{22}$$

$$c_o^* = p_L + \bar{b} \tag{23}$$

$$p_L = \theta/R \tag{24}$$

Here, the notations F_n and F_a represent the corresponding partial derivatives.

From Euler's theorem, we can conclude that:

$$c_y^* = F(n^*, 1) - p_L - \bar{b}$$

The level of labor is then determined by the household's Euler equation:

$$u'(F(n^*, 1) - p_L - \bar{b}) = \beta(1+R)u'(p_L + \theta + \bar{b}) \tag{25}$$

This equation implies that the qualitative comparative statics described in Section 2 apply in this incomplete labor markets model with diminishing returns.

3.2 Adding Capital

In this subsection, I change the earlier model so that the initial old are endowed with k units of capital (along with the bond and land endowments mentioned earlier). Capital depreciates at rate δ from one period to the next, and firms produce output using capital and labor according to the constant returns-to-scale production function $F(k, n)$. Then, given a nominal interest rate R, a real debt level $\bar{b}$, and a constant wage $\overline{W}$, I define an incomplete labor markets (steady-state) equilibrium in this economy to be a price level P, a real land price p_L, a capital rental rate r, and quantities $(c_y^*, c_o^*, n^*, k^*, \tau^*, b^*)$ such that:

1. Households optimize with respect to consumption, land, bonds, and capital:

$$
\begin{aligned}
(c_y^*, c_o^*, L^*, b^*, k^*) \in \; & \arg \max_{(c_y, c_o, L, b, k)} u(c_y) + \beta u(c_o + \theta L) \\
& s.t. \; P[c_y + p_L L + k + \frac{b}{1+R}] = \overline{W} n^* - P\tau^* \\
& s.t. \; P c_o = P[p_L L + rk + (1-\delta)k + b] \\
& s.t. \; c_y, c_o, L, b, k \geq 0
\end{aligned}
$$

2. Firms maximize profits:

$$
(k^*, n^*) \in \arg \max_{n,k \geq 0} P[F(k, n) - rk] - \overline{W} n
$$

3. Markets clear:

$$c_y^* + c_o^* + \delta k^* = F(k^*, n^*)$$

$$L^* = 1$$

$$b^* = \overline{b}$$

Given $(R, \overline{b}, \overline{W})$, an incomplete labor markets equilibrium $(c_y^*, c_o^*, n^*, w, r, \tau^*, p_L, k^*, b^*)$ is defined by the equations:

$$\overline{W} = PF_n(k^*, n^*) \tag{26}$$

$$r = F_k(k^*, n^*) \tag{27}$$

$$u'(c_y^*) = \beta(1+R)u'(c_o^* + \theta) \tag{28}$$

$$(1 - \delta + r) = (1 + R) \tag{29}$$

$$\tau^* = \frac{\overline{b}R}{1+R} \tag{30}$$

$$c_y^* = \overline{W}n^*/P - p_L - \overline{b} - k^* \tag{31}$$

$$c_o^* = p_L + \overline{b} + k^*(1 - \delta + r) \tag{32}$$

$$p_L = \frac{\theta}{R} \tag{33}$$

Here, the notations F_n and F_k represent the corresponding partial derivatives.

Given R, equation (29) determines r, equation (27) determines the ratio $\widehat{k} = k^*/n^*$, and equation (26) determines P. The level of labor is then determined by the household's Euler equation:

$$u'(\frac{\overline{W}n^*}{P} - \frac{\theta}{R} - \overline{b} - \widehat{k}n^*) = \beta(1+R)u'(\frac{\theta(1+R)}{R} + \overline{b} + \widehat{k}(1-\delta+r)n^*) \quad (34)$$

In the appendix, I prove that if u exhibits nonincreasing relative risk aversion and $\beta(1+R) \geq 1$, then n^* is increasing as a function of $\overline{b}$ and θ in the neighborhood of a steady state in which $F_n(\widehat{k}, 1) > \widehat{k}(2-\delta+r)$. Under these same conditions, n^* is decreasing as a function of R in the neighborhood of a steady state in which $-F_{kk}k < 1$, where F_{kk} represents the partial second derivative with respect to k. I show too that this restriction on F is satisfied if F is Cobb-Douglas and R is sufficiently close to zero.

3.3 Dynamic Inefficiency: The Collapse of a Bubble

I return to the overlapping generations model without capital of the last section. However, I change the model of preferences so that agents have a utility function of the form:

$$u(c_y) + \beta u(c_o)$$

so that land has no intrinsic service flow. This modeling approach allows for the possibility that land prices have a bubble. In particular, given a nominal interest rate $R = 0$ and an outside real debt level $\overline{b}$, an incomplete labor markets (steady-state) equilibrium $(c_y^*, c_o^*, n^*, P, \tau^*, p_L)$ in this economy is defined by the equations:

$$\overline{W} = PA \tag{35}$$

$$u'(c_y^*) = \beta u'(c_o^*) \tag{36}$$

$$\tau^* = 0 \tag{37}$$

$$c_y^* = An^* - p_L - \overline{b} \tag{38}$$

$$c_o^* = p_L + \overline{b} \tag{39}$$

There is a continuum of possible steady-state equilibria in this economy, indexed by the real price of land. Across these steady states, output and employment (that is, n^*) are increasing functions of p_L (that is, the bubble).

What if R is set to a constant value other than zero? In that case, the price of land cannot be constant in equilibrium (because it must rise at the rate of interest). If R is set to a constant that is less than zero, there is a continuum of possible equilibria. In all of these equilibria, the land price eventually converges to zero (because the real interest rate is negative). In contrast, if R is set equal to a constant greater than zero, then the unique equilibrium is one in which the price of land equals its fundamental value of zero. In this sense, this model justifies the notion that easy monetary policy generates bubbles.[4]

[4]This result contrasts with the analyis of Gali (2013). He considers an overlapping generations model with nominal rigidities. However, he assumes that the relevant rigidities are nonbinding in any deterministic steady state. Hence, he finds that monetary policy is irrelevant for the existence of deterministic bubbles.

3.4 Borrowing Constraints

Consider an economy with a unit measure of *even* agents and a unit measure of *odd* agents. All agents are infinitely lived and have the same utility function:

$$\sum_{t=1}^{\infty} \beta^{t-1} u(c_t + \theta d_t)$$

where c_t is the agent's consumption in period t, and d_t is the land owned by the agent at the beginning of period t. All agents are endowed with one unit of time in every period. Odd agents can produce An units of consumption by working n units of time in odd-dated periods, but they are unproductive in even-dated periods. The reverse is true of even agents.

The even agents (who are unproductive in period 1) are initially endowed with one unit of land. The even agents are also each endowed with $\bar{b}$ units of a one-period bond that pays off one unit of consumption in period 1. The government raises the taxes to pay that bond by taxing the productive agents τ^* units of consumption and issuing bonds with nominal interest rate R that are worth $\bar{b}/(1+R)$ units of consumption. Agents cannot short-sell land or bonds.

I consider a steady-state incomplete labor markets equilibrium, in which productive agents always consume the same amount c_p^*, unproductive agents always consume the same amount c_u^*, and agents who are productive in a given period begin that period holding no land. Mathematically, given a constant nominal interest rate R, I define an incomplete labor markets equilibrium in this economy to be a specification of a real land price p_L, a price level P, and quantities $(c_p^*, c_u^*, n^*, \tau^*)$ such that:

$$u'(c_p^*) = \beta(1+R)u'(c_u^* + \theta) \tag{40}$$

$$u'(c_u^* + \theta) \geq \beta(1+R)u'(c_p^*) \tag{41}$$

$$c_p^* + c_u^* = An^* \tag{42}$$

$$\overline{W} = PA \tag{43}$$

$$\tau^* = \overline{b}R/(1+R) \tag{44}$$

$$p_L = \theta/R \tag{45}$$

$$c_p^* = An^* - \overline{b} - p_L \tag{46}$$

$$c_u^* = \overline{b} + p_L \tag{47}$$

If we translate c_y^* into c_p^* and c_o^* into c_u^*, these conditions are identical to the ones characterizing the incomplete labor markets equilibrium in the original overlapping generations economy. The exception is (41). That condition guarantees that the unproductive agents don't want to buy any land or bonds. It is satisfied if $\beta(1+R) \leq 1$.

4 Recent Macroeconomic Experience

In this section, I interpret recent macroeconomic data using the benchmark incomplete labor markets model and describe the model's implications for the impact of various policy interventions.

4.1 Interpreting Data

At the end of 2012, the price of residential land in the United States was considerably lower than at the end of 2006. I believe that it is not unreasonable to treat this fall as largely unanticipated. Consider the benchmark overlapping generations model with incomplete labor markets models discussed in Section 2. Suppose that, at some date T, the utility θ from land services falls permanently to a new value $\theta' < \theta$. How does this change affect the path of employment in this benchmark model – assuming, for the moment, that the nominal interest rate R and the real government debt $\bar{b}$ do not change?

In the benchmark model, transitions are simple. The old agents' demand for consumption is always equal to the sum of the real value of land and the real payoff from bonds. Hence, after the unexpected fall in θ occurs in period T and thereafter, employment falls to n', which solves:

$$\begin{aligned} u'(c'_y) &= \beta \frac{(1+R)}{1+\overline{\pi}_W} u'(c'_o + \theta') \\ An' &= c'_y + c'_o \end{aligned}$$

where c'_o is the new consumption of the old agents and c'_y is the new consumption of the young agents. The fall in θ lowers $c'_o + \theta'$. Given a fixed R, the fall in $c'_o + \theta'$ leads to a fall in c'_y:

$$c'_y = u'^{-1}\left(\beta \frac{(1+R)}{1+\overline{\pi}_W} u'(c'_o + \theta')\right)$$

The impact on n' depends on the functional form of u, and the impact of the fall in θ' on the consumption of the old agents. Suppose, for example, that $u'(c) = c^{-\gamma}$. In that case, if $c'_o + \theta'$ falls by $\alpha\%$, so do employment and output, regardless of the size of γ.

Hence, in the benchmark incomplete labor markets model, a fall in θ triggers a simultaneous fall in land prices, consumption, and employment even though real wages do not change. This implication is roughly consistent with the observation that land prices, per capita consumption, and per capita employment have fallen in the United States over the past six years, while real wages have remained roughly constant.[5]

4.2 Policy Perspectives

In the previous subsection, I considered the impact of an unanticipated fall in θ at date T in the benchmark model. Suppose that the government reacts to that fall in θ by lowering interest rates R in period T and thereafter. That fall in R translates into an increase in p_L and c'_y, and thereby into a permanent increase in n'. Note that all agents are better off. The young agents are unhappy because they are receiving a lower real interest rate – but that decline is offset by the increase in their labor incomes.

Now suppose that the government sells bonds worth $\overline{b}'$ units of consumption in period T and thereafter, where $\overline{b}' > \overline{b}$. It spends the extra resources in period T on public goods or alternatively distributes them to the old agents

[5] As measured by real hourly compensation in the nonfarm business sector.

in period T. The additional bonds serve to deliver more consumption to old agents in period $(T + 1)$ and thereafter. That leads the young to demand more consumption in period T and thereafter. Again, all agents are better off, *regardless of how the government spends the extra resources in period* T.

I see this result about government debt as being linked to Caballero and Farhi's (2012) analysis of what they term a safe asset mechanism. The basic problem in the incomplete labor markets model is that a decline in land prices drives down the real interest rate that is consistent with full employment. By issuing more safe debt, the government has the ability to raise the real interest rate consistent with full employment. Essentially, the decline in land prices robs the economy of safe assets in Caballero and Farhi's sense. The government can replace the lost safe assets, assuming that its debt is indeed safe.

More generally, the government could raise employment and welfare by introducing any lump-sum tax/transfer program that drives out private saving. For example, suppose the government were to tax the young and transfer more to the old. This tax/transfer scheme raises the consumption of the old agents. Given a fixed R, productive agents' demand for consumption rises, and that generates more employment.

5 Some Conclusions

There is an ongoing debate among policymakers and academics about the appropriate policy response to the recent large and persistent decline in employment in the United States. In this paper, I contrast the policy implications of what I term *complete* and *incomplete* labor markets models. In the former class of models, labor markets are Walrasian. In the latter class of models, workers are unable to offer to work more hours for a lower wage, and the wage rate is exogenous. In the former class of models, unanticipated declines in the price of land have no impact on employment. In the latter class of models, an unanticipated decline in the price of land results in an inefficient decline in employment. Relatedly, expansionary fiscal and monetary policy are both welfare-improving responses to such a decline in the price of land in the incomplete labor markets models. The analysis suggests that a key issue in the policy debate is the responsiveness of wages to labor supply conditions.

Some might simply discard incomplete labor markets models out of hand based on (at least) two philosophical considerations. The first is Lucas' famous criticism (1980, p. 709) that disequilibrium models inevitably involve more free parameters than equilibrium models, and we should be wary of theorists bearing free parameters. The second is Barro's (1977) equally famous skepticism that much unemployment could result from the failure of firms and workers to reach mutually beneficial agreements.

There was a time, I think, when these observations might well have seemed very compelling. (They certainly did to me for many years.) I have to say, though, that time is past. In terms of Lucas' observation, empirically relevant equilibrium models typically come equipped with a host of less-than-fully-motivated shocks to preferences, technology, and market power. It is not obvious why this approach is preferable to the incomplete labor markets approach that I pursue in this paper.

In terms of Barro's observation, there is a great deal of cutting-edge modeling in macroecononomics that is based on the assumption that financial markets are incomplete. This modeling approach proceeds by imposing ad hoc restrictions on the ability of model entities to make mutually beneficial exchanges. As my language in the current paper suggests, I see little a priori distinction between this modeling paradigm and the one that I adopt in this paper.

So, given how macroeconomics has developed over the past thirty years, I don't find the above philosophical reactions dispositive. I would rather proceed empirically. Here, it seems to me that – over thirty years after Kydland and Prescott (1982) and Long and Plosser (1983) – there are still important holes in economists' understanding of the cyclical determinants of employment. (And I mean to include both labor economists and macroeconomists in that characterization.) Thus, I see the two classes of models in this paper – complete labor markets and incomplete labor markets models – as both being unduly stark. I do believe that, unlike what is posited in incomplete labor markets models, wages are responsive to labor supply conditions. However, I don't believe that the nature of that response is well captured by complete labor markets models. In those models, if the nominal interest rate doesn't fall sufficiently, the labor market clears because excess labor supply pushes *upward* on the growth rate of nominal wages. This kind of adjustment process certainly does not take place instantaneously. More troublingly, it seems somewhat counterintuitive over any time horizon.[6]

Ultimately, as economic scientists and policymakers, we need to have a considerably better understanding of the determinants of the adjustment process of wages and its eventual impact on macroeconomic outcomes. I believe that this understanding will be based on the rich body of available microeconomic evidence, possibly supplemented by survey work along the lines of that done by Bewley (1999).

[6]In New Keynesian models with sticky wages, only some (randomly selected) suppliers of imperfectly substitutable labor are able to adjust their wages at any point in time. In equilibrium, wages adjust only slowly in response to shocks. See Schmitt-Grohe and Uribe (2012) and Christiano, Eichenbaum, and Trabandt (2013) for other models of nominal wage evolution. Importantly, in all of these papers, the underlying adverse shock to demand is transitory. In the current paper, the underlying adverse shock to demand is permanent.

6 Appendix[7]

Let $q = (1+R)^{-1}$ and $w = F_n(\widehat{k}, 1)$. In this appendix, I use the equilibrium condition:

$$qu'(wn^* - \frac{\theta q}{1-q} - \overline{b} - \widehat{k}n^*) - \beta u'(\frac{\theta}{1-q} + \overline{b} + \widehat{k}n^*(1-\delta+r)) = 0 \quad (48)$$

from the model with capital to derive local comparative statics of n^* with respect to $\theta, \overline{b}$, and q. I begin by assuming that:

$$u \text{ is NIARA}$$
$$\beta \geq q$$
$$w > \widehat{k}(2-\delta+r)$$

The derivative of the condition (48) with respect to n^* is:

$$qu''(c_y^*)(w-\widehat{k}) - \beta u''(c_o^* + \theta)\widehat{k}(1-\delta+r)$$

[7] I thank Bernabe Lopez-Martin for his excellent research assistance with this appendix.

Since $q \leq \beta$, $c_y^* \leq (c_o^* + \theta)$. Since u is NIARA, we know that $u''(c_y^*)/u'(c_y^*) \leq u''(c_o^* + \theta)/u'(c_o^* + \theta)$. Hence $-qu''(c_y^*) \geq -\beta u''(c_o^* + \theta)$, and the derivative:

$$\begin{aligned} & qu''(c_y^*)(w - \widehat{k}) - \beta u''(c_o^* + \theta)\widehat{k}(1 - \delta + r) \\ \leq\ & qu''(c_y^*)(w - \widehat{k} - \widehat{k}(1 - \delta + r)) \\ <\ & 0 \end{aligned}$$

is negative. This result immediately implies that, for a fixed q, n^* is an increasing function of θ and B in a neighborhood of the steady state.

I next add the assumption that:

$$-F_{kk}k < 1 \tag{49}$$

The derivative of the condition (48) with respect to q is:

$$u'(c_y^*) + qu''(c_y^*)(\frac{\partial w}{\partial q}n^* - \frac{\partial \widehat{k}}{\partial q}n^* - \frac{\partial p_L}{\partial q}) \tag{50}$$

$$-\beta u''(c_o^* + \theta)(\frac{\theta}{(1-q)^2} + \frac{\partial \widehat{k}}{\partial q}n^*(1 - \delta + r) + \widehat{k}n^*\frac{\partial r}{\partial q}) \tag{51}$$

I want to prove that this derivative is positive (which will imply that n^* is an increasing function of q in a neighborhood of the steady-state).

Define $f(\widehat{k}) = F(\widehat{k}, 1)$. The assumption (49) implies that $-f''(\widehat{k})\widehat{k} < 1$.

From the first-order condition defining $\widehat{k}$, we know that:

$$-q^{-2} = f''(\widehat{k})\frac{\partial \widehat{k}}{\partial q}$$

and so:

$$\frac{\partial \widehat{k}}{\partial q} > 0$$

It is easy to show from the first-order condition for labor, and the homogeneity of F, that:

$$\frac{\partial w}{\partial q} = -f''(\widehat{k})\widehat{k}\frac{\partial \widehat{k}}{\partial q}$$

Since $-f''(\widehat{k})\widehat{k} < 1$, this ensures that the first term (50):

$$qu''(c_y^*)(\frac{\partial w}{\partial q}n^* - \frac{\partial \widehat{k}}{\partial q}n^* - \frac{\partial p_L}{\partial q})$$

is positive. As well:

$$\frac{\partial r}{\partial q} = f''(\widehat{k})\frac{\partial \widehat{k}}{\partial q}$$

and so:

$$\begin{aligned} & \frac{\partial \widehat{k}}{\partial q}n^*(1-\delta+r) + \widehat{k}n^*\frac{\partial r}{\partial q} \\ = \quad & \frac{\partial \widehat{k}}{\partial q}n^*(1-\delta+f'(\widehat{k})) + \widehat{k}n^*f''(\widehat{k})\frac{\partial \widehat{k}}{\partial q} \\ = \quad & \frac{\partial \widehat{k}}{\partial q}n^*(q^{-1}+\widehat{k}f''(\widehat{k})) \end{aligned}$$

which is positive because $q^{-1} > \beta^{-1} > 1 > -\widehat{k}f''(\widehat{k})$. It follows that (51) is also positive.

Note that if $F(k,n) = k^{\alpha} n^{1-\alpha}$, then $-F_{kk}k = \alpha(1-\alpha)\widehat{k}^{\alpha-1}$. Since $\alpha\widehat{k}^{\alpha-1} = q^{-1} - 1 + \delta$, $-F_{kk}k < 1$ iff $(1-\alpha)(q^{-1} - 1 + \delta) < 1$, which is true if:

$$q > \frac{(1-\alpha)}{1 + (1-\alpha)(1-\delta)}$$

References

[1] Barro, R.J. (1977): "Long-Term Contracting, Sticky Prices, and Monetary Policy," *Journal of Monetary Economics*, 3 (3), pp. 305-316.

[2] Bewley, T. (1999): *Why Wages Don't Fall During a Recession*, Harvard University, Cambridge, MA.

[3] Caballero, R. and E. Farhi (2012): "A Model of the Safe Asset Mechanism (SAM): Safety Traps and Economic Policy," MIT working paper.

[4] Christiano, L., M. Eichenbaum, and C. Evans (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy* 113(1), pp. 1-45.

[5] Christiano, L, M. Eichenbaum, and M. Trabandt (2013): "Unemployment and Business Cycles," Northwestern University working paper.

[6] Farmer, R. E. A. (2011): "Confidence, Crashes and Animal Spirits," unpublished manuscript, UCLA.

[7] Gali, J. (2013): "Monetary Policy and Rational Asset Bubbles," CREI working paper.

[8] Hall, R. E. (2011a): "The Long Slump," *American Economic Review*, 101 (2), pp. 431–469.

[9] Hall, R. E. (2011b): "Clashing Theories of Unemployment," Hoover Institution and Stanford University.

[10] Heathcote, J., and F. Perri (2012): "Wealth and Volatility," Federal Reserve Bank of Minneapolis working paper.

[11] Kydland, F. E., and E. C. Prescott (1982): "Time to Build and Aggregate Fluctuations," *Econometrica* 50 (6), pp. 1345-70.

[12] Long Jr., J. B., and C. I. Plosser (1983): "Real Business Cycles," *Journal of Political Economy* 91 (1), pp. 39-69.

[13] Lucas Jr., R. E. (1980): "Methods and Problems in Business Cycle Theory," *Journal of Money, Credit and Banking* 12 (4), Part 2, pp. 696-715.

[14] Michaillat, P. (2012): "Do Matching Frictions Explain Unemployment? Not in Bad Times," *American Economic Review* 102 (4), pp. 1721-50.

[15] Ohanian, L. E. (2010): "The Economic Crisis from a Neoclassical Perspective," *Journal of Economic Perspectives* 24 (4), pp. 45-66.

[16] Schmitt-Grohe, S., and M. Uribe (2012): "Pegs and Pain," Columbia University working paper.

[17] Shimer, R. (2012): "Wage Rigidities and Jobless Recoveries," The University of Chicago working paper.

[18] Woodford, M. (1986): "Stationary Sunspot Equilibria in a Finance-Constrained Economy," *Journal of Economic Theory* 40 (1), pp. 128-37.