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Housing investment, default risk, and expectations: Focusing on the *chonsei* market in Korea☆

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ABSTRACT

This paper notes that the Korean *chonsei* lease contract, in which the tenant provides a lump sum deposit equivalent to a large part of the housing value to the landlord for the contract period, is in effect a mortgage provided by the tenant to finance the landlord's housing investment. The paper presents a model for deriving the size of the equilibrium chonsei deposit by incorporating the default risk of chonsei for the first time. Using the mortgage-market equilibrium model with default costs, this paper explores the link between default cost, house price expectations of the landlord, and the chonsei deposit. The model shows that the higher is the landlord's default cost (the less risky he/she is), the smaller is the chonsei deposit, while the more favorable are the expectations for future house prices, the greater is the chonsei deposit. The predictions of the theoretical model are tested and confirmed using bank data and survey data. The limitations of the empirical approach of existing studies are overcome by taking advantage of the survey data.

1. Introduction

There is a unique but widely used rental system called *chonsei* in Korea. Under the *chonsei* scheme, the tenant pays the landlord 40–60% of the value of the house in a lump sum (called *chonsei deposit*), rents the house, and receives the money back at the end of the contract period. In other words, the tenant lends the chonsei deposit to the landlord at the expense of general consumption, and the landlord can use the chonsei to invest in the house. Therefore, chonsei is like a mortgage supplied by the tenant, not a bank, and it has essentially the same structure as a mortgage.

As Navarro and Turnbull (2010) point out, in countries based on civil law, an antichresis contract requiring deposit of a lump sum can be used in a lease contract, and chonsei is a form of such a contract. In Korea, however, chonsei is a type of contract that accounts for over 50% of the housing rental market, and the total amount of chonsei deposits in the economy is estimated to be $420 billion in 2016. Therefore, considering the size and the proportion of chonsei in the housing market, the significance of the system in the Korean housing market is apparent.

This paper goes beyond simply studying the lease contract between the landlord and the tenant. Chonsei is a private mortgage provided by the tenant, and we contribute to existing mortgage-related research by analyzing the chonsei, taking into account the nature of the mortgage and the default risk. Therefore, it is necessary to review the existing studies on both chonsei and the mortgage market in order to approach chonsei as a financing method for housing investment.

Studies on the Korean chonsei market have focused on why the chonsei system has arisen and why chonsei has become the most representative type of lease contract. Renaud (1989) suggests the friendly policy of the Korean government toward the industrial sector as a reason for the chonsei system becoming popular. He argues that the Korean government focused on lending money to the industrial sector at low interest rates for economic growth, and that the real estate market has therefore experienced financial repression. In this situation, chonsei has become an important source of funding for those who want to buy real estate. That is, in a situation where it is difficult to access a mortgage loan, a lump-sum chonsei deposit has become an important catalyst facilitating the purchase of a home. In addition, a high rate of real estate price increases in line with economic growth has ensured a safe return of chonsei deposits, which makes chonsei widely used in the real estate rental market.

Son (1997) also explains why the chonsei system became popular in terms of the demand and supply of rental housing. In Korea, the demand for housing has increased rapidly due to rapid industrialization. On the supply side, however, the government focused on allowing individuals to own their own homes and was reluctant to support adequate rental housing. In this situation, the main supplier of rental housing became the private home buyer, and in a situation where the mortgage mar-

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ket is not relatively developed, home buyers became dependent on the tenant's chonsei.

The reason why the market for chonsei has developed in Korea has been discussed sufficiently, but there has not been much theoretical and equilibrium analysis of the market itself. The discussion of Ambrose and Kim (2003) is most relevant to our argument, since they first considered the default risk of chonsei. Kim (2013) explains through a general equilibrium model that choosing chonsei instead of monthly rent is the mutually optimal choice on the premise that either chonsei or monthly rent can be selected.[1]

This study focuses on the mortgage aspect of chonsei and considers the fact that landlords who receive chonsei may default. On the institutional side, when the landlord defaults, the tenant cannot foreclose as in the case of a mortgage. Therefore, the tenant has the risk of not receiving the deposit back. According to actual real estate auction statistics, among 31,363 apartments in the Seoul metropolitan area auctioned from 2010 to June 2013 showed that 76.2% of tenants did not receive back some or all of the chonsei deposit when the property was sold.

In the past when real estate prices rose rapidly, there was no major concern about landlords potentially defaulting on the chonsei deposit, because it was widely believed that the property value would be much higher than the deposit after the contract ended. However, after the real estate crisis, real estate prices experienced a sharp decline, and the continued decline of property values put tenants at risk of failing to receive their deposit after the contract period. Therefore, this study reflects the characteristics of chonsei and the possibility that chonsei can involve default like mortgage. To this end, it is necessary to examine the collection of studies on the default behavior of mortgages.

First, for default behavior, Campbell and Dietrich (1983) and Vandell and Thibodeau (1985) support the argument that default occurs when equity is negative, referred to as ruthless default. On the other hand, studies including Lekkas et al. (1993), Hendershott and Schultz (1993), Quigley and Van Order (1995), and Capozza et al. (1997) have shown that the default does not usually exhibit ruthless behavior. In order to explain this empirical behavior, Quigley and Van Order (1995) introduced the concept of default cost, which captures credit and financial-transaction impairment when default occurs. Brueckner (2000) derived an optimal contract that takes into account default cost under asymmetric information.

Brueckner et al. (2012) use the default model with default cost, assuming that house price appreciation leads to favorable expectations for future house prices, and showing that this expectation leads to relaxation of underwriting standards. They also provide an empirical test of this proposition. Brueckner et al. (2016) use the same approach to study the relationship between house price expectations and the use of alternative mortgage products (AMPs). These studies suggest that lenders and borrowers are more likely to anticipate that defaults will not occur when expectations for future home prices become more favorable, thereby increasing the use of risky mortgage products or relaxing underwriting standards.

For the relationship between default cost and mortgage loan-to-value, the most relevant research is Harrison et al. (2004). They study mortgage data and FICO scores, finding that borrowers with low default cost select high LTV ratios.

This paper utilizes existing theoretical models, but derives an optimal contract between the landlord and the tenant through a new approach, and it also overcomes some limitations of the empirical methods found in existing discussions. Kim (2013) derives an equilibrium contract based on a process in which the landlord provides the tenant with housing consumption, but this paper derives an optimal contract between the tenant and the landlord with a focus on the mortgage nature of chonsei. This paper also extends the scope of the existing discussion by applying Brueckner's (2000) model of the mortgage market with default costs to individual chonsei lease contracts.

In addition, Brueckner et al. (2012) use appreciation of past house prices as an indicator of favorable expectations for future house prices, but this approach may not accurately reflect true expectations. This paper complements and develops the existing empirical analysis using the landlords' actual expectation of future house prices derived directly from a survey.

Through these new approaches, this paper derives the equilibrium size of the chonsei deposit in a model that considers the mortgage characteristics of chonsei along with default risk. We also examine the effect of expectations of future housing prices on the size of chonsei deposits, and then test these predictions empirically using real data. The theoretical model to be described in the next section shows the relationship between chonsei deposit, default cost, and expectations for future housing prices.

Theoretically, we find that the larger is the default cost, the smaller is the chonsei deposit and, conversely, the more favorable are the expectations of future house prices, the greater is the chonsei deposit. Empirically, the propositions of the theoretical model are verified by using bank data and survey data. Some limitations of existing studies are overcome using the characteristics of the survey data.

The discussion proceeds as follows. Section 2 provides an overview of the chonsei system in Korea. Section 3 describes the theoretical model showing an optimal chonsei deposit considering chonsei default, Section 4 presents the characteristics of the data for empirical work, and verifies the propositions of the theoretical model through the estimation results.

2. Overview of the Korean chonsei

This section provides an overview of the chonsei system in Korea. The most common rental system in Korea, chonsei does not involve a monthly rent in most cases. Instead, the tenant provides the landlord with a lump sum of 40%–60% of the property value for the contract period. The tenant then enjoys the housing consumption during the contract period, and the landlord invests the chonsei in the purchase of housing. After the contract period ends, the landlord returns the deposit to the tenant without interest.

It is unclear when the chonsei system started, but it has become the most popular housing lease system during Korea's period of rapid industrialization. Chonsei is by no means the only existing form of lease contract in the country,[2] but in 2016, chonsei was the most common type of contract, accounting for more than 50% of lease contracts.

As Son (1997) and Kim (2013) explain, the rapid urbanization of Korea and the government's financial repression have made chonsei an attractive system for both the landlord and the tenant. Because the government's banking policy favored the industrial sector, landlords could not access enough funds to invest in housing. Chonsei came to fill this gap for the landlord. At the same time, tenants were able to save money by renting through chonsei, and they were able to use the money returned at the end of the contract period as funds to purchase new homes.[3] Rapid urbanization increased demand for housing, but

[1] For additional studies on chonsei, see Cho (2010), Gyourko and Han (1989), Kim (1990), and Lee and Chung (2010).

[2] For example, if the landlord makes a contract with a monthly rent and chonsei, the contract is mixed chonsei. Pure chonsei and pure monthly rent are a form of mixed chonsei.

[3] In a mortgage scheme, the bank and the landlord enter into a contract, and the landlord pays interest and a part of the principal to the bank for a certain period and repays the principal upon termination of the contract. In comparison, chonsei differs in that the tenant and the landlord enter into a contract and provide housing consumption to the tenant for a period of time, the tenant earns "interest" in the form of reduced rent, and the landlord returns the principal to the tenant upon termination of the contract.

supply was limited by the government's land use controls. As a result, investment in housing became a superior choice over other investments. The combination of the above-mentioned factors led to an increase in housing investment, which the landlord financed through the chonsei provided by the tenant.[4] In return for financing the landlord with the interest-free chonsei deposit, the tenant gained housing consumption and savings opportunities.[5]

3. The model

This section derives the effect of default cost and expectations of future house prices on the equilibrium of lease contracts with a combination of chonsei deposit and monthly rent, an arrangement called "mixed" chonsei. We use the mortgage-market equilibrium model with default costs proposed by Brueckner (2000), and incorporate chonsei and monthly rent selection following Kim (2013).

This model adds novel aspects to existing discussion in several respects. First, we incorporate default risk for the chonsei deposit. As explained by Ambrose and Kim (2003), the tenant is not authorized foreclose due to the nature of the chonsei system, so there is a risk of losses from chonsei default. In the model, chonsei default risk is introduced for the first time to make the existing model more sophisticated and fill the existing theoretical gap.

Next, the influence of changes in parameters such as default costs and future house-price expectations on the chonsei deposit, and the conditions under which monthly rent may coexist with chonsei, are derived through the model. While showing the change in the chonsei deposit as parameters change, the model also articulates the conditions under which pure chonsei contracts (rental contract using only chonsei) and mixed chonsei contracts (rental contract using both chonsei deposit and monthly rent) exist.

In addition, we theoretically analyze the interaction of the landlord and tenant in the chonsei system, providing a further example of how housing finance operates under default risk. Chonsei is a system of housing financing between individuals rather than between financial institutions (bank) and borrowers, and our discussion extends the existing literature by analyzing the behavior of housing finance under such a relationship.

3.1. Model setup

This section derives an optimal lease contract with the tenant incorporating default cost. The landlord and tenant agree to a lease contract using monthly rent (R) and a chonsei deposit (D). Reflecting the characteristics of the chonsei contract, the lease agreement is made over two periods, and the chonsei deposit paid at period-0 is assumed to be returned to the tenant at period-1. However, if chonsei default occurs, the tenant is not authorized to foreclose on the house. Tenant may, however, file a claim with the landlord through a lawsuit. In such cases, the tenant will be able to get back only a portion of the house value that is less than the deposit.

At period-0, the landlord pays P_0, buys the house, and leases it to the tenant. The reason for chonsei default is that the price of the house is stochastic. We assume that the value of the house in period-1 has a distribution with density of $f(\cdot)$. In the following discussion, it is assumed that housing prices have a uniform distribution to facilitate intuitive explanations. However, assuming a general distribution, many of the conclusions of the discussion remain unchanged.

The default cost (C) of the landlord is the cost incurred when chonsei default occurs at the end of the contract term, including credit restrictions and other limits on financial activities.[6] If the landlord defaults, the tenant cannot foreclose on the house, but we assume that the tenant receives a fraction α of the house value, where $\alpha P < D$.[7] Incorporating default cost, default is optimal for the landlord when

$$P - D \le (1-\alpha)P - C \tag{1}$$

The left side of (1) is housing equity in period-1, which is the residual value of period-1 housing net of the deposit if no default occurs. Thus, if the value of $P - D$ is sufficiently small, so that its absolute value is less than the residual value of period-1 housing net of the repayment for the tenant (αP) and the default cost, it is optimal for the landlord to default. Rewriting (1) as $P \le \frac{D-C}{\alpha}$, $\frac{D-C}{\alpha}$ can be called the default price, and the larger is $\frac{D-C}{\alpha}$, the more likely that default will occur.[8]

Under the assumption that D is given, default's occurrence is associated with C, and the smaller is C, the more likely chonsei default is to occur, and therefore the more risky is the landlord. If one landlord is more risky than other landlords, that landlord will have a relatively small C value. The observability of C can vary depending on whether it is private information, but because, when the landlord and tenant make a contract, they share official information (such as the debt of the landlord) and informal information (such as the occupation, residential area of the landlord) through the real estate agency, C is assumed to be information that the tenant can observe.

The cumulative distribution function of future house prices considering house price expectation can be defined as follows:

$$F(P,\delta) = \int_0^P f(p,\delta)dp \tag{2}$$

where $f(p,\delta)$ is the density function of the house price and δ is a parameter that shifts the density to the right. The support of the density is $(\overline{P}, \underline{P})$. As a parameter indicating favorable expectations for future house prices, the larger is the value of δ, the higher P is expected to be, with $F_P > 0$.

[4] Chonsei is also more advantageous to the landlord than a loan because it is free of interest. It also enables large-scale funding compared to monthly rent. Chonsei is also beneficial for the landlord in that, unlike a mortgage, chonsei does not affect an individual's credit rating because it takes the form of a lease, not a loan contract.

[5] Kim (2013) explains that a chonsei tenant can save more compared to a landlord or an owner-occupier. The data used by Lee and Chung (2010) also shows that the deposit-to-monthly-rent conversion rate is from 11.76% to 14.4% a year between 2002 and 2008, compared to a bank interest rate of 4.05%–5.46%. These discussions show that tenants can save using chonsei rather than using monthly rental contracts.

[6] Therefore, it can be assumed that the landlord's credit rating is related to default cost. If a default occurs, this is undesirable for the landlord, as it will result in a decline in the landlord's credit rating, which will negatively affect the landlord's reputation. The higher is the credit rating, the greater is the cost of default, which ruins the credit rating.

[7] Although D is endogenous, all possible equilibrium values are assumed to satisfy this relationship (otherwise default is ruled out). Although it is somewhat unusual to assume a condition involving values of an endogenous variable, doing so seems appropriate in the current model.

[8] In this paper, we assume that α has a fixed arbitrary value which is less than one. In the chonsei scheme, the tenant is unable to foreclose when chonsei default occurs, and the house is auctioned through a court case. Based on consultations with bank officials, we have learned that in practice a fixed ratio of P gets returned to the tenant in case of default after various fee deductions, but we were unable to obtain data on the precise ratio. Therefore, the final amount the tenant gets paid back will be a certain percentage of the market price of the house. Government policy on housing may affect α. For example, in 2013, the government introduced chonsei deposit insurance. If the tenant uses this insurance and pays the insurance premium, the government pays all or part of the chonsei deposit. Therefore, the introduction of this policy also provides an environment in which the tenant can receive the chonsei deposit even if default occurs.

The landlord purchases the house at period-0 and rents it to tenant using the chonsei deposit (D) and monthly rent (R).[9] The landlord's wealth changes according to the house price of the next period, and the objective function is

$$\pi = -P_0 + D + R + \theta(R + \int_{\underline{P}}^{\frac{D-C}{\alpha}} ((1-\alpha)P - C)f(P,\delta)dP + \int_{\frac{D-C}{\alpha}}^{\overline{P}} (P-D)f(P,\delta)dP) \quad (3)$$

Equation (3) describes the present value of landlord's profit. The landlord buys the house by paying P_0 and then rents to tenant receiving D in period-0 and R in both periods.[10] If the value of the house in the next period is less than $\frac{D-C}{\alpha}$, chonsei default occurs. However, since the tenant will not be able to foreclose on the house, the tenant will get back αP, not P, and the landlord will receive $(1-\alpha)P$ net of default cost (C) when the house is sold at the end of period-1. If the house value is greater than $\frac{D-C}{\alpha}$, the landlord pays back the chonsei deposit and has wealth equal to $P - D$. $\theta < 1$ is the discount factor of the landlord.

The landlord considers monthly rent (R) and chonsei (D) together when renting out a house, and if there is no monthly rent, the contract is purechonsei. On the other hand, if the landlord makes a contract with a mixture of monthly rent and chonsei, the contract is mixed chonsei.

The landlord's objective function involves the following assumptions. First, it is assumed that the landlord is risk neutral and the purchase price of the house (P_0) at 0-period is fixed. Thus, P_0 is not a decision variable in the landlord's objective function. It is also assumed that the landlord has only one default opportunity. Thus, the lease with the tenant is a one-period contract and does not depend on changes in house prices in multiple periods in the future.

The tenant's utility function can also be derived in conjunction with the landlord's profit function. Based on the assumptions of the landlord's objective function, the tenant assumes that a part of period-1 housing value (αP) is returned if chonsei default occurs. The objective function of the tenant is then

$$U = -D - R + \eta(-R + \int_{\underline{P}}^{\frac{D-C}{\alpha}} \alpha P f(P,\delta)dP + \int_{\frac{D-C}{\alpha}}^{\overline{P}} Df(P,\delta)dP) \quad (4)$$

where $\eta < 1$ is the tenant's discount factor. In other words, tenant assumes that if the house value is less than $\frac{D-C}{\alpha}$, only αP is returned, with D returned only if the house value is greater than $\frac{D-C}{\alpha}$. Thus, the utility of tenant is determined by the expected return of the chonsei deposit considering the landlord's default.

3.2. Zero-profit and indifference curves of the landlord and tenant

The analysis discussed in this section develops the characteristics of the landlord's zero-profit curve and tenant's indifference curves from the objective functions described in (3) and (4). Each curve shows the relationship between D and R under the contract for given profit and utility, and equilibrium is a point of tangency between these two curves.

If we set the profit of the landlord to zero, we can obtain the zero profit curve. To do so, the derivatives of π with respect to D and R can be obtained by using Leibniz's rule:

$$\pi_D = 1 + \theta(-(1 - F(\frac{D-C}{\alpha}, \delta))) \quad (5)$$

$$\pi_R = 1 + \theta \quad (6)$$

Using (5) and (6), the slope of the zero profit curve of the landlord in (D, R) space[11] is obtained as

$$\frac{\partial R}{\partial D}|_L = -\frac{\pi_D}{\pi_R} = MRS_L = -\frac{1 + \theta(-(1 - F((\frac{D-C}{\alpha}, \delta)))}{1 + \theta} \quad (7)$$

To demonstrate the equilibrium through a concrete case, we assume that P follows a uniform distribution with support of $[\underline{P} + \delta, \overline{P} + \delta]$. In this case, the density of P is $1/(\overline{P} - \underline{P})$ and Equation (6) can be expressed as

$$\frac{\partial R}{\partial D}|_L = -\frac{1 + \theta((\frac{1}{\alpha}(D-C) - (\overline{P} + \delta))/(\overline{P} - \underline{P}))}{1 + \theta} \quad (8)$$

In order to derive the characteristics of the tenant's indifference curve, we differentiate the utility function with respect to D and R using Leibniz's rule:

$$U_D = -1 - \eta(\frac{1}{\alpha} Cf(\frac{D-C}{\alpha}, \delta) - (1 - F(\frac{D-C}{\alpha}, \delta)) \quad (9)$$

$$U_R = -(1 + \eta) \quad (10)$$

The slope of the indifference curve is obtained as follows:

$$\frac{\partial R}{\partial D}|_T = -\frac{U_D}{U_R} = MRS_T = -\frac{1 + \eta(\frac{1}{\alpha} Cf(\frac{D-C}{\alpha}, \delta) - (1 - F(\frac{D-C}{\alpha}, \delta)))}{1 + \eta} \quad (11)$$

With a uniform house-value distribution, (11) can be written as

$$\frac{\partial R}{\partial D}|_T = -\frac{1 + \eta((\frac{1}{\alpha} D - (\overline{P} + \delta))/(\overline{P} - \underline{P}))}{1 + \eta} \quad (12)$$

In the situation where D is given, a bigger R increases the profit of the landlord, but it negatively affects tenant because the tenant has to use more resources for the contract. Thus, the utility of the tenant in the $D - R$ plane is higher as the curve is located lower, while the profit of the landlord is higher as the curve is located higher.

In order to derive the equilibrium, the curvature of the zero profit curve and the indifference curve should be confirmed. The curvature of each curve can be derived by differentiating the MRS of the landlord and the tenant with respect to D, using (8) and (12):

$$\frac{\partial MRS_L}{\partial D} = -\frac{1}{\alpha} \frac{\theta}{1 + \theta} < 0 \quad (13)$$

$$\frac{\partial MRS_T}{\partial D} = -\frac{1}{\alpha} \frac{\eta}{1 + \eta} < 0 \quad (14)$$

Since (13) and (14) have negative values, the zero-profit and indifference curves are concave.

With this background, the optimal rental contract between the landlord and tenant can be characterized. The equilibrium will be at a point where the lowest indifference curve touches the zero profit curve. For this point to be a tangency, the indifference curve must be more concave than the zero profit curve, as seen in Fig. 1. Therefore, given (13) and (14), $\eta > \theta$ must hold in order to satisfy the relative concavity condition for a mixed equilibrium.[12] This conclusion follows because (13)

[9] As a simplifying abstraction, we assume the landlord has no other reason to demand chonsei deposit than to invest in a house; that the landlord's demand for any income stream can be met by the landlord's choice of R. Therefore we do not consider interest generated with the chonsei deposit. Also, tenants do not save since their deposit is returned in the future, which means that interest rates also do not enter their object function, considered below.

[10] The tenant in reality would pay a monthly rent periodically between periods zero and one. However, since our model consists of two periods, the R can be viewed as a discounted value of rent over multiple short periods.

[11] In this model, the purchase price of P_0 is fixed and thus is not a decision variable of the landlord. Thus, the landlord's zero profit curve is fixed with respect to P_0, with zero profit maintained by variation in D and R.

[12] $\eta > \theta$ must hold for the mixed equilibrium to be admissible. Otherwise the equilibrium will always be a corner solution.

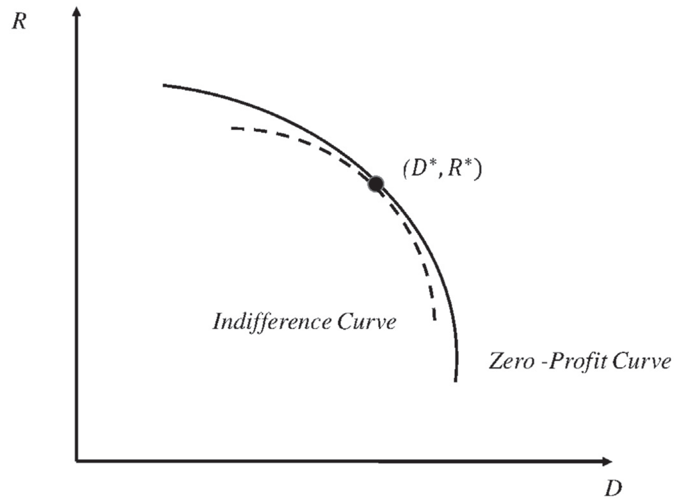

Fig. 1. Equilibrium contract.

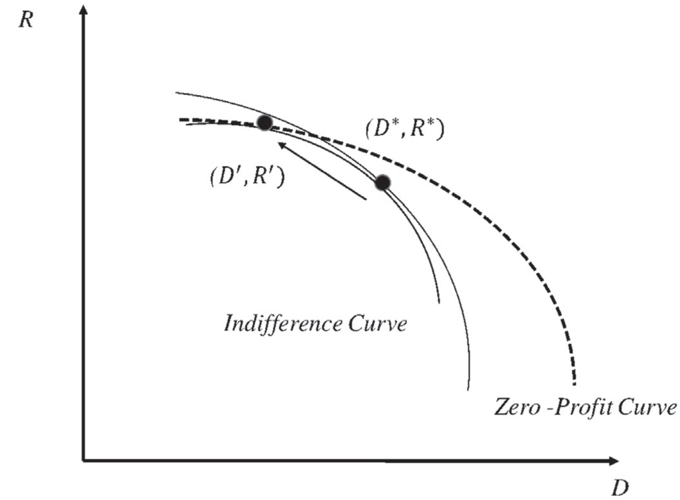

Fig. 2. Change of equilibrium with change of C.

and (14) are increasing in the discount factors so that $\frac{\partial MRS_L}{\partial D} > \frac{\partial MRS_T}{\partial D}$ requires $\eta > \theta$.[13]

3.3. Equilibrium analysis

In this section, the equilibrium contract is derived. To find the equilibrium, we set the tenant's indifference curve slope equal to the landlord's zero profit curve slope, using (8) and (12):

$$\frac{\partial R}{\partial D}|_L = MRS_L = -\frac{1+\theta((\frac{1}{\alpha}(D-C)-(\overline{P}+\delta))/(\overline{P}-\underline{P}))}{1+\theta}$$

$$= \frac{\partial R}{\partial D}|_T = MRS_T = -\frac{1+\eta((\frac{1}{\alpha}D-(\overline{P}+\delta))/(\overline{P}-\underline{P}))}{1+\eta} \quad (15)$$

Then, (15) is solved for D to derive

$$D^* = 2\alpha(\overline{P}+\delta) - \alpha(\underline{P}+\delta) - \frac{\theta(1+\eta)}{(\eta-\theta)}C \quad (16)$$

The optimal D^* depends on the default cost C and double the future maximum house value $(\overline{P}+\delta)$ minus future minimum house value $(\underline{P}+\delta)$.[14] Differentiating D^* with respect to C and δ yields

$$\frac{\partial D^*}{\partial C} = -\frac{\theta(1+\eta)}{(\eta-\theta)} < 0 \quad (17)$$

$$\frac{\partial D^*}{\partial \delta} = \alpha > 0 \quad (18)$$

As can be seen, a favorable shift in the future house price distribution (an increase in δ) raises D^*. This conclusion makes sense because the higher δ makes it less likely that the deposit will be lost via default. The relative concavity condition shows that η is greater than θ, so the denominator of the factor multiplying default cost in (17) is positive. As a result, the optimal D^* has a negative relation to default cost.[15]

This relationship can be easily seen through the changing position of the zero profit curve as default cost changes. To determine the change of the curve, the *MRS* expression of the landlord is differentiated with respect to C:

$$\frac{\partial}{\partial C}\frac{\partial R}{\partial D}|_L = \frac{1}{\alpha}\frac{\theta}{1+\theta} \quad (19)$$

Equation (19) shows that zero profit curve becomes flatter (with a less negative slope) as default cost increases. Intuitively, as C rise, the landlord requires less compensation in the form of higher R when D falls, a consequence of a lower likelihood of default. Since C has no effect on the slope of the indifference curves and the landlord's zero profit curve becomes flatter, the equilibrium D will decrease, as seen in Fig. 2.[16] Summarizing the preceding analyses yields.

Proposition 1. If the relative concavity condition and maintained assumptions are satisfied, an increase in the landlord's default cost (a higher credit rating) has the effect of reducing the chonsei deposit D, while a favorable change in the expected density of future house prices (a higher δ) increases the chonsei deposit.

Based on the solution for D^*, the equilibrium of monthly rent (R^*) can be derived by substituting D^* in the landlord's zero profit condition ($\pi = 0$ in (3)).[17] We can say that contract moves away from pure chonsei as C increases and toward pure chonsei as δ increases.[18]

4. Empirical approach

To empirically verify the model's predictions, we need variables that reflect the landlord's credit information (C), lease information (P, D),

[13] The discussion focuses on the case where the slopes of the landlord's zero-profit curve and tenant's indifference curve are negative. However, whether each slope has a negative value or a positive value does not make any difference in the analysis. As can be seen from Equations (13) and (14), the curvature of each curve is determined independently of the slope, and even if the slope is positive, the indifference curve must be relatively more concave than the zero-profit curve for a tangency equilibrium.

[14] The optimal D^* is also dependent on α, and D must be greater than αP. If $D > \alpha(\overline{P}+\delta)$, then $D > \alpha P$ is always satisfied. When we apply D^* to this condition, then $D^* > \alpha(\overline{P}+\delta)$ if $\alpha > \frac{\frac{\theta(1+\eta)}{(\eta-\theta)}C}{\overline{P}-\underline{P}}$. This tells us that α cannot have too small a value.

[15] We also do comparative statics for the likelihood of default. We confirm that the default probability increases with an increase in δ, but the change of the default probability with an increase in C is ambiguous, which is determined by the relative size of η and θ. See Appendix 2 for a detailed discussion.

[16] Differentiating MRS_L and MRS_T against δ reveals that the landlord's zero profit curve and the indifference curve of the tenant are both flattened, but the indifference curve of the tenant becomes even more flat $(\frac{\eta}{1+\eta} > \frac{\theta}{1+\theta})$.

[17] See Appendix 3 for a detailed discussion.

[18] Appendix 1 shows mixed chonsei and pure chonsei graphically.

Table 1
Summary statistics of the bank data.

VARIABLES	Observations	Mean	Std. Dev	Description
CHONSEI	13,588	14,874	12,372	The amount of chonsei deposit
VALUE	13,588	50,866	41,974	Market price of leased house
CREDITSCORE	13,588	860.8	135.3	Credit score (0–2000 points) assessed in a manner similar to FICO
CREDITGRADE	13,588	11.59	1.723	Credit rating based on credit score (D to AAA), a number from 0 to 14 assigned to the 14 letter grade
SIZE	13,588	136.4	463.9	Size of house (in square meters)
SEX	13,588	0.603		1-Male, 0-Female
AGE	13,588	54.27	12.24	The age of householder
INCOME	13,588	354.32	760.95	Monthly income of householder
JOBDUMMY	13,588	0.569		1- have a job, 0-No occupation at the time of application
JOBTYPE	13,588	0.147		1-self employed, 0-otherwise

The sample is comprised of 6 years, which span from 2011 to 2016.
Variables with missing Std. Dev. are dummy variables.
Monetary units are in 10,000 Korean won, which is approximately equivalent to 10 US dollars.

and expectations for future house prices (δ). However, since the information on individual leases is not collected and accurate data on credit information cannot be constructed in relation to the lease contract, the literature so far has not studied the relationship between credit information and the chonsei deposit used as a means of housing investment.

In this section, we analyze this relationship using an extensive and unique bank data set to overcome these limitations. As shown in the model, default cost affects the chonsei deposit, and we can reasonably assume that the higher the credit rating of the landlord, the higher the default cost. The data includes credit information such as the credit score, letter grade of credit using the score, income, occupation, etc. of the landlord who applied for a mortgage. The data also include house price, the location of the house, and how much chonsei deposit was received from the tenant.

In addition, by using the method of Brueckner et al. (2012), which sets the prior house-price appreciation in the area to be the expectation index for future house price increases, we match the location information of the data with the local house price index and analyze the effect of house price appreciation on the chonsei deposit.

The methodology used by Brueckner et al. (2012), however, has limitations because rise in house prices in the region may not accurately reflect the expectation of future price increases, as was pointed out in their study. In order to overcome the limitations of this indirect method, we also examine the relationship between expectations and the chonsei deposit using survey data on housing finance conducted every year by the Korean government. Because these data are based on questionnaires, there is no information about the individual's credit rating. However, since the expectations of future house prices are directly measured, the predictions of the model can be verified more directly than in existing studies.

In summary, we verify the propositions of the theoretical model for the relationship between the chonsei deposit, default cost, and price expectations using two sets of data. In particular, we use survey data to supplement the existing studies by directly exploring the relationship between expectations and the chonsei deposit.

4.1. Data sources

The first data set consists of data on mortgage applicants from one of the largest banks in terms of asset size, from 2011 to 2016. All applicants in the data are landlords who originally purchased a property and leased the house to a tenant using chonsei only and had no previous record of taking out a mortgage. This prior information, which pertains to an earlier situation where the landlord did not have a mortgage, is used for purposes of testing the model's predictions.[19] In these data, the borrower's credit score is assessed when a new mortgage is created in a particular year, using a similar method to the way the FICO score is set (the sample score range is from 0 to 2000). Based on this credit score, letter grading from D to AAA is assigned. Income and age of the landlord are also shown in the data set.

Using information about housing location in these data, we link the house price index of the district[20] unit that the Korean government creates based on actual selling prices. Brueckner et al. (2012) argued that high housing price appreciation generates a price-expectations shift like that portrayed in the theoretical model. Using this methodology, we examine the effect of favorable price expectations on the chonsei deposit. This data set includes 13,588 observations of applicants who previously invested in housing using only chonsei without a mortgage. Table 1 reports summary statistics for the key variables.

The second data set is based on the Korean government's annual housing finance survey. The database consists of 5000 households nationwide sampled in the same way as the census method each year, and it has data from 2013 to 2016. Some survey respondents are landlords and some are tenants. If the respondent is a tenant, some information, such as the housing prices or the expectation of changes in housing prices, are lacking. Therefore we only use the subsample of respondents who are landlords, for whom such information is available.

The data are based on 1863 observations of houses rented to tenants and consist of information on the amount of the chonsei deposit, monthly rent, and the expectations of the future house price (the variable equals 1 if future house prices are expected to rise and equals zero if they are expected to fall or stay the same). The data also contain information about the contract type (the variable equals 1 if the contract type is pure chonsei and equals zero if it is mixed chonsei). In addition, variables such as the location of the house and income are also surveyed. This data set helps to overcome the limitations of using

[19] The information about the landlord when earlier buying a house using chonsei may not be accurate at the time of his credit rating evaluation since the information in the bank data are associated with the mortgage application, but due to the limitations of the data, accuracy cannot be confirmed. In addition, the data set can lead to potential sample selection bias issues because it does not have information on landlords who may have accessed to mortgage financing or landlords that could not access or chose not to use mortgages when buying a house for the first time. However, the advantage of the dataset lies in the homogeneity of the landlords in the sample, all of whom originally purchased their house using only chonsei without a mortgage. This provides a good environment for empirically confirming the changes in D as parameters change.

[20] District is a higher administrative unit than town, the smallest administrative unit. Real estate regulations are applied differently across districts, and the house price index is also generated at the district level.

Table 2
Summary statistics of the survey data.

VARIABLES	Observations	Mean	Std. Dev	Description
CHONSEI	1863	12,313	11,124	The amount of chonsei deposit
CONTRACTTYPE	1863	0.684		Lease contract type (1 = pure chonsei, 0 = mixed chonsei)
EXPECTATION	1863	0.366		Answers to expectations that future housing prices will rise (1 = will rise, 0 = will fall or similar)
VALUE	1863	26,119	30,893	Market price of leased house
SEX	1863	0.846		1-Male, 0-Female
AGE	1863	46.34	8.193	The age of householder
INCOME	1863	569.50	277.69	Monthly income of household

The sample is comprised of 4 years, which span from 2013 to 2016.
Variables with missing Std. Dev. are dummy variables.
Monetary units are in 10,000 Korean won, which is approximately equivalent to 10 US dollars.

Table 3
The relationship between the chonsei deposit, landlord's default cost, and house price appreciation.

	(1)	(2)	(3)	(4)	(5)
	Estimation using Credit Score		Estimation using Credit Grade		Estimation using HPICHG
VARIABLES			log(CHONSEI)		
CREDITSCORE	−8.96e-05***	−8.64e-05**			
	(3.40e-05)	(3.40e-05)			
CREDITGRADE			−0.0178***	−0.0175***	
			(0.00235)	(0.00236)	
HPICHG		0.00316***		0.00308***	0.00316***
		(0.000939)		(0.000936)	(0.000939)
log(VALUE)	0.839***	0.838***	0.843***	0.842***	0.837***
	(0.00862)	(0.00863)	(0.00865)	(0.00865)	(0.00860)
SIZE	3.86e-05	3.87e-05	3.90e-05	3.91e-05	3.86e-05
	(4.74e-05)	(4.73e-05)	(4.72e-05)	(4.70e-05)	(4.74e-05)
SEX	0.0230***	0.0222***	0.0238***	0.0230***	0.0220***
	(0.00840)	(0.00840)	(0.00839)	(0.00839)	(0.00841)
AGE	0.00211***	0.00215***	0.00200***	0.00205***	0.00217***
	(0.000335)	(0.000335)	(0.000334)	(0.000335)	(0.000335)
INCOME	−2.30e-10***	−2.33e-10***	−2.21e-10***	−2.24e-10***	−2.40e-10***
	(7.62e-11)	(7.69e-11)	(7.45e-11)	(7.52e-11)	(7.71e-11)
JOBDUMMY	0.00926	0.0101	0.0130	0.0137	0.00862
	(0.00944)	(0.00945)	(0.00942)	(0.00942)	(0.00944)
JOBTYPE	−0.00980	−0.0101	−0.0150	−0.0152	−0.00846
	(0.0122)	(0.0122)	(0.0121)	(0.0122)	(0.0121)
Observations	13,588	13,542	13,588	13,542	13,542
R-squared	0.645	0.645	0.646	0.646	0.645

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
All regressions include a constant, year fixed-effects and region fixed-effects.

past appreciation as a proxy for house price expectations. The main features of these data are shown in Table 2.

The two data sets differ in some respects. First, the price of the house and the age of the landlord in the bank data are larger than those in the survey data, but the income of the landlord in the bank data is lower. This discrepancy emerges because the two data sets are based on different populations. The bank data is based on people applying for a mortgage, most likely because they bought an expensive home relative to their income. On the other hand, in the survey data, the respondents are randomly selected from the population. Our analysis, however, focuses on the impact of parameters such as credit score[21] or expectation of future house prices on D, and a consistent result using two different data sets can show robustness of what the theory predicts.

4.2. Empirical strategy

The main empirical model using the bank data relates the chonsei deposit for the household i in district j in year t, denoted as $CHONSEI_{ijt}$, to the one-year lag of annual house-price appreciation, denoted as $HPICHG_{ijt-1}$ (where HPI is the house price index), and the credit score of the landlord, denoted by $CREDITSCORE_{ijt}$, indicating default cost. The $CREDITGRADE_{ijt}$ variable was created by assigning a number from 0 to 14 to the 14 letter grades (D to AAA) based on $CREDITSCORE$, which is used as an independent variable for further estimation. $HPICHG_{ijt-1}$ is calculated as $(HPI_{ijt-1} - HPI_{ijt-2})/HPI_{ijt-2}$. Thus, the key estimation model is

$$\log\left(CHONSEI_{ijt}\right) = \alpha + \lambda_j + \tau_t + \beta_1 CREDITSCORE_{ijt} + \beta_2 HPICHG_{ijt-1} + \beta_3 X_{ijt} + \varepsilon_{ijt} \quad (20)$$

[21] Credit score is considered exogenous because it is calculated based on the individual's credit and payment history. To check for the possibility that the credit score is endogenous, we used a two-stage instrumental variable regression analysis that uses the income and age of the landlord as the instrument variables. However, the *F-statistics* of the first stage regressions using the 1) income only, 2) age only, and 3) both income and age as instrument variables are as low as 8.531, 3.387 and 6.579, respectively, which means that instrumental variables are weak instruments.

Table 4
The relationship between the CTV, landlord's default cost, and house price appreciation.

VARIABLES	(1) Estimation using Credit Score	(2)	(3) Estimation using Credit Grade	(4)	(4) Estimation using HPICHG
	CTV = (CHONSEI/VALUE)*100				
CREDITSCORE	−0.00172**	−0.00162*			
	(0.000868)	(0.000866)			
CREDITGRADE			−0.482***	−0.472***	
			(0.0689)	(0.0690)	
HPICHG		0.0760***		0.0738***	0.0760***
		(0.0250)		(0.0249)	(0.0250)
log(VALUE)	−4.383***	−4.392***	−4.267***	−4.277***	−4.420***
	(0.382)	(0.382)	(0.386)	(0.386)	(0.379)
SIZE	0.000889	0.000890	0.000901	0.000902	0.000888
	(0.00117)	(0.00116)	(0.00116)	(0.00115)	(0.00116)
SEX	0.662***	0.645***	0.686***	0.668***	0.640**
	(0.249)	(0.249)	(0.248)	(0.248)	(0.250)
AGE	0.0549***	0.0559***	0.0520***	0.0530***	0.0562***
	(0.00977)	(0.00979)	(0.00981)	(0.00983)	(0.00978)
INCOME	−4.61e-09***	−4.68e-09***	−4.31e-09***	−4.37e-09***	−4.81e-09***
	(1.57e-09)	(1.59e-09)	(1.52e-09)	(1.54e-09)	(1.59e-09)
JOBDUMMY	0.280	0.299	0.393	0.410	0.272
	(0.276)	(0.276)	(0.277)	(0.277)	(0.275)
JOBTYPE	−0.116	−0.125	−0.269	−0.276	−0.0954
	(0.329)	(0.330)	(0.330)	(0.331)	(0.329)
Observations	13,588	13,542	13,588	13,542	13,542
R-squared	0.151	0.151	0.154	0.153	0.150

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
All regressions include a constant, year fixed-effects and region fixed-effects.

where ϵ_{ijt} is the error term and X_{ijt} is the vector of additional covariates that represent the characteristics of the house and the household. α_i, λ_j, and τ_t represent a household fixed effect, a region fixed effect, and a year fixed effect, respectively. X_{ijt} includes a housing price variable, $\log(VALUE_{ijt})$, which controls for the impact of the house price on $CHONSEI_{ijt}$. We expect $\beta_2 > 0$ and $\beta_1 < 0$.

The second empirical model using the survey data identifies the effect of house price expectations by relating the chonsei deposit for the household i in district j in year t to the expectations of future house prices as captured by $EXPECTATION_{ijt}$:

$$\log\left(CHONSEI^1_{ijt}\right) = \alpha^1 + \lambda^1_j + \tau^1_t + \beta^1_1 EXPECTATION_{ijt} + \beta^1_2 X^1_{ijt} + \varepsilon^1_{ijt} \tag{21}$$

Like the first empirical method, X^1_{ijt} includes includes a housing price variable, $\log(VALUE^1_{ijt})$ and other housing and household-related covariates. We expect $\beta^1_1 > 0$ in this estimation.

The third empirical model using the survey data identifies the effect of house price expectations on the contract type (pure vs mixed chonsei) for household i in district j in year t:

$$CONTRACTTYPE_{ijt} = \alpha^2 + \lambda^2_j + \tau^2_t + \beta^2_1 EXPECTATION_{ijt} + \beta^2_2 X^2_{ijt} + \varepsilon^2_{ijt} \tag{22}$$

$CONTRACTTYPE_{ijt}$ equals 1 for pure chonsei and 0 for mixed chonsei. Equation (25) is a linear probability model, but we also estimate a probit model. We expect $\beta^2_1 > 0$ in this estimation, given that a higher δ moves the contract toward pure chonsei ($\frac{\partial D^*}{\partial \delta} > 0$ and $\frac{\partial R^*}{\partial \delta} < 0$)

4.3. Empirical results

4.3.1. Estimation results using the bank data

The results of the estimation using the bank data are shown in Table 3. Our interest is the coefficients of *CREDITSCORE* and *HPICHG*. First, *CREDITSCORE* and *CREDITGRADE* have negative coefficients at statistically significant levels, confirming what Proposition 1 predicts. Columns (1), (3), and (5) show the separate effects of credit score and *HPICHG*, and columns (2) and (4) show the effects of both variables together. The estimation results show that, as the credit score increases, the chonsei deposit decreases. That is, when the credit score increases by 100 points, the chonsei deposit decreases by 0.9%. The results of the estimation using the credit rating expressed in the letter form are shown in columns (3) and (4). It can be seen that when the credit rating goes up by one unit, the chonsei deposit decreases by about 1.8%.

Next, looking at the coefficients of *HPICHG* in columns (2), (4), and (5), we can see that *HPICHG* and the chonsei deposits are positively related at a statistically significant level, again confirming the model's predictions from Proposition 1. From the estimation results, we can

Table 5
The relationship between the chonsei deposit and expectations of future house prices.

VARIABLES	(1) log(CHONSEI)	(2) log(CHONSEI)
EXPECTATION	0.108**	0.107**
	(0.0521)	(0.0521)
log(VALUE)	0.618***	0.609***
	(0.0369)	(0.0387)
SEX		0.0281
		(0.0681)
AGE		−0.00972***
		(0.00305)
INCOME		0.000193
		(0.000107)
Observations	1863	1863
R-squared	0.256	0.262

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
All regressions include a constant year fixed-effects and region fixed-effects.

Table 6
The relationship between the contract type and expectations of future house prices.

VARIABLES	(1)	(2)	(3)	(4)
	Linear probability model		Probit model	
	Contract Type		Contract Type	
	(1 = Pure chonsei, 0 = Mixed chonsei)		(1 = Pure chonsei, 0 = Mixed chonsei)	
EXPECTATION	0.0507**	0.0500**	0.158**	0.156**
	(0.0215)	(0.0216)	(0.0657)	(0.0658)
log(VALUE)	0.0810***	0.0794***	0.235***	0.230***
	(0.0151)	(0.0160)	(0.0436)	(0.0461)
SEX		0.0311		0.0911
		(0.0302)		(0.0864)
AGE		−0.00187		−0.00539
		(0.00133)		(0.00394)
INCOME		2.86e-05		8.53e-05
		(4.19e-05)		(0.000127)
Observations	1863	1863	1863	1863
R-squared	0.070	0.072	0.055	0.057

Robust standard errors in parentheses in the linear probability model.
T statistics in parentheses in the probit model.
Pseudo R-squared is presented for the Probit model.
***p < 0.01, **p < 0.05, *p < 0.1.
All regressions include a constant year fixed-effects and region fixed-effects.

see that the chonsei deposit increases by about 0.3% when house price appreciation rises by 1 percentage point, and that this result is robust across specifications.

The relationships between the chonsei deposit and other covariates suggest that a male landlord has a greater chonsei deposit than a female landlord. In addition, the chonsei deposit increases with the age and decreases with the income of landlord. Also, a 1% increase in house value leads to about a 0.8% increase in the chonsei deposit.

We also check the regression where the ratio of chonsei and house price (CTV = chonsei/Value) is the dependent variable. The results of the estimation in Table 4 are consistent with the regression with chonsei as dependent variable. One difference is that when the CTV is used as a dependent variable, the income of the landlord shows a significant relationship with CTV. This shows that the landlord considers the proportion of chonsei in the house price rather than the size of the chonsei according to his income.

4.3.2. Estimation results using the survey data

The estimation results using the survey data are shown in Tables 5 and 6. Our main interest is the effect of the surveyed house price expectations on the chonsei deposit. This approach complements the indirect method of using the past housing appreciation rate from Brueckner et al. (2012). Columns (1) and (2) show the results of the empirical analysis with and without household characteristics. The estimation results show that if the house price is expected to rise in the future, the chonsei deposit will be 11% greater than if prices are expected to fall or stay the same. The age of respondent has a small but significantly negative relationship with the chonsei deposit while the effect of the house value on the chonsei deposit is again positive. Unlike estimation results using bank data, income has an insignificant relationship with chonsei. Also, the age of the landlord is negatively related to chonsei. This discrepancy presumably can be attributed to the difference in the composition of observations in the survey data, which were randomly selected from the population. Another possible explanation may lie in the difference in income levels of the two populations, which can result in different preferred combinations of R and D. In the case of the survey data, higher-income individuals may be more willing to forego R in order to focus on housing investment; whereas the population of mortgage applicants in the bank data could prefer R to compensate for their relatively low income.

Table 6 shows the estimation results showing the effect of the surveyed house price expectations on the contract type. Columns (1) and (2) show the results of the linear probability model with and without household characteristics, while columns (3) and (4) show the estimation results using the probit model in the same specification. Looking at the coefficients of *EXPECTATION*, we can see that if the house price is expected to rise in the future, pure chonsei becomes more likely than mixed chonsei. This finding confirms the implication of the model, which shows that the contract move toward pure chonsei as δ increases. Also, the probability that the lease contract type is pure chonsei is positively related to the house value.

Table 7 shows the regression results using the ratio of chonsei and house price (CTV) as a dependent variable. The results are consistent with the results using chonsei as a dependent variable. Through the estimation results using two data sets, we can confirm that the relationship between chonsei and expectations for future house prices, which

Table 7
The relationship between the CTV and expectations of future house prices.

VARIABLES	(1) CTV = (CHONSEI/VALUE)*100	(2) CTV = (CHONSEI/VALUE)*100
EXPECTATION	5.073**	4.939**
	(2.407)	(2.403)
log(VALUE)	−29.32***	−31.30***
	(3.833)	(4.146)
SEX		3.128
		(2.876)
AGE		−0.155
		(0.151)
INCOME		0.00181***
		(0.00435)
Observations	1863	1863
R-squared	0.183	0.191

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
All regressions include a constant year fixed-effects and region fixed-effects.

is one of our main interest, in samples with different characteristics is consistent. This shows the robustness of the empirical estimation results for what the model predicts.

5. Conclusion

This study examines chonsei as a means of housing investment by simultaneously incorporating the mortgage nature of chonsei and its character as a lease contract. To this end, we present a theoretical model and derive an equilibrium chonsei contract while empirically verifying the predictions of the model.

This model shows that the higher is the landlord's default cost, the smaller is the chonsei deposit, while the more favorable are expectations for future housing prices, the greater is the chonsei deposit. We confirm the validity of the theoretical predictions by showing empirically how the chonsei deposit changes as the landlord's credit rating and house price expectations change. The paper also complements existing research methodology that indirectly proxies price expectations through the housing price appreciation of the previous period. We empirically verify the predictions of the theoretical model using survey data that directly asks for expectations about future housing prices.

By presenting a solid theoretical model that incorporates the mortgage characteristics of the chonsei system and verifying it empirically, we are able to extend the existing studies on housing finance. Furthermore, this study is meaningful in that it predicts the change of the housing rental market according to the change of the economic environment by analyzing the effects of the change of the economic parameters on the chonsei deposit and lease contract type.

Appendix -1

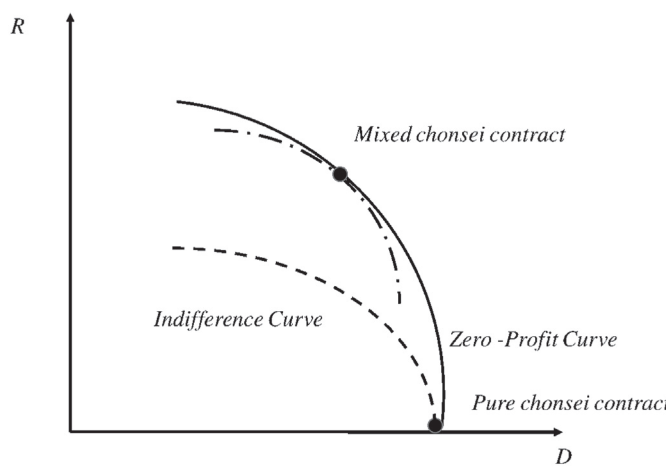

Fig. 3. Pure chonsei and mixed chonsei contract in $R-D$ plane.

Appendix -2

Using (3), the default probability is obtained as

$$P(default) = \int_{\underline{P}}^{\frac{D-C}{\alpha}} f(P,\delta)dP = \frac{\frac{(D-C)}{\alpha} - \underline{p}}{\overline{p} - \underline{p}} \tag{23}$$

Using (16), we can check the change of the default probability according to the change of δ and c. Applying D^* to (23) gives the equilibrium likelihood default as

$$P^*(default) = \frac{2(\overline{p} - \underline{p}) + \delta - \frac{\theta(1+\eta)-\eta+\theta}{\alpha(\eta-\theta)}C}{\overline{p} - \underline{p}} \tag{24}$$

Differentiating P^* with respect to C and δ yields

$$\frac{\partial P^*(default)}{\partial C} = -\frac{\frac{\theta(1+\eta)-\eta+\theta}{\alpha(\eta-\theta)}}{\overline{p} - \underline{p}} \tag{25}$$

$$\frac{\partial P^*(default)}{\partial \delta} = \frac{1}{\overline{p} - \underline{p}} \tag{26}$$

As can be seen, a favorable shift in the future house price distribution (an increase in δ) raises P^*. This conclusion makes sense because the higher δ makes D^* increase and it will make the likelihood of default increase. However, the effect of C on the likelihood of default is ambiguous, being determined by the relative sizes of η and θ.

Appendix -3

Substituting D^* in (3) yields

$$(1+\theta)R^* = P_0 - D^* - \frac{1}{2}\theta(\overline{P}+\underline{P}) + \theta C - \theta(\frac{\frac{1}{2\alpha}(D^*-C)(D^*-C-2\alpha\overline{P})}{\overline{P}-\underline{P}}) \tag{27}$$

Let $\Omega \equiv -\frac{\theta(1+\eta)}{(\eta-\theta)}$ where $\Omega < 0$ by previous discussion. Then, after substituting D^* from (16), in (20), we can rearrange the expression for R^* to yield

$$(1+\theta)R^* = P_0 - (2\alpha + \frac{1}{2}\theta)\overline{P} + (\alpha - \frac{1}{2}\theta + \alpha\theta)\underline{P} \tag{28}$$

$$-\alpha(1+\theta)\delta + (2\theta - \Omega(1+\theta))C - \theta(\frac{\frac{(\alpha\delta+(\Omega-1)C)^2}{2\alpha} - \frac{2\alpha-1}{4}\underline{P}^2}{\overline{P}-\underline{P}})$$

Let $\Theta \equiv \frac{(\alpha\delta+(\Omega-1)C)^2}{2\alpha}$. Then, we can rewrite (28) as

$$(1+\theta)R^* = P_0 - (2\alpha + \frac{1}{2}\theta)\overline{P} + (\alpha - \frac{1}{2}\theta + \alpha\theta)\underline{P} \tag{29}$$

$$-\alpha(1+\theta)\delta + (2\theta - \Omega(1+\theta))C - \theta\frac{\Theta}{\overline{P}-\underline{P}} + \theta\frac{\frac{2\alpha-1}{4}\underline{P}^2}{\overline{P}-\underline{P}}$$

Our interest is in how R^* changes with changes in C and δ. As can be seen from (29), when C increases, R^* increases because factors multiplying C are positive ($(2\theta - \Omega(1+\theta)) > 0$, and $-\theta\Theta'_C > 0$ since $(\Omega - 1) < 0$). Also, factors multiplying δ are negative ($-\alpha(1+\theta) < 0$, and $-\theta\Theta'_\delta < 0$ since $\alpha > 0$). Therefore, R^* decreases as δ increases.[22]

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[22] $-\theta\Theta'_C > 0$ and $-\theta\Theta'_\delta < 0$ hold when $\alpha\delta + (\Omega - 1)C > 0$ and $\alpha\delta + (\Omega - 1)C$ is less than 0 but its absolute value is not too large.