Financing Growth without Banks: Korean Housing Repo Contract*

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Abstract

Imperfect financial intermediation is a key bottleneck in economic development. Korea's unique *Jeonse* or housing repo contract channels funds directly from tenant/lenders to landlord/entrepreneurs, bypassing the banking system. In a housing repo, the landlord/entrepreneur puts up the house as collateral when borrowing from the tenant/lender. The lender's loan is secured by living in the collateral asset, lowering the cost of capital and increasing credit. Jeonse has been the dominant form of rental contract in Korea, and has served as a mode of direct debt financing that by-passes the banking sector.

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1 Introduction

Capital accumulation supported by efficient channeling of financial resources is key to successful economic development. However, the imperfect nature of financial intermediation has presented serious bottlenecks to the smooth flow of financing. The challenges posed by informational asymmetries and lack of enforcement mechanisms often rule out direct financing from savers to entrepreneurs. Banks play the role of delegated monitor (Diamond (1984), Dewatripont and Tirole (1994)) channeling funds from deposits to borrowers.

However, financial intermediation through the banking sector is beset by its own challenges. Among other things, financial intermediation through the banking sector is subject to a "double-decker" moral hazard problem - the first between the depositor and the bank, and the second between the bank and the borrower (Holmstrom and Tirole (1997, 1998)). Even for an advanced economy, overcoming the double decker moral hazard problem can be a serious hurdle to the smooth functioning of the financial system, as seen recently during the global financial crisis. For a developing economy, the challenges are even more serious and often results in a distorted banking sector that shuts out all but the best borrowers, and any financing provided by the banking sector comes with a hefty spread.

A snapshot of the cost of intermediated finance in developing countries can be seen in Figure 1, which plots the spread between the bank lending rate and the deposit rate for 87 countries whose per capita GDP averaged less than $10,000 during the period 2000 - 2009. The average spread is 9.3 percentage points, with several countries exceeding 20%. When the lending rate is inflated by such spreads, credit is out of reach for all but a small minority of borrowers.

Under such severe brakes on lending, any social institution that can bypass the banking sector and yet enable direct debt financing from lenders to borrowers would be invaluable in tackling the financial bottleneck to development. In this paper, we point to the housing contract in Korea - the

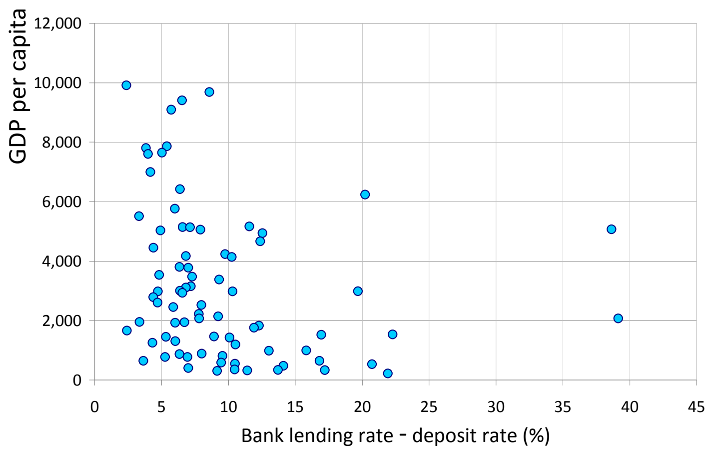

Figure 1. Spread between bank lending rate and deposit rate (%) for emerging and developing countries with per capita GDP of less than $10,000. Source: IMF International Financial Statistics (2010)

Jeonse system[1] - as an institution that enables direct financing to become viable that by-passes the banking sector.

The *Jeonse* contract is essentially a repurchase agreement (repo) in which the landlord borrows from the tenant, with the house as collateral. At the contracting date, the landlord grants the tenant the right of occupation (not ownership) for payment of q, where q is some fraction of the purchase price p of the house.[2] The contract specifies a termination date (typically two years after the contract date) at which time the landlord repays the initial nominal amount q in return for reposession of the house. In the interim period, there are no cash payments in either direction.

The housing repo is the bundling of two separate economic transactions into one where the cash flows net out. It is a collateralized loan from the tenant to the landlord. But it is also a lease on the house, where the lender actually *lives inside* the collateral. By sitting on the collateral (literally), the

[1]Jeonse is also spelled "Chonsei".

[2]Typically, q is between 40% and 60% of p. We will model the relationship between q and p below.

creditor's cost of managing the collateral is minimized, and by cutting out the middle man (the bank), the "double decker" agency costs are eliminated. Moreover, because the two implicit cash flows (interest payment and rent) are designed to net out, the hold-up problems associated with delinquent tenants who are late on their rents are also eliminated.

Jeonse has been the dominant form of rental contract in Korea since the 1960s.[3] At its peak in the mid-1990s, Jeonse accounted for two-thirds of all housing rents and leases and 30% of all dwellings.[4] The legal underpinnings governing *Jeonse* are highly developed in Korea, with many-layered legal safeguards for the smooth working of the contract. For instance, if the landlord declares bankruptcy, the tenant has the senior lien on the house, and comes before other creditors. In return, the landlord's legal claim to the house at the end of the contract is protected.

The landlord might be an urban small business owner, or an extended family member of a small business owner who needs business financing but is shut out of the formal banking sector. The tenant might be a young worker who has yet to save enough to buy a house outright or is a recent arrival in the city who is saving to get on the housing ladder. The combination of the lack of a mortgage market in Korea and the *Jeonse* system is one possible reason for the high savings rate in Korea in the years of its rapid

[3]When including quasi-*Jeonse* (where a tenant pays 30-70% of the full Jeonse deposit at the contracting date and a substantially reduced amount of monthly rent), *Jeonse* and quasi-*Jeonse* account for 97% of all Korean housing rental contracts in 2009. Pure monthly rent contracts accounts for only 3% of the total.

[4]Although the original contractual form of Korean Jeonse housing contract can be traced back several hundred years in Korea, the heyday of the Jeonse contract was in the period of rapid industrialization and urbanization in the 1960s and 1970s in Korea, backed by the body of laws that were revised or newly promulgated to govern the practice. The incidence of the Jeonse contract has slightly waned in recent years, but still accounts for 54% of total housing leases and 23% of all dwellings currently. In Korea, about 40-50% of households live in leased houses. The Jeonse contract (also spelled "Chonsei") was mentioned by Follain, Lim and Renaud (1980) in their study of housing demand in Korea. Ambrose and Kim (2003) study the default option in the Jeonse contract, and Cho (2006) examines the relation between house prices and jeonse prices.

industrialization.[5]

Our paper is a theoretical investigation of the economic properties of the *Jeonse* repo contract, focusing on the credit relationship that is created when the lease is signed. We build a model of an economy with two types of agents, either of which could become entrepreneurs: households who own a house but without financial resources and non-house owners with some savings. Our setting is one where contract enforcement problems are severe, so that it is costly to enforce the payment of interest and rent.

In the benchmark case where the landlord and the tenant do not have access to the housing repo contract but only to the traditional monthly rent contract, the entrepreneur obtains inefficiently low financing for his project, and there is inefficiently low supply of housing. With the introduction of the housing repo contract, however, there is a substantial gain in efficiency of financing and a lowering of cost of capital.

Critical to the efficiency gain is the netting out of the two cashflows that individually are subject to frictions, but where together, they net out. The landlord does not need to collect monthly rent from the tenant, nor the tenant needs to collect interest from the landlord.

The remarkable feature of this institution is that the channeling of funds from savers to entrepreneurs is achieved directly, without the need to go through the banking sector with all its attendant frictions. By enabling the direct channeling of finance, the system mimics the textbook competitive market for credit where borrowers and lenders come together and transact at the market-clearing price. Although the banking sector is by-passed and is smaller as a consequence, investment is at or close to first best, since finance is still flowing - directly, rather than through the banking sector. Thus, raw measures such as the bank credit to GDP ratio underestimates the underlying credit flows in the economy. This feature explains our title:

[5]During the era of remarkable 8 percent growth, Korea's savings rate has dramatically risen. The savings as percentage of GDP roses from 9 percent in 1960 to 33 percent in 2005.

"Financing Growth without Banks".

The importance of the availability of collateral assets for efficiency has been emphasized by Holmstrom and Tirole (1998, 2001) in their work on the private and public supply of liquidity, although their focus has been on developed financial markets and the role of treasury securities. Kiyotaki and Moore (1997, 2001) have shown how the efficiency of the use of collateral assets affects financial cycles. Collateral is a way to secure a repayment of loan principal and interest. Our model of housing repo emphasizes the role of bilateral collateralization and net-out of bilateral cash flows. Eisfeldt and Rampini (2009) is more directly concerned with the comparison between collateralized lending versus leasing. They show how leasing expands the implicit debt capacity of the borrower compared to secured borrowing.

The outline of the paper is as follows. We begin by laying out the fundamentals and the efficient benchmark in the absence of frictions. If direct finance is ruled out, banks can channel financing, but inefficiently. We show that the repo contract improves efficiency and lowers the cost of capital for investment, raising output. We conclude with a broader discussion of why the repo contract was able to develop in Korea, and why financial development has put strains on the system in recent years. These recent difficulties are also revealing in their own right, since they point to the pre-conditions that allow the system to take root.

2 Model and Efficient Benchmark

The economy is populated by a continuum of individuals, each endowed with a project, but where the productivity differs across individuals in the population. Time is discrete, indexed by the positive integers, and agents live forever. All agents have identical quasi-linear preferences with log utility defined over consumption and housing services given by

$$\sum_{t=0}^{\infty} \beta^t \left(\ln c_t + v\right) \tag{1}$$

where β is the subjective discount factor and v is the per-period utility coming from housing consumption, to be defined shortly. Initially, we will assume that there is no saving in the economy so that the model is essentially a sequence of static economies. We examine saving and capital accumulation in a later section.

Although preferences are identical, endowments are not. There is a measure m of agents who own a house, but nothing else, and there is a measure n of agents (with $n > m$) who do not own a house, but each have w units of the consumption good that can be stored for consumption next period or used in investment. Each house has one spare room that can accommodate a lodger, and this room can be rented out.[6]

Since $n > m$, there is insufficient housing to accommodate everyone. Individuals who do not own or rent a house sleep rough, and the housing component v in the utility function is zero. For those who have housing (either rented or owned), we have $v = \bar{v} > 0$. Assume for simplicity that there is no additional utility gained from using the whole house, rather than sharing it with a tenant. This fixes the supply curve for housing to be vertical at m.

Productivity is uniformly distributed in the following way. The productivity of an individual is determined by his type, indexed by $i \in [0, 1]$, and is equal to $\theta \times i$ for some constant θ that is common to all individuals. Type i has a project whose output y^i depends on input z as follows.

$$y^i(z) = \begin{cases} 0 & \text{if } z < k \\ (\theta \times i)k & \text{if } z \geq k \end{cases}$$

[6]This feature captures the common practice in Korea in the early years of the housing repo, where one section of the house would be rented out to a tenant. This practice has become rarer with the advent of apartments.

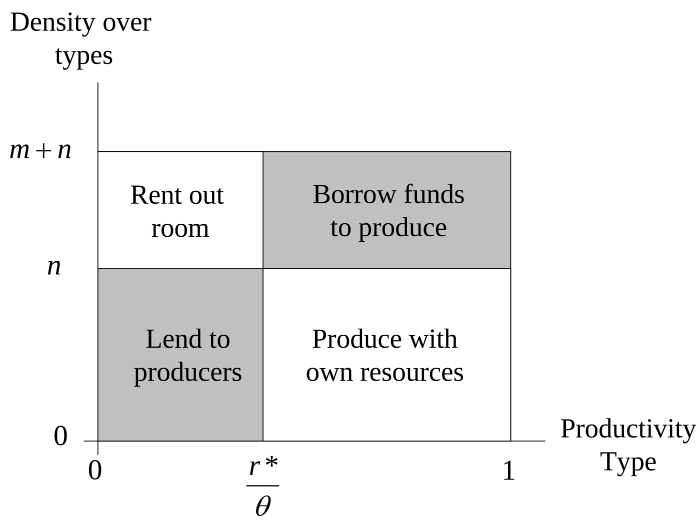

Figure 2. Productivity types in the economy and the demand and supply of credit

for constant k. Assume that $k < w$, so that non-house owners have enough funds to produce without borrowing.

There are two prices in this economy - the per period rent R and gross interest rate r. We first solve for the competitive equilibrium in the frictionless economy which will serve as the efficient benchmark. In this benchmark, the credit market clears through the interest rate r and the rent R clears the housing rental market.

Consider first the market for credit. For both house owners and non-house owners, production is optimal if and only if $\theta \times i \geq r$. If $\theta \times i < r$, then for house owners, their income is limited to the rental income R by taking in a lodger. For non-house owners with $\theta \times i < r$, their income comes from lending out their endowment w at the interest rate r. Figure 2 depicts the population density of types in the economy and the market clearing interest rate r^*.

Given the interest rate r, the demand for credit comes from house owners with types higher than r/θ. Since the population density over types is uniform, the demand for credit is linear and given by $m\,(1 - r/\theta)\,k$. The supply of credit comes from the low types of non-house owners, plus any residual wealth that high type non-house owners have left over after investment. The supply of credit is given by

$$\begin{aligned} & n\frac{r}{\theta}w + n\left(1-\frac{r}{\theta}\right)(w-k) \\ = \; & n(w-k) + \frac{r}{\theta}nk \end{aligned} \tag{2}$$

Equating the demand and supply of credit, the competitive interest rate r^* and the threshold type i^* are given by:

$$i^* = \frac{r^*}{\theta} = \frac{m+n-n\frac{w}{k}}{m+n} \tag{3}$$

The competitive rental rate R clears the housing rental market by making the marginal type indifferent between living rough (but not paying rent) and paying R to lodge in a house. Denote by $\tilde{\imath}$ this threshold type of non-house owners. There are two cases to consider, depending on whether $\tilde{\imath} \geq i^*$ or $\tilde{\imath} < i^*$. We outline the solution here only for the case where $\tilde{\imath} \geq i^*$.[7] Appendix A solves for the case where $\tilde{\imath} < i^*$. Letting $\tilde{\imath} \geq i^*$, the indifference condition is

$$\ln\left(\theta\tilde{\imath}k + r(w-k)\right) = \ln\left(\theta\tilde{\imath}k + r(w-k) - R\right) + \bar{v} \tag{4}$$

Solving for $\tilde{\imath}$,

$$\tilde{\imath} = \frac{R}{\theta k(1-e^{-\bar{v}})} - \frac{r^*(w-k)}{\theta k} \tag{5}$$

So the demand for rented rooms is

$$n(1-\tilde{\imath}) \;= n\left(1 - \frac{R}{\theta k(1-e^{-\bar{v}})} + \frac{r^*(w-k)}{\theta k}\right) \tag{6}$$

Since the supply of housing is constant at m, the equilibrium rent R can be solved as

$$R = \left(1-\frac{m}{n}\right)\theta k(1-e^{-\bar{v}}) + \frac{\theta(m+n-n\frac{w}{k})}{m+n}(w-k)(1-e^{-\bar{v}}) \tag{7}$$

[7] Using the equilibrium solutions for $\tilde{\imath}$ and i^*, we can express this condition as a function of only exogenous variables: $w \geq \frac{m(m+n)}{n^2}k$.

The full solution of the competitive benchmark consists of four components - the interest rate r^*, the rent R and the two threshold types i^* and $\tilde{\imath}$. We now examine the consequences of shutting down the competitive market for credit and introducing an (imperfect) banking sector.

3 Economy with Banking Sector

We now examine an economy where directly granted credit through the competitive market for credit is no longer feasible due to information and enforcement problems. The only way to channel credit is through the banking sector that takes deposits and extends loans. For simplicity, assume that the banks have no capital, so that total loans are equal to total deposits.

Second, there is costly enforcement of the rental contract as the tenant may renege on the rental contract. The rental contract is for one period only and signed at the beginning of each date t. There is the potential for a hold-up problem from delinquent tenants who renege on the contract. We model the costly enforcement by introducing a cost $\tilde{x}_t$ of enforcing the rent. Assume that the rent net of enforcement cost, $\tilde{R}(\tilde{x}_t) - \tilde{x}_t$ is positive and increasing in the enforcement cost for $\tilde{R}(\tilde{x}_t) \leq R_t$. Let x_t denote the enforcement cost needed to receive the full rent as contracted: $\tilde{R}(x_t) = R_t$.

House owners need to borrow from banks in order to engage in production. Let b_t denote the borrowing from banks, and $\tilde{r}_t$ be the bank's lending interest rate (which depends on the bank's monitoring effort as will be discussed shortly). So the profit from entrepreneurial activities is $y_t^i - \tilde{r}_t b_t$.

The optimization problem of the house owner-entrepreneur is

$$\max_{\tilde{x}_t, b_t} \sum_{t=0}^{\infty} \beta^t \left[\ln c_t + \bar{v}\right]$$

$$\text{s.t.} \quad c_t = \left(\tilde{R}(\tilde{x}_t) - \tilde{x}_t\right) + (y_t^i - \tilde{r}_t b_t)$$

Given our assumption on $\tilde{x}_t$, rent net of enforcement cost is maximized when $\tilde{x}_t = x_t$. Hence, the landlord's income from rent is $R_t - x_t$.

The optimal borrowing is k for the house owners whose productivity satisfies $\theta i > \tilde{r}_t$ and zero otherwise. The threshold type who is indifferent between borrowing and not borrowing is

$$i^* = \frac{\tilde{r}_t}{\theta} \tag{8}$$

and total demand for bank credit is

$$m(1 - i^*)k = \frac{\theta - \tilde{r}_t}{\theta} mk \tag{9}$$

Non-house owners provide funding to the banks by depositing their endowment of w. Assume that bank deposits are fully insured so that it is risk-free to the depositor. Let r_t^d be the risk-free deposit interest rate. Let us index non-house owners by $j \in [0, 1]$ and house owners by $i \in [0, 1]$ to capture the fact that financial frictions make the behavior of the two groups deviate from each other. Type j of non-house owner is indifferent between depositing the endowment in the bank and investing in the project when $\theta j = r_t^d$, so that the threshold depositor type is

$$j^* = \frac{r_t^d}{\theta} \tag{10}$$

We maintain our assumption that $w > k$. Non-house owning entrepreneurs use k out of wealth w for production and deposit the rest $w - k$ in the bank. The aggregate deposits (which is equal to total lending by banks) is

$$\begin{aligned} & nj^* w + n(1 - j^*)(w - k) \qquad (11) \\ = \;& n(w - k) + \frac{r_t^d}{\theta} nk \end{aligned}$$

The marginal type of non-house owner who is indifferent between renting and living rough is

$$\tilde{j} = \frac{R_t}{\theta k (1 - e^{-\bar{v}})} - \frac{r_t^d (w - k)}{\theta k}$$

We solve for the case where $\tilde{j} \geq j^*$. Appendix A deals with the case where $\tilde{j} < j^*$, where the qualitative results go through unchanged. The aggregate demand for rental accommodation is given by

$$n(1-\tilde{j}) \ = n\left(1 - \frac{R_t}{\theta k(1-e^{-\bar{v}})} + \frac{r_t^d(w-k)}{\theta k}\right) \tag{12}$$

The banks must pay an enforcement cost of $\tilde{s}$ to ensure repayment of the loan. The monitoring cost is a pure social loss. Let r_t denote the contracted bank lending rate. The actual gross rate of return that the bank receives from the borrower, denoted by $\tilde{r}_t$, increases with the monitoring cost. Let s denote the bank's monitoring cost (per unit of lending) needed to fully receive the contracted rate of interest. Then it is optimal for a bank to monitor up to s, which maximizes $\tilde{r}_t(\tilde{s}_t)$.[8] As the bank incurs the maximum monitoring/enforcement cost, the actual interest the bank receives is equal to the contracted rate r_t.

$$\tilde{r}_t = r_t \tag{13}$$

We solve for the equilibrium in the bank loan market. The banking sector is perfectly competitive so that banks earn zero profit. Hence,

$$r_t = r_t^d + s \tag{14}$$

The aggregate borrowing from banks (9) as a function of r_t^d is

$$\frac{\theta - r_t^d - s}{\theta} mk \tag{15}$$

The market clearing condition for the bank loan rate equates (15) and (11)

$$\frac{\theta - r_t^d - s}{\theta} mk = n(w-k) + \frac{r_t^d}{\theta} nk \tag{16}$$

[8] We introduce banks to reflect the fact that lenders' direct monitoring normally incurs far higher cost than banks' monitoring cost s. But we might here instead introduce a model without banks where lenders directly lend to borrowers with direct monitoring cost $s\prime(> s)$, which would not alter the main results.

The equilibrium bank deposit rate is

$$r_t^d = \frac{\theta(m + n - n\frac{w}{k}) - ms}{m + n} \tag{17}$$

House owner-entrepreneurs borrow at the bank lending rate. So the equilibrium cost of capital, denoted by z_t, is

$$z_t = r_t^d + s = \frac{\theta(m + n - n\frac{w}{k}) + ns}{m + n} \tag{18}$$

Equilibrium j^* is given by

$$j^* = \frac{r_t^d}{\theta} = \frac{\theta(m + n - n\frac{w}{k}) - ms}{\theta(m + n)} \tag{19}$$

The equilibrium i^* is given by[9]

$$\begin{aligned} i^* &= \frac{r_t}{\theta} = \frac{r_t^d + s}{\theta} = \frac{\theta(m + n - n\frac{w}{k}) + ns}{\theta(m + n)} \\ &= j^* + \frac{s}{\theta} \end{aligned} \tag{20}$$

The spread between the bank deposit and lending rates creates an inefficiency. Since $i^* > j^*$ some house owners do not produce even though they are more productive than some non-house owners who currently produce. The inefficiency of the economy is proportional to the difference: $i^* - j^* = \frac{s}{\theta}$. Figure 3 depicts the size of the inefficiency as the gap between the types i^* and j^*.

The aggregate capital used by house owners is

$$K_t = (1 - i^*)k = \frac{ns(\frac{\theta w}{sk} - 1)}{\theta(m + n)}k \tag{21}$$

which is equal to the size of banking sector assets (and also equal to total deposits).

[9]Under the condition that $s\frac{k}{w} < \theta < s\frac{m}{m+n-n\frac{w}{k}}$, both i^* and j^* lie between 0 and 1.

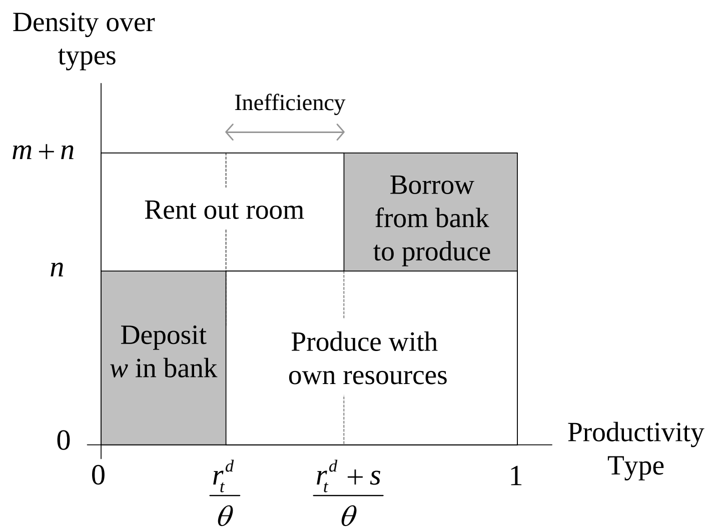

Figure 3. **Inefficient resource allocation with banks.** The spread s in bank deposit and lending rates generates inefficiency with lower total saving and lower productivity

The housing market clears through the price of rent R_t. The threshold $\tilde{j}$ and price of rent are given respectively by

$$\tilde{j} = 1 - \frac{m}{n} \tag{22}$$

$$R_t = (1 - \frac{m}{n})\theta k(1 - e^{-\bar{v}}) \; + \frac{\theta(m + n - n\frac{w}{k}) - ms}{m + n}(w - k)(1 - e^{-\bar{v}}) \tag{23}$$

which is constant. We denote the monitoring cost needed to receive the constant equilibrium R_t by x.

4 Housing Repo Contract

We now introduce the housing repo contract. Landlord and tenant sign (or renew) the contract at the beginning of each period. Let q_t denote the repo price of a room. If the tenant moves out, the house owner returns q_t to the tenant. The landlord does not receive any other payment for rent.

4.1 Landlord/Borrower

The house owner may use q_t for two different purposes. First, the house owner may invest it in her own production which requires k amount of capital. We will consider the case where q_t is small so that production needs additional borrowing. In other words, $q_t \leq k$.

The house owner, as entrepreneur, may also borrow b_t which is large enough to produce $(\theta i)k$ from the bank at bank lending rate $\tilde{r}_t$. Recall that given the assumption that $\tilde{r}'_t(\tilde{s}_t) - 1 > 0$, each bank monitors up to s, which leads the actual interest rate to be equal to the contracted rate $\tilde{r}_t = r_t$. By investing the repo lease loan q_t and the borrowing from banks $b_t(\geq k - q_t)$, she produces $(\theta i)k$ at the end of each period.

But she does not pay interest on the repo lease loan to the tenant. In effect, the monthly interest on the repo loan and monthly rent net out. Denoting by r'_t the implicit interest rate on repo lease lending and R'_t is the implicit monthly rent, we have $r'_t q_t = R'_t$. Under the housing repo, the house owner does not have to worry about the tenants' not paying the monthly rent, and the tenant/lender about the landlord's not paying the interest on the repo loan.

Hence, the repo-leasing house owner's budget constraint is

$$c_t + r'_t q_t = R'_t + (y^i_t - r_t b_t) \tag{24}$$

which, given $r'_t q_t = R'_t$, is reduced to

$$c_t = y^i_t - r_t b_t \tag{25}$$

The repo-leasing home owner's optimization problem is

$$\max_{b_t} \sum_{t=0}^{\infty} \beta^t [\ln c_t + \bar{v}]$$

$$\text{s.t.} \quad c_t = y^i_t - r_t b_t$$

Given the production technology, a house owner's optimal borrowing from banks is $b_t = k - q_t$ when she engages in production.

Alternatively, the house owner may deposit q_t at the bank. Her return from the deposit is $r_t^d q_t$. Her budget constraint is then given by

$$c_t = r_t^d q_t \tag{26}$$

Whether a specific house owner engages in production using the housing repo loan or deposits the repo loan in a bank depends on her productivity θi. There is a house owner, indexed by i^*, who is indifferent between direct investment and bank deposit. For her, the income from production is equal to that from the bank deposit:

$$(\theta i^*)k - r_t(k - q_t) = r_t^d q_t$$

which yields

$$\theta i^* = r_t \left(1 - \frac{q_t}{k}\right) + r_t^d \left(\frac{q_t}{k}\right) \tag{27}$$

From (27), the effective cost of capital z_t for house owners under housing repo is a weighted average of the bank lending rate (r_t) and deposit rate (r_t^d), and hence lower than the bank lending rate. In addition, the larger the portion of financing through housing repo ($=\frac{q_t}{k}$) is, the lower is the effective cost of capital is. Thus, the smaller the size of the banking sector, the lower is the cost of capital.

Using (27), threshold value of i for prodcution is

$$i^* = \frac{z_t}{\theta} = \frac{r_t - s\frac{q_t}{k}}{\theta} = \frac{r_t^d + s(1 - \frac{q_t}{k})}{\theta}. \tag{28}$$

House owners with $i \geq i^*$ will engage in production by using repo loan, making up the funding gap by borrowing from banks $b_t = k - q_t$. House owners with $i < i^*$ will deposit their repo lease proceed q_t in banks.[10] There-

[10] Under a monthly-rent system, the houseowners whose θi is less than r_t do not engage in production because it gives them negative profits. Under housing repo, however, some of the houseowners with $\theta i < r_t$ can now enjoy positive profits because their cost of capital is reduced to $r_t - s\frac{q_t}{k}$. There are still some others whose θi is less than $r_t - s\frac{q_t}{k}$, for whom profit is still negative. So they deposit all of q_t at a bank and have $r_t^d q_t$ as only source of income.

fore, under housing repo, the aggregate net borrowing from banks by house owners is

$$\begin{aligned} & m(1-i^*)(k-q_t) - mi^* q_t \\ = & \frac{\theta - r_t^d - s(1-\frac{q_t}{k})}{\theta} mk - mq_t \end{aligned}$$

The aggregate supply of rental rooms by home-owners is m, which is the same as in the case of monthly rent.

4.2 Tenant/Lender

The tenant either pays q_t to the landlord and deposits the remainder $w - q_t$ in a bank to earn $r_t^d(w-q_t)$.[11] Or she may invest k out of $w-q_t$ and deposit the remainder to earn $\theta jk + r_t^d(w-k-q_t)$. Whether a non-house owner deposits or invests k depends on whether the deposit rate r_t^d is greater than θj. So the cut-off j^* under housing repo is given by

$$j^* = \frac{r_t^d}{\theta} \tag{29}$$

which is the same as in the case of monthly-rent.

The income of non-house owners who rent a room is given by $\max[\theta j, r_t^d]k + r_t^d(w-k-q_t)$. She consumes all of what she earned in the period (for now we maintain our no savings assumption). When she moves out, she receives q_t. Therefore, her budget constraint is

$$c_t + R_t' = r_t' q_t + \max[\theta j, r_t^d]k + r_t^d(w-k-q_t) \tag{30}$$

which, given $r_t' q_t = R_t'$ can be written

$$c_t = \max[\theta j, r_t^d]k + r_t^d(w-k-q_t) \tag{31}$$

[11] According to a survey in 2006, repo-lease loans held by Korean households dwelling in repo-lease houses is about 1.5 times of their financial assets.

Utility when she renting a room is

$$\sum_{t=0}^{\infty}\beta^t[\ln(\max[\theta j, r_t^d]k + r_t^d(w-k-q_t)) + \bar{v}]$$

When the agent does not rent a room, she may deposit or invest w. Her income is given by $\max[\theta j, r_t^d]k + r_t^d(w-k)$, and her utility is

$$\sum_{t=0}^{\infty}\beta^t[\ln(\max[\theta j, r_t^d]k + r_t^d(w-k))]$$

We here focus on the case where $\tilde{j} \geq j^*$. For the threshold non-house owners $\tilde{j}$, who is indifferent between renting a house or not, we have

$$\begin{aligned} & \sum_{t=0}^{\infty}\beta^t[\ln(\max[\theta \tilde{j}, r_t^d]k + r_t^d(w-k))] \\ = & \sum_{t=0}^{\infty}\beta^t[\ln(\max[\theta \tilde{j}, r_t^d]k + r_t^d(w-k-q_t)) + \bar{v}]. \end{aligned} \tag{32}$$

which gives

$$\tilde{j} = \frac{r_t^d q_t}{\theta k(1-e^{-\bar{v}})} - \frac{r_t^d(w-k)}{\theta k} \tag{33}$$

So the aggregate demand for rented accommodation is given by

$$n(1-\tilde{j}) = n\left(1 - \frac{r_t^d q_t}{\theta k(1-e^{-\bar{v}})} + \frac{r_t^d(w-k)}{\theta k}\right) \tag{34}$$

Given $\tilde{j} \geq j^*$, non-house owners can be divided into three groups: those who produce and rent a room, those who produce but do not rent a room, and those who do not produce or rent a room. Non-house owner's deposit to banks thus has three cases:

$$\begin{cases} w & \text{if } 0 \leq j < j^* \\ w-k & \text{if } j^* \leq j < \tilde{j} \\ w-k-q_t & \text{if } \tilde{j} \leq j \leq 1 \end{cases} \tag{35}$$

The aggregate deposit to banks by non-house owners is then given by

$$\begin{aligned} & nj^*w + n(\tilde{j} - j^*)(w-k) + n(1-\tilde{j})(w-k-q_t) \\ = \quad & n(w-k) + j^*nk - n(1-\tilde{j})q_t \\ = \quad & n(w-k) + \frac{r_t^d}{\theta}nk - n(1-\tilde{j})q_t \end{aligned} \tag{36}$$

which is an increasing function of the deposit rate of interest r_t^d.

4.3 Equilibrium

Since supply is fixed at m, we have

$$\tilde{j} = 1 - \frac{m}{n} \tag{37}$$

which is the same as in the monthly-rent case.

By equating the net demand for the bank loans by house owners and deposit supply by non-house owners, we have

$$\frac{\theta - r_t^d - s(1-\frac{q_t}{k})}{\theta}mk - mq_t = n(w-k) + \frac{r_t^d}{\theta}nk - n(1-\tilde{j})q_t \tag{38}$$

From (37), we have $mq_t = n(1-\tilde{j})q_t$. Using this and the market clearing condition (38), the equilibrium deposit rate r_t^d under the housing repo system is given by:

$$r_t^d = \frac{\theta(m+n-n\frac{w}{k}) - ms(1-\frac{q_t}{k})}{m+n} \tag{39}$$

and the equilibrium cost of capital is

$$z_t = r_t^d + s\left(1 - \frac{q_t}{k}\right) = \frac{\theta(m+n-n\frac{w}{k}) + ns(1-\frac{q_t}{k})}{m+n} \tag{40}$$

Using (37) and (33), we solve for the equilibrium q_t from

$$q_t = (1-\frac{m}{n})\theta k(1-e^{-\bar{v}})\frac{m+n}{\theta(m+n-n\frac{w}{k}) - ms(1-\frac{q_t}{k})} + (w-k)(1-e^{-\bar{v}}) \tag{41}$$

The equilibrium i^* is then given by

$$i^* = \frac{z_t}{\theta} = \frac{\theta(m+n-n\frac{w}{k}) + ns(1-\frac{q_t}{k})}{\theta(m+n)} \tag{42}$$

and the equilibrium j^* is given by

$$j^* = \frac{r_t^d}{\theta} = \frac{\theta(m+n-n\frac{w}{k}) - ms(1-\frac{q_t}{k})}{\theta(m+n)} \tag{43}$$

where q_t is given by (41).

The aggregate capital used by house owners is

$$K_t = (1-i^*)\ k = \frac{ns(\frac{\theta w}{sk} - (1-\frac{q_t}{k}))}{\theta(m+n)}\ k \tag{44}$$

among which fraction $\frac{q_t}{k}$ is funded through housing repos and fraction $1-\frac{q_t}{k}$ through banks.

4.4 Efficiency Gain

The introduction of housing repo reduces the wedge between borrowers' cost of capital and depositors' rate of return. Under the monthly rent system there is a wedge of size s between the house owner's cost of capital (z_t), which is the bank lending rate, and the tenants' rate of return from deposit (r_t^d). Under housing repo, the house owners' cost of capital is reduced to $r_t - s\frac{q_t}{k}$. Therefore, the wedge is reduced to

$$r_t - s\frac{q_t}{k} - r_t^d = s\left(1-\frac{q_t}{k}\right) \tag{45}$$

In the special case where $q_t = k$, the wedge is zero. Housing repo, by reducing the wedge, lowers the house owners' borrowing cost, and induces more productive house owners to engage in production.

The housing repo reduces the wedge by increasing the bank deposit rate and reducing the cost of capital at the same time. To see this, let $r_t^{d,mo}$ and $r_t^{d,re}$ denote the equilibrium deposit rate of interest under monthly-rent and housing repo system, respectively, and z_t^{mo} and z_t^{re} be the equilibrium cost of capital under monthly-rent and housing repo system. Comparing (17) and (18) with (39) and (40), we have

$$r_t^{d,mo} < r_t^{d,re} \leq z_t^{re} < z_t^{mo} \tag{46}$$

so that housing repo lowers the cost of capital and raises the deposit rate at the same time.

By reducing the wedge, housing repo promotes efficient channeling of financial resources from potential lenders to entrepreneurs. To see this, let i^{re} and i^{mo} denote i^* in the case of housing repo and monthly-rent lease, respectively and also let j^{re} and j^{mo} denote j^* in the case of housing repo and monthly-rent lease, respectively. From a comparison of (19), (43), (20) and (42), we have

$$j^{mo} < j^{re} \leq i^{re} < i^{mo} \tag{47}$$

This suggests that the number of house owners who produce under housing repo lease system ($= 1 - i^{re}$) is greater than under monthly rent system ($= 1 - i^{mo}$) and that the number of non-house owners who work as entrepreneur under housing repo lease system is lower than under monthly rent system. Therefore, the housing repo raises improves efficiency by reducing the gap between i^* and j^*, which captures inefficiency in financing. In a special case where housing repo loan q_t fully covers the cost of production k, we achieve the first best.

As the difference $i^* - j^*$ narrows, more resources are channeled to production by types with higher productivity:

$$K_t^{re} > K_t^{mo} \tag{48}$$

where K_t^{re} and K_t^{mo} represent capital used by house owner-entrepreneurs under housing repo and monthly rent system, respectively. From (21) and (44), the increase in capital channeled is calculated to be $K_t^{re} - K_t^{mo} = \frac{nsq_t}{\theta(m+n)}$. Note that total financing increases under housing repo, but the banking sector is smaller.

As more resources are shifted from low productivity types to the higher productivity types, the aggregate output of the economy (which is also the aggregate consumption under our assumption) increases when housing repo is introduced. As shown in Appendix B, an economy's output is raised by

$$\begin{aligned} Y^{re} - Y^{mo} &= \frac{1}{2}\theta k \left(m(i^{mo})^2 - m(i^{re})^2 + n(j^{mo})^2 - n(j^{re})^2 \right) \\ &\quad + xm \\ &\quad + skm(1 - i^{mo}) - skm \left(1 - \tfrac{q_t}{k}\right)(1 - i^{re}). \end{aligned} \tag{49}$$

The three terms in (49) have the following interpretation. The first term on the right hand side is the gain due to the increase in financing used by more able entrepreneur (who are house owners) instead of less able non-house owners. The second expression, xm, is the savings in housing lease-related monitoring costs. The two expressions are positive (see also Appendix B for details). The third term is the savings in lending-related enforcement/monitoring costs due to the adoption of housing repo. Note that $\frac{q_t}{k}$ captures the fraction of capital that the house owner-entrepreneurs finance using housing repo loan. In an economy where the portion of housing repo lease ($\frac{q_t}{k}$) is large (i.e., close to one), the third expression is also positive, and therefore we have

$$Y^{re} > Y^{mo} \tag{50}$$

which tells us that the adoption of repo lease system raises aggregate output.

The above result suggests that the housing repo may eliminate both the inefficiency due to housing lease-related monitoring and due to loan monitoring simultaneously, and encourage capital to be used by more able entrepreneurs. Particularly in an economy where $q_t = k$ (when all financing is raised by housing repo), the housing repo guarantees the first-best equilibrium: despite information asymmetries, the housing repo induces a full-information equilibrium.

So far, we have considered the monthly rent and housing repo systems separately. We now consider an economy where both contracts are allowed, and see which of the two will emerge when in competition with each other. Since the housing repo reduces inefficiency, moving to the housing repo presents opportunities for Pareto improvements and can be expected to crowd out monthly rents. We verify that this is indeed the case.

Consider the optimal choice of tenants on whether to rent a room in the form of monthly rent or housing repo. If a tenant rents via housing repo, she lends q_t to the landlord, and does not pay monthly rent nor receives interest. If she rents by monthly rent and deposits q_t in a bank, she receives interest ($= r_t^d q_t$) and pays monthly rent R_t to the landlord. Therefore, tenants would prefer monthly rent if $R_t < r_t^d q_t$, and housing repo if $R_t > r_t^d q_t$. They would be indifferent if $R_t = r_t^d q_t$.

For the landord, monthly rent gives $(R_t - x) + (\theta ik - r_t k)$ for type $i \geq i^{re}$, and $R_t - x$ for types $i < i^{re}$. Housing repo eliminates the monitoring cost of x and net income is $\theta ik - r_t(k - q_t)$ for types $i \geq i^{re}$ and $r_t^d q_t$ for types i $< i^{re}$. So the house owners with $i \geq i^{re}$ prefer monthly rent if $R_t > x + r_t q_t$ and house owners with $i \geq i^{re}$ prefer monthly rent if $R_t > x + r_t^d q_t$.

Given the choices of landlords and potential tenants, there is no R_t that makes both tenants and landlords choose monthly rent, if they are already on housing repo.[12] Of course, if there is no inefficiency due to enforcement/monitoring problems (that is, $x = s = 0$), both monthly-rent lease and housing repo would bring the first-best. They also would be equally preferred by house owners and tenants (and so both are equilibria). In the presence of inefficiencies, however, housing repo could be preferred and Pareto-improving. When $q_t = k$, the housing repo brings the first-best even with $x > 0$ and $s > 0$.

[12] We here focus on the case where non-houseowners have the same amount of initial capital, and housing repo dominates, which is the case of Korea where housing repo including quasi housing repo accounts for 97% of housing lease and pure monthly rent only 3%. An earlier version of this paper also discuss the case where non-houseowners have different amount of capital, which leads to the coexistence of housing repo and monthly rent lease.

5 Dynamic Economy

So far we have considered a static economy without capital accumulation. We now consider a dynamic model with saving and capital accumulation in a basic way by allowing non-house owners' capital to be determined endogenously each period as a result of their optimal intertemporal decision. Using this simple model, we compare saving and output growth under housing repo with those under monthly-rent system. We follow by solving for the relationship between the purchase price of the house and the price of the housing repo.

5.1 Capital Accumulation

Consider first the monthly-rent system under which the non-house owner faces the budget constraint

$$c_t^j + (w_{t+1}^j - w_t^j) + R_t = r_t^{d,mo}(w_t^j - k) + \max[\theta j, r_t^{d,mo}]k \tag{51}$$

or

$$c_t^j + (w_{t+1}^j - w_t^j) = r_t^{d,mo}(w_t^j - k) + \max[\theta j, r_t^{d,mo}]k \tag{52}$$

depending on whether she rents a room or not. Here, $w_{t+1}^j - w_t^j$ represents her savings - that is, the increase in her wealth.

Let the initial wealth of non-house owners be $w_0^j = w > k$, as in the static benchmark case. Then the equilibrium bank deposit rate $r_t^{d,mo}$ is determined from

$$\frac{\theta - r_t^{d,mo} - s}{\theta} mk = n(W_t - k) + \frac{r_t^{d,mo}}{\theta} nk \tag{53}$$

which is the same as (16) except replacing w by $W_t = \int_0^1 w_t^j \, dj$.

Given the assumption of $w_0 > k$, non-house owners who produce deposit all of their new savings. Hence, the rate of return from savings by any non-house owners is given as the bank deposit rate $r_t^{d,mo}$. Assume that

$\frac{\theta(m+n-n\frac{W_0}{k})-ms}{m+n} > 0$, so that the deposit rate at the initial period $r_0^{d,mo}$ is positive.

Regardless of whether she rents a room or not, the first-order condition for the non-house owner's optimal choice of w_{t+1} is

$$-\beta^t \frac{1}{c_t^j} + \beta^{t+1}(1 + r_{t+1}^{d,mo})\frac{1}{c_{t+1}^j} = 0$$

which yields

$$\frac{c_{t+1}^j}{c_t^j} = \beta(1 + r_{t+1}^{d,mo}) \tag{54}$$

which holds for all the non-house owners, given that the rate of return from savings is the same at $r_t^{d,mo}$ across non-house owners. Given log utility, all the non-house owners increase their consumption at the same rate $\beta(1 + r_{t+1}^{d,mo})$.

Letting $c_{t+1} = c_t$, we derive the steady state deposit rate under monthly-rent system, denoted by $r_{S.S}^{d,mo}$.

$$r_{S.S}^{d,mo} = \frac{1}{\beta} - 1 \tag{55}$$

Along the steady state, no one in the economy accumulates capital, and hence the aggregate capital stays constant.

Before reaching the steady state, however, the economy has positive capital accumulation and growth. During the transitional period, the deposit rate $r_t^{d,mo}$ remains higher than $r_{S.S}^{d,mo}$, but converges to it. As the deposit rate declines along the transitional path, so does the bank lending rate. As a result, the number of house owners and non-house owners who engage in production increases, whose capital input is supplied by the savings by non-house owners.

Now consider the housing repo system, under which the non-house owner faces one of the following budget constraints, depending on whether she rents or not. If she rents, it is

$$c_t^j + (w_{t+1}^j - w_t^j) = r_t^{d,re}(w_t^j - q_t - k) + \max[\theta j, r_t^{d,re}]k \tag{56}$$

If not, it is

$$c_t^j + (w_{t+1}^j - w_t^j) = r_t^{d,re}(w_t^j - k) + \max[\theta j, r_t^{d,re}]k \tag{57}$$

where $r_t^{d,re}$ is determined from

$$\frac{\theta - r_t^{d,re} - s(1 - \frac{q_t}{k})}{\theta} mk - mq_t = n(W_t - k) + \frac{r_t^{d,re}}{\theta} nk - n(1 - \tilde{j})q_t \tag{58}$$

The first-order condition for the non-house owner's optimal choice of w_{t+1} gives

$$\frac{c_{t+1}^j}{c_t^j} = \beta(1 + r_t^{d,re}) \tag{59}$$

The steady state deposit rate under housing repo, denoted by $r_{S.S}^{d,re}$ is given by

$$r_{S.S}^{d,re} = \frac{1}{\beta} - 1 \tag{60}$$

Note that the steady state deposit rate of interest is the same as the monthly system at $\frac{1}{\beta} - 1$ and the growth rate is zero for both systems. But the steady state capital stock differs.

By putting $r_{S.S}^{d,mo} = r_{S.S}^{d,re} = \frac{1}{\beta} - 1$ in (53) and (58), we can calculate the steady state aggregate capital stock, denoted by $W_{S.S}$. From a comparison between (53) and (58), we have

$$(W_{S.S})^{mo} < (W_{S.S})^{re} \tag{61}$$

while the initial aggregate capital stock is the same at $W_0 = \int_0^1 w_0^j \, dj = \int_0^1 w \, dj = w$ regardless of lease system.

This suggests that housing repo induces higher level of aggregate capital stock in the steady state than monthly-rent lease. It then also follows that during the transitional period housing repo may induce faster capital accumulation and growth than monthly rent system. During the transition period, housing repo induces a higher deposit interest rate compared to monthly-rent system (recall that we have $r_t^{d,mo} < r_t^{d,re}$ in our benchmark model). That promotes faster savings, which accelerates output growth during the transition period.[13]

5.2 Purchase Price and Repo Price

Up to now, we assumed that the house owner always rents out a room, either on monthly rent lease or housing repo. We now allow house owners to sell or purchase rooms outright as well as to rent them out as a repo lease, and examine how the outright purchase price of the room is determined in relation to the housing repo price (i.e., the price of the right of using the room) in the dynamic economy introduced above.

In keeping with our narrative, house owners can sell the spare room outright (much like selling a condo). We will then solve for the relationship between the purchase price and repo price, and thereby solve for the "haircut" in the housing repo.

Let p_t denote the outright purchase price of a room at time t. Consider the house owner type $i \geq i^{re}$, who engages in production. Suppose that she purchases additional rooms only at period 0. To purchase h_0 units of additional rooms, the house owner pays $p_0 h_0$, for which she borrows from banks, at the beginning of period 0. Thereafter, she rolls over the debt every period, and pays the interest $r_t p_0 h_0$ at the end of every period. From period 0 on, she leases the $1 + h_0$ houses in the form of housing repo at repo price

[13]We may also allow houseowners to accumulate capital, which does not alter the main results. The reason is clear. More able houseowners (whose θi is greater than the cost of capital) make savings until their wealth hit k, and the rate of wealth accumulation depends on the rate of return from the accumulation, which is θi. However, once their accumulated capital hits k, they have to deposit the portion of their wealth which exceeds k, and hence the rate of return from savings becomes r_t^d. As a result, after their capital reaches k, the first order condition of their optimization problem becomes the same as that of non-houseowners (eq. (54) in case of monthly-rent and eq. (59) in case of housing repo). Therefore, we also obtain the same steady state deposit rate for the two different lease systems, and come to the same conclusion that $(w_{S.S})^{mo} < (w_{S.S})^{re}$as the case where we allow only non-houseowners to accumulate capital.

q_t. This reduces her borrowings for production by $q_t h_0$, every period, as her borrowing is now reduced to $b_t = k - q_t(1 + h_0)$. So the house owner's consumption in each period is: $c_t = \theta ik - r_t(k - q_t(1 + h_0)) - r_t p_0 h_0$.

The house owner seeks to maximize the intertemporal utility V_e:

$$V_e = \sum_{t=0}^{\infty} \beta^t [\ln(\theta ik - r_t(k - q_t(1 + h_0)) - r_t p_0 h_0) + \bar{v}] \tag{62}$$

The derivative of the utility function with respect to h_0 is:

$$V'_e = -p_0 \sum_{t=0}^{\infty} \beta^t r_t \frac{1}{c_t} + \sum_{t=0}^{\infty} \beta^t q_t r_t \frac{1}{c_t} \tag{63}$$

The first term on the right side captures the utility loss due to paying the borrowing cost for the purchase of new houses and the second gives the utility gain due to the income from leasing the newly purchased houses in the form of housing repo. Both depend on the bank lending rate r_t.

If V'_e is positive, the optimal h_0 is positive at $k/q_t - 1$ given that production requires k amount of capital and no more. If V'_e is negative, the optimal h_0 is negative, at -1. That is, it is optimal for the house owner to sell the spare room in which she does not live. If V'_e is zero, the optimal h_0 is indeterminate, and the house owner is indifferent between purchasing and selling houses. This gives the net demand curve by these house owners, which is horizontal at p_0 which makes V'_e zero, and vertical at $m(1 - i^{re})(k/q_t - 1)$ for p_0 which makes V'_e positive.

Now consider the house owner with $i < i^{re}$, who deposits the proceeds of the housing repo. The house owner receives p_0 for selling a spare room at the beginning of period 0. By depositing p_0, she earns interest income $r_t^d p_0$. So the house owner's consumption is $c_t = r_t^d p_0$.

She seeks to maximize her utility

$$V_d = \sum_{t=0}^{\infty} \beta^t [\ln(r_t^d p_0) + \bar{v}]$$

The derivative of the utility function with respect to f_0 is:

$$V_d' = p_0 \sum_{t=0}^{\infty} \beta^t r_t^d \frac{1}{c_t} - \sum_{t=0}^{\infty} \beta^t q_t r_t^d \frac{1}{c_t} \tag{64}$$

If V_d' is positive, the optimal f_0 is positive at one. If V_d' is negative, the optimal f_0 is negative (that is, she wants to purchase houses). If V_d' is zero, the optimal f_0 is indeterminate. Therefore, the supply curve by these house owners is horizontal at p_0 which makes V_d' zero, but vertical at mi^{re} for p_0 which makes V_d' positive.

Consider the case where $mi^{re} \leq m(1-i^{re})(k/q_t - 1)$. Then total demand for houses (by house owners with $i \geq i^{re}$) is greater than total supply (by house owners with $i < i^{re}$). Therefore, in equilibrium all the house owner with $i < i^{re}$ sell their spare room, but house owner with $i \geq i^{re}$ purchase rooms but not as much as they want. The equilibrium house price is then determined as the level where (63) becomes zero, and therefore the equilibrium purchase price of a room at time 0 is given by

$$p_0 = \frac{\sum_{t=0}^{\infty} \beta^t q_t r_t \frac{1}{c_t}}{\sum_{t=0}^{\infty} \beta^t r_t \frac{1}{c_t}} \tag{65}$$

We derive (65) for the case where sales and purchases of houses occur at the beginning of period 0. But we can extend it to the case where sales and purchases can occur every period, and derive the same (65). In this more general case, the outright purchase price of a room in any period t is

$$p_t = \frac{\sum_{l=0}^{\infty} \beta^l q_{t+l} r_{t+l} \frac{1}{c_{t+l}}}{\sum_{l=0}^{\infty} \beta^l r_{t+l} \frac{1}{c_{t+l}}} \tag{66}$$

As W_t increases along the transitional path, so does q_t.[14] Let g_t denote the growth rate of q_t at time t. During the transitional period where W_t

[14]In this dynamic setting, q_t is determined from

$$q_t = (1 - \frac{m}{n})\theta k (1 - e^{-\bar{v}}) \frac{1+n}{\theta(1 + n - n\frac{W_t}{k}) - s(1 - \frac{q_t}{k})} + (w^{\tilde{j}} - k)(1 - e^{-\bar{v}}).$$

rises, g_t is positive. We rewrite (66) as

$$p_t = \frac{r_t \frac{1}{c_t} + \sum_{l=1}^{\infty} \beta^l \, (\Pi_{s=1}^{l}(1+g_{t+s}))r_{t+l} \, \frac{1}{c_{t+l}}}{r_t \frac{1}{c_t} + \sum_{l=1}^{\infty} \beta^l \, r_{t+l} \, \frac{1}{c_{t+l}}} \, q_t \tag{67}$$

which, with $g_{t+s} > 0$ for transitional period, gives

$$p_t > q_t \tag{68}$$

and

$$p_{t+1} > p_t. \tag{69}$$

This suggests that in a growing economy which is yet to reach the steady state, the outright purchase price of a house should be greater than the housing repo price and it should increase over time. When house owners are allowed to sell or purchase houses, house owners could raise more fund by selling the house than renting it out (that is, $p_0 > q_0$). However, they also resort to housing repo. The reason is that when they lease the houses, they will be able to enjoy the continuous increase in the housing repo price (q_t) or the ensuing capital gains due to the increase in the house price (p_t).[15]

In the case where $mi^{re} > m(1-i^{re})(k/q_t - 1)$, we derive the same results: $p_t > q_t$ and $p_{t+1} > p_t$. In this case, the demand for houses by house owners with $i \geq i^{re}$ is smaller than the supply by house owners with $i < i^{re}$. Therefore, all house owners with $i < i^{re}$ sell their spare rooms, and those

[15] Suppose the houseowner purchases and leases a room at period t, and sells it at period $t+1$. In equilibrium, the marginal benefit from purchasing a room, which is $r_t q_t \frac{1}{c_t} + (p_{t+1} - p_t) \sum_{l=0}^{\infty} \beta^{t+l} r_{t+l} \frac{1}{c_{t+l}}$, is equal to the marginal loss, which is $-r_t p_t \frac{1}{c_t}$. The equilibrium condition can then be expressed as

$$\frac{q_t}{p_t} = 1 - \frac{1}{r_t} \frac{p_{t+1} - p_t}{p_t} \frac{\sum_{l=0}^{\infty} \beta^{t+l} r_{t+l} \frac{1}{c_{t+l}}}{\frac{1}{c_t}}.$$

This suggests that the ratio of repo price to purchase price ($\frac{q_t}{p_t}$) is less than one, reflecting the capital gain ($\frac{p_{t+1}-p_t}{p_t}$). The larger the capital gain is, the lower the ratio is. If the capital gain is zero, ($\frac{q_t}{p_t}$) becomes one.

with $i \geq i^{re}$ purchase the houses to the maximum. As a result, the outright purchase price of a room is determined at a level which makes V_d' zero:

$$p_t = \frac{r_t^d \frac{1}{c_t} + \sum_{l=1}^{\infty} \beta^l (\Pi_{s=1}^l (1 + g_{t+s})) r_{t+l}^d \frac{1}{c_{t+l}}}{r_t^d \frac{1}{c_t} + \sum_{l=1}^{\infty} \beta^l r_{t+l}^d \frac{1}{c_{t+l}}} q_t \tag{70}$$

which resembles (67) except that r_{t+l} is replaced by r_{t+l}^d.

6 Concluding Remarks

We have argued that housing repo enhances efficiency through the net-out of cash flows that go in the opposite direction, combined with bilateral collateralization. The net-out of bilateral cash flows is not unique in housing lease arrangements nor in Korea.

Multiple security deposits (MSD) in car lease, which is used in the U.S. and European countries, can be viewed as such a repo lease. According to MSD, the leasee of a car pays up to ten month deposits at inception and receives the deposit at the end of the lease term, which lowers the monthly lease payments. The portion of deposit that exceeds one monthly security deposit can be considered as a loan by the leasee, and the implicit interest on the loan is equal to the subtracted amount of monthly lease payments.

The netting out of cash flows also applies to franchise arrangements. A franchisor firm often asks franchisees to pay refundable deposit at the beginning of the franchise term while it lowers the loyalty or other periodic payments from franchisees. This franchise deposit, which is a form of borrowings by franchisors who do not have sufficient equity, eliminates inefficiencies by netting out interest payments from the franchisor and a part of loyalty or other payments from franchisees.

A lease contract similar to housing repo has been a predominant form, accounting for 97 percent (including quasi housing repo) of lease contract in Korea as of 2009. Such housing repo contract, however, is seldom used in the other countries. This raises a question of why the housing repo contract is so widely used only in Korea.

There might be several factors that have jointly contributed to the prevalence of housing repo contracts in Korea. A contributing factor at least until late 1990s might be the under-developed formal banking sector, lacking in commercial orientation due to the government's directed credit policy. Among 27 Korean commercial banks, 17 banks had capital adequacy ratios below the 8 percent BIS minimum requirement at the end of 1997. The weak financial sector was considered a major culprit of the 1997-98 Korean financial crisis, during which a majority of banks were closed, merged or nationalized (see Chopra et al (2002)).

Another factor might be that many of Korean house owners in the cities served entrepreneurs during the period of its rapid growth and industrialization. The landlords of Korean housing repo houses were typically small business owners who have access to investment projects with high return. So they have strong incentive to borrow through housing repo which substantially reduces the cost of capital. We capture this feature in the model by focusing on the case where a large fraction of house owners are also entrepreneurs and a large fraction of original non-house owners become entrepreneurs. This appears not always the case in many other countries, where a majority of house owners do not have access to productive technology. So they would not have much incentive to borrow in the form of housing repo.

Korea's rapid economic growth at about 7-8 percent per year for more than three decades might also be a contributing factor. In a fast growing economy like Korea, the market price of houses rises fast as well (possibly at the rate of output growth under logarithmic utility). In this situation, if a house owner sells a house, she forgoes large capital gains. Therefore, a house-owning entrepreneur might prefer to lease her house through housing repo, instead of selling the house. In other economies with low growth (say, with zero growth), however, house owners would not enjoy much capital gains by using housing repo. So they might not have much incentive to lease a repo house rather than to sell the house.

The long absence of mortgage and other housing finance in Korea might also have contributed to the prevalence of the housing repo. Korean government had long directed banks to concentrate their credit on corporate loans, instead of consumer loans, at least until late 1990s. This has prevented housing finance from developing in Korea. Mortgage was introduced only in 2004, and the mortgage loan is still at its infant stage, accounting for only a small portion of bank loans. In this situation, non-house owners who do not have enough wealth to pay the house price p resort to renting a house in the form of housing repo, whose price q is about 40-60% of he outright purchase price p.[16]

With the development of the financial system, many of the imperfections that give an advantage to the housing repo system have been gradually eroded. Thus, if a country has mature financial system, the prevalence of the housing repo contract would wane rapidly. However, for many developing countries with financial systems that are at an early stage of development, the housing repo contract sets an important example of how institutional arrangements can help to mitigate the frictions that hold back financial development and hence economic development.

[16]Legal institution is also an important factor. Housing repo in Korea is supported by the law on housing lease, which allows for housing repo deposit, which is normally more than ten years' monthly rent, and guarantees for its return. In the US, however, security deposit for monthly rent housing is legally restricted not to exceed one or two monthly rent in many states.

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Appendix A

In sections 2-4, we focus on the case where $j^* \leq \tilde{j}$. In this appendix, we consider the case where $\tilde{j} < j^*$. In this case, all the non-house owners with $j < j^*$ deposit their wealth w in banks, and therefore, earn the same income despite their difference in entrepreneurial abilities.

In this case, the demand for rented rooms by non-house owners slightly changes compared to the case where $j^* \leq \tilde{j}$. Under monthly-rent system, any of them consumes $r_t^d w$ if she does not rent a room, and $r_t^d w - R_t$ if she rents a room. Therefore, all of them are indifferent between renting a room and not doing so if

$$\sum_{t=0}^{\infty} \beta^t \left[\ln(r_t^d w)\right] = \sum_{t=0}^{\infty} \beta^t \left[\ln(r_t^d w - R_t) + \bar{v}\right].$$

The aggregate demand for rented rooms under monthly-rent system is then given by

$$\begin{aligned} M_t^D &= n \quad for\ R_t < r_t^d w(1 - e^{v-\bar{v}}) \\ &= 0 \quad for\ R_t > r_t^d w(1 - e^{v-\bar{v}}) \\ &= \text{indeterminate} \quad for\ R_t = r_t^d w(1 - e^{-\bar{v}}) \end{aligned} \tag{71}$$

suggesting a horizontal demand curve for leased houses at $R_t = r_t^d w(1 - e^{v-\bar{v}})$.

The aggregate supply of leased room is m, suggesting a vertical supply curve. So the equilibrium $\tilde{j}$ is given by

$$\tilde{j} = 1 - \frac{m}{n} \tag{72}$$

which is the same as in the case of $j^* \leq \tilde{j}$.

From (71) and (**??**), the equilibrium monthly rent under monthly-rent lease is given by

$$R_t = \frac{\theta(m + n - n\frac{w}{k}) - ms}{m + n} w(1 - e^{-\bar{v}}) \tag{73}$$

In a similar way, we derive the equilibrium housing repo price under housing repo as

$$q_t = w(1 - e^{\underline{v}-\bar{v}}) \tag{74}$$

which suggests that in the case where $\tilde{j} < j^*$, R_t and q_t slightly change.

In the case where $\tilde{j} < j^*$, however, we can easily see that there is no change in the optimal decision of house owners on the demand for capital and the supply of leased rooms in both monthly-rent and housing repo cases. In addition, there is no change in the non-house owners' decision on deposits in both monthly-rent and housing repo cases. Therefore, our main results on the determination of the deposit rate of interest, the cost of capital, and the aggregate output ((46)-(50)) remain the same as in the case where $j^* \leq \tilde{j}$.

Appendix B

In this appendix, we derive (49). Under housing repo, total income of home-owners is:

$$\begin{aligned} & m\int_0^{i^{re}} r_t^{d,re} q_t \; di + m\int_{i^{re}}^1 [\theta ik - (r_t^{d,re}+s)(k-q_t)]\, di \\ = \; & (r_t^{d,re} q_t) m i^{re} + \frac{1}{2}\theta km(1-(i^{re})^2) - r_t^{d,re}(k-q_t)m(1-i^{re}) \\ & -s(k-q_t)m(1-i^{re}) \end{aligned}$$

and total income of non-house owners is

$$\begin{aligned} & n\int_0^{j^{re}} r_t^{d,re} w \; dj + n\int_{j^{re}}^{\tilde{j}^{re}} [\theta jk + r_t^{d,re}(w-k)]\, dj \\ & + n\int_{\tilde{j}^{re}}^1 [\theta jk + r_t^{d,re}(w-k-q_t)]\, dj \\ = \; & (r_t^{d,re} w) n j^{re} + \frac{1}{2}\theta kn(1-(j^{re})^2) + r_t^{d,re}(w-k)n(1-j^{re}) \\ & -r_t^{d,re} q_t n(1-\tilde{j}^{re}) \end{aligned}$$

Using the market clearing conditions (37) and (38), we can express the aggregate output under housing repo, which is the sum of total income of house owners and non-house owners, as:

$$Y^{re} = \frac{1}{2}\theta km(1-(i^{re})^2) + \frac{1}{2}\theta kn(1-(j^{re})^2) - s(k-q_t)m(1-i^{re}). \tag{75}$$

Under monthly-rent leasing, total income of homeowners is

$$\begin{aligned} & m\int_0^{i^{mo}} (R_t - x_t) di + m\int_{i^{mo}}^1 [(R_t - x_t) + (\theta i - (r_t^{d,mo}+s))k]\, di \\ = \; & (R_t - x)\, m + \frac{1}{2}\theta km(1-(i^{mo})^2) - r_t^{d,mo} km(1-i^{mo}) - skm(1-i^{mo}) \end{aligned}$$

and total income of non-house owners is

$$\begin{aligned}
& n\int_0^{j^{mo}} r_t^{d,mo} w \; dj + n\int_{j^{mo}}^{\tilde{j}^{mo}} [\theta jk + r_t^{d,mo}(w-k)]\, dj \\
& +n\int_{\tilde{j}^{mo}}^{1} [\theta jk + r_t^{d,mo}(w-k) - R_t)]\, dj \\
= & \; (r_t^{d,mo} w) n j^{mo} + \frac{1}{2}\theta kn(1-(j^{mo})^2) + r_t^{d,mo}(w-k)n(1-j^{mo}) \\
& -R_t n(1-\tilde{j}^{mo})
\end{aligned}$$

which, together with (16), gives the aggregate output under monthly-rent system as

$$Y^{mo} = \frac{1}{2}\theta km(1-(i^{mo})^2) + \frac{1}{2}\theta kn(1-(j^{mo})^2) - skm(1-i^{mo}) - xm \quad (76)$$

By subtracting (76) from (75), we have

$$\begin{aligned}
Y^{re} - Y^{mo} \; = \; & \frac{1}{2}\theta k[m(i^{mo})^2 - m(i^{re})^2 + n(j^{mo})^2 - n(j^{re})^2] \\
& + xm + skm(1-i^{mo}) - skm(1-\frac{q_t}{k})(1-i^{re}).
\end{aligned}$$

In this appendix, we also show that the first expression of the right side of the above equation, $\frac{1}{2}\theta k[m(i^{mo})^2 - m(i^{re})^2 + n(j^{mo})^2 - n(j^{re})^2)]$, is positive. Using (20), (42), (19) and (43), we rewrite the expression as

$$\begin{aligned}
& \frac{1}{2}\theta k[m(i^{mo})^2 - m(i^{re})^2 + n(j^{mo})^2 - n(j^{re})^2] \\
= & \; \frac{1}{2}\theta km[\frac{\theta(m+n-n\frac{w}{k}) + ns}{\theta(m+n)}]^2 - \frac{1}{2}\theta km[\frac{\theta(m+n-n\frac{w}{k}) + ns(1-\frac{q_t}{k})}{\theta(m+n)}]^2 \\
& + \frac{1}{2}\theta kn[\frac{\theta(m+n-n\frac{w}{k}) - ms}{\theta(m+n)}]^2 - \frac{1}{2}\theta kn[\frac{\theta(m+n-n\frac{w}{k}) - ms(1-\frac{q_t}{k})}{\theta(m+n)}]^2 \\
= & \; \frac{k}{2\theta(m+n)^2} Q(n)
\end{aligned}$$

where

$$
\begin{aligned}
Q(n) &= m[\theta(m+n-n\frac{w}{k})+ns]^2 - m[\theta(m+n-n\frac{w}{k})+ns-ns\frac{q_t}{k})]^2 \\
&\quad +n[\theta(m+n-n\frac{w}{k})-ms]^2 - n[\theta(m+n-n\frac{w}{k})-ms+ms\frac{q_t}{k})]^2 \\
&= 2m[\theta(m+n-n\frac{w}{k})+ns](ns\frac{q_t}{k}) - m(ns\frac{q_t}{k})^2 \\
&\quad -2n[\theta(m+n-n\frac{w}{k})-ms](ms\frac{q_t}{k}) - n(ms\frac{q_t}{k})^2 \\
&= 2mns(ns\frac{q_t}{k}) - m(ns\frac{q_t}{k})^2 + 2nms(ms\frac{q_t}{k}) - n(ms\frac{q_t}{k})^2 \\
&= (2mns - mns\frac{q_t}{k})(ns\frac{q_t}{k}) + (2nms - n(ms\frac{q_t}{k}))(ms\frac{q_t}{k}) \\
&= (2-\frac{q_t}{k})mns(ns\frac{q_t}{k}) + (2-\frac{q_t}{k})mns(ms\frac{q_t}{k}) \\
&= (m+n)mns^2(2-\frac{q_t}{k})(\frac{q_t}{k})
\end{aligned}
$$

Given that $0 < \frac{q_t}{k} \leq 1$, $Q(n)$ is positive, and hence $\frac{1}{2}\theta k[m(i^{mo})^2 - m(i^{re})^2 + n(j^{mo})^2 - n(j^{re})^2]$ is positive.