An Equilibrium Model of the Chonsei System*

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Abstract

Chonsei deposits are a unique form of real estate credit popular in the Korean housing market, in which tenants make interest-free loans to landlords in exchange for paying reduced rent. This paper constructs an equilibrium model of the Chonsei market. Chonsei deposit size is pinned down by requiring tenants to be indifferent between renting, and borrowing from banks at positive interest rates to fund Chonsei deposits. Thus, the Chonsei-rent ratio should be approximately equal to the interest rates at which Chonsei tenants borrow from banks. We verify the model's predictions in the data. Our model implies that, when interest rates decrease towards zero, Chonsei deposits can grow unboundedly large. A simple policy – imposing a proportional tax on Chonsei deposits – can substantially reduce the size of Chonsei deposits, and also dampen the effect of interest rate changes on the size of Chonsei deposits.

Keywords: Chonsei, Credit, Housing, Mortgage

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1 Introduction

The Chonsei, or "key money", system is a form of housing credit provision which is popular in the Korean housing market. In a Chonsei arrangement, a tenant gives a large, interest-free deposit to her landlord, in exchange for paying zero or lower rent payments. Chonsei arrangements are very popular in the Korean housing market, with roughly equal shares of the population using Chonsei and standard rental agreements. Chonsei deposit size is also very volatile over time: the average ratio between median Chonsei deposit size and median annual rents rose from roughly 12.9 in 2012 to 21.8 in 2020. However, Chonsei deposits are still poorly understood from the perspective of economic theory. We do not know what forces determine the equilibrium size of Chonsei deposits, and why the size of deposits rose dramatically in recent years. We also do not understand how different policy interventions affect the Chonsei market.

This paper constructs a simple equilibrium model of the Chonsei system. Our core result is that Chonsei deposit size is determined by the following condition:

$$(\mathit{Chonsei\ deposit\ size}) \times (\mathit{Chonsei\ interest\ rate}) = \mathit{Rent} \tag{1}$$

Where the interest rate is the positive rate that tenants pay to banks to borrow funds, in order to fund Chonsei deposits. In words, (1) states that the interest payment on tenants' loans from banks – the product of Chonsei deposit size and Chonsei interest rates – must equal rent. We show that this equilibrium condition is able to rationalize cross-sectional and time-series variation in the size of Chonsei deposits. In particular, our model can quantitatively explain why a relatively small decrease in central bank policy rates from 2012 to 2020 led median Chonsei deposit size to increase by 57% from 2012 to 2020. Our results have implications for macroprudential policy: in our calibrated model, we find that simple policies which impose proportional taxes on Chonsei deposits can substantially lower the pass-through of the interest rate.

In a Chonsei arrangement, renters can choose to leave a large deposit with their landlord, which allows them to pay no or reduced rents. The Chonsei deposit is often very large, at around 70% of house prices.[1] Renters generally borrow from banks to afford

[1]Mean value during the sample period of 2012 to 2020 (Source: Korea Real Estate Board).

the Chonsei deposit. Thus, effectively, renters make interest-free loans to landlords to purchase houses, instead of paying rent. Motivated by these stylized facts, we construct a simple model of equilibrium in Chonsei and housing markets. In the model, renters choose between purchasing housing services by paying rent, or borrowing from banks to fund Chonsei deposits. Landlords choose whether to buy houses outright, or using credit from Chonsei deposits. In equilibrium, renters must be indifferent between Chonsei deposits and paying rent, so the annual interest payments that Chonsei tenants make to their banks must equal rents, giving us (1). Chonsei deposit size then influences house prices through a standard credit channel: when Chonsei deposits are larger, landlords' liquidity constraints are relaxed, so landlords' willingness-to-pay for housing increases, and house prices increase.

The core prediction of our model is that the interest rates paid by renters determines the ratio between Chonsei deposit size and rents in equilibrium. The model thus makes two predictions which we bring to the data. First, cross-sectionally, Chonsei-rent ratios and price-rent ratios should be higher in areas where *renters* are more creditworthy, since these can borrow from banks at lower interest rates. Second, in the time series, decreases in interest rates should associate with increases in Chonsei-rent and price-rent ratios. We verify both predictions empirically. We also show that our model can quantitatively rationalize the shift in Chonsei-rent and price-rent ratios, driven by interest rates. From 2012 to 2018, the bank of Korea's policy interest rates fell from around 3% to 1.5%; our model thus predicts that the Chonsei-rent ratio should approximately double. Indeed, in the data, the Chonsei-rent ratio increased by approximately 64% over the same time horizon.

Our model implies that interest rates have a quantitatively very large effect on Chonsei deposit sizes in equilibrium. Chonsei deposits effectively behave like infinite-maturity assets, which must have interest payments equal to rents each period. When interest rates decrease towards zero, Chonsei deposit size must increase unboundedly. Our results thus suggest that, if the Korean central bank wishes to decrease the pass-through of interest rates into Chonsei deposit sizes, it should explore policies to limit the size of Chonsei deposits.

We then propose a simple policy to limit the pass-through of interest rates to Chonsei deposits: the government could impose a proportional tax on Chonsei deposits. There are a number of similar policies to this tax with slightly different distributional implications: the government could require tenants to make side payments of at least some fraction of the deposit to landlords, or require banks to charge higher interest rates on loans to fund tenants' Chonsei deposits. These policies decrease the equilibrium size of Chonsei deposits, and also the sensitivity of loan size to interest rates. We then calibrate our model to the data, and evaluate the effectiveness of these policies at limiting pass-through and the boom in house prices. We find that, over the period 2012-2018, an annual tax of 3% of loan size would have decreased the level increase of Chonsei-rent ratios from 8.5 to 5.2. Thus, our results can inform macroprudential policy aimed at controlling the magnitude of credit-induced booms in the Korean housing market.

1.1 Literature review

This paper also relates to a literature on how credit conditions move house prices. Mian and Sufi (2009) and Favilukis, Ludvigson and Van Nieuwerburgh (2017) argue that an increase in mortgage credit availability was an important driver of the 2006 housing boom. Kaplan, Mitman and Violante (2020) argues that expectations, rather than credit conditions, were the main driver of the 2006 housing boom and bust. Greenwald and Guren (2021) argues that the effect of credit on house prices depends on the degree of segmentation between rental and housing markets. Mian and Sufi (2018) show that credit supply expansion drove an increase in speculative activity, leading to an amplified housing boom and bust.

Our paper also related to a small literature on the Chonsei system. A closely related paper is Park and Pyun (2020). The core object of the model and empirical analysis in Park and Pyun (2020) is the ratio of deposits to rents, for individual housing units which have some deposit and some rental payments. Park and Pyun (2020) argue that deposit-rent ratios are higher, and deposit-only contracts are more likely – that is, deposit-rental ratios at the individual unit level can approach infinity – for areas where renters' cost of capital is lower, and provide evidence that this prediction holds in the cross-section of counties. The core difference between our paper and Park and Pyun (2020) is that we focus on the ratio of average rents on rent-only buildings, to Chonsei deposits on comparable deposit-only buildings. This is a different ratio to that studied in Park and Pyun (2020). Our model argues that this ratio is also driven by renters' cost of capital, and we provide evidence that differences in renters' costs of capital can explain cross-sectional variation as well as time-series variation in this ratio.

A number of other papers analyze the Chonsei system. Yoon (2003) is an overview and history of the Chonsei system. Ambrose and Kim (2003) discuss the history and development of the Chonsei system, and analyze the put option for the renter embedded in the Chonsei contract. Choi and Lee (2009) construct a model of equilibrium house prices, taking as given Chonsei deposit sizes. Kim (2013) constructs a model in which "mixed Chonsei" arrangements are possible, and shows conditions under which full Chonsei arrangements emerge as the Pareto-optimal outcome. Shin, Kim et al. (2013) compares Chonsei deposits to repo contracts, and constructs a model in which disintermediation of the banking industry through the Chonsei system improves overall efficiency. A number of other papers analyze determinants of the equilibrium ratio between Chonsei deposit size and house prices (Cho, 2007; Moon, 2018*a*).

1.2 Outline

The paper proceeds as follows. Section 2 describes institutional background around the Chonsei system. Section 3 presents our model, and Section 4 presents empirical tests of the model's predictions. Section 5 calibrates our model to data and performs our policy counterfactuals. We conclude in Section 6. A description of datasets we use and cleaning steps is in Appendix A, and model proofs are in Appendix B.

2 Institutional Background

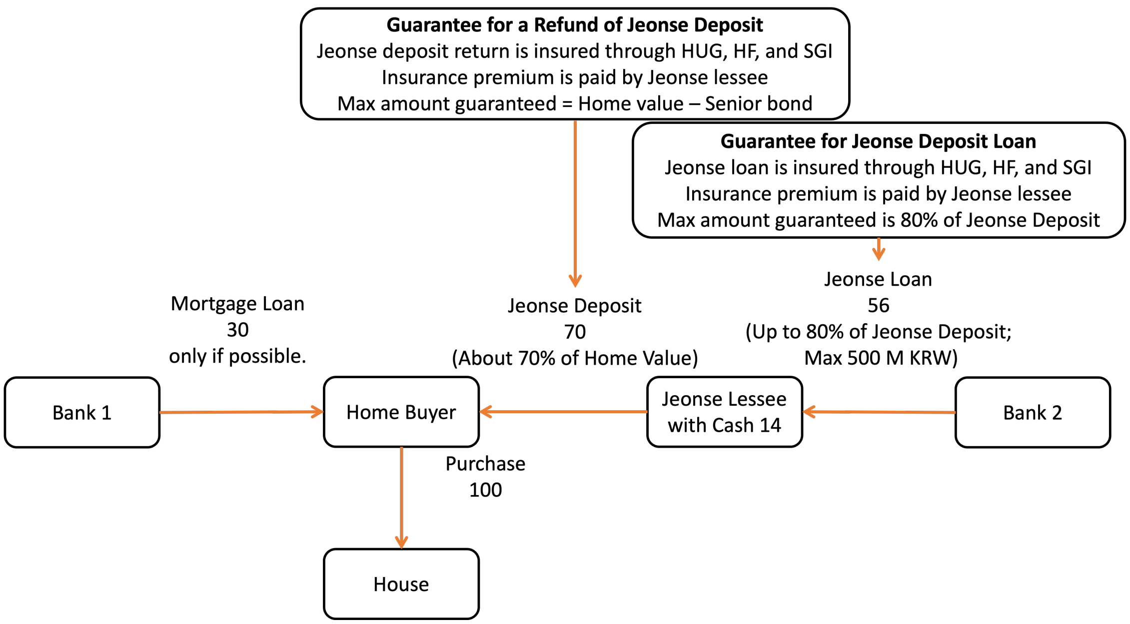
Renters in the Korean housing market who wish to purchase housing services, without owning houses, essentially have two options. The first is to enter into a standard rental contract, paying a landlord periodic rent payments. The second is to enter into a Chonsei agreement. Chonsei tenants deposit a large sum of money with homeowners, in exchange for paying zero (or highly reduced) rental payments. Once the Chonsei contract ends, if the tenant decides not to continue living in the property, the homeowner pays the Chonsei deposit back to the tenant, without any interest. Chonsei deposits thus serve essentially as interest-free loans from tenants to homeowners.

Figure 1 shows the flow of funds in a Chonsei transaction. In the example, the house price is 100. The homeowner is able to demand an interest-free Chonsei deposit of 70 from the tenant. The tenant is protected from the homeowner defaulting because the deposit is guaranteed by the government, with an insurance premium paid by the lessee; the maximum amount guaranteed is a function of the home value. Chonsei tenants generally cannot afford the entirety of the Chonsei deposit upfront, so tenants will generally fund the deposit by borrowing from a bank, with positive interest rates. Banks are restricted to lending up to 80% of the Chonsei deposit to tenants. The government also insures banks' loans to Chonsei tenants, so banks are also insulated from potential tenant default. Logistically, funds from lending banks are sent directly to homeowners, so lenders have no opportunity to redirect the funds lent by the bank.

From the perspective of a potential tenant, the choice between renting and using a Chonsei deposit is thus a tradeoff between paying rent to a homeowner, and paying interest to a bank on a Chonsei deposit, since the tenant receives no interest on the Chonsei deposit from the homeowner, but borrows at a positive rate from the bank. Our model will focus on this tradeoff and show how it pins down the equilibrium size of Chonsei deposits.

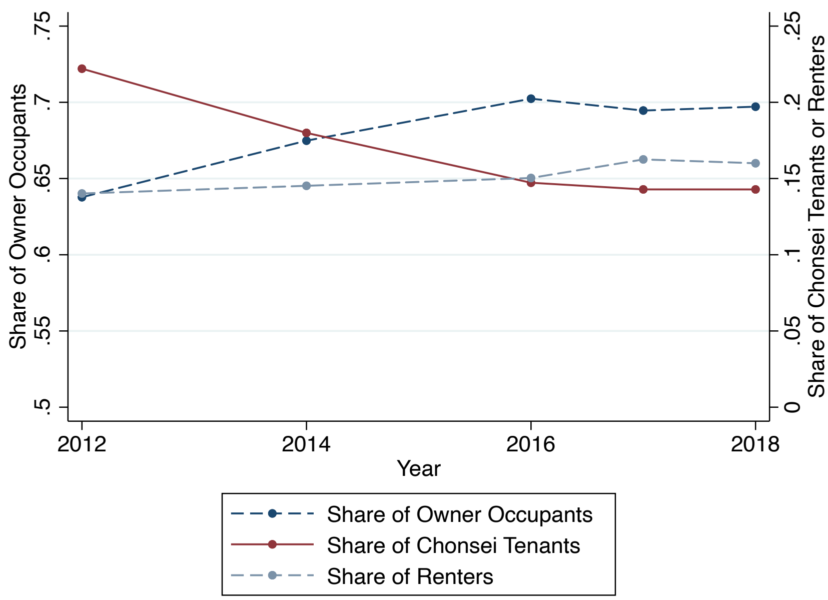
Chonsei deposits are very common in the Korean housing market. Figure 2 shows that, besides the roughly 70% of households who are owner-occupants, Chonsei tenants and renters constitute similar shares of the population at roughly 15-20% of households each. Appendix Tables A.1 and A.2 characterize features of Chonsei tenants and units. Chonsei tenants tend to have wealth and incomes that are higher on average than renters, but lower than owner-occupants. Consistent with this, Chonsei-deposit housing units tend to be larger than rental units, and smaller than owner-occupied units. During our sample period, the average term of a Chonsei deposit was 2 years, and the average length of residence in a Chonsei housing unit was 4 years.

Figure 1: Flow of funds in a Chonsei transaction



Notes. Flow of funds in a hypothetical Chonsei transaction.

Figure 2: Chonsei deposit prevalence



Notes. Share of households who are owner-occupants, Chonsei tenants, and renters by year. The data source is the Korean Housing Survey.

3 Model

There are an infinite number of periods, $t = 0, 1 \ldots \infty$. There are overlapping generations of renters and homeowners. There is a measure $Q_H < 1$ of houses available for purchase. There is a unit measure of potential homebuyers in each period, who buy houses, and either rent them, or use Chonsei to rent them to tenants. There is a unit measure of rental tenants, who can choose between renting and Chonsei.

We assume that rent n_t is exogeneously determined, by factors such as local job opportunities and wages. n_t is expected to grow at a constant rate g per period:

$$n_t = (1+g)^t n_0$$

We assume there is a measure $1 - Q_H$ of houses which are owned by inelastic landlords, who set rents at n_t and never sell. This is a modelling device, which ensures that renters must be indifferent between using Chonsei and renting in equilibrium.

We aim to solve for a balanced growth path, where all variables – house prices, rents, wealth, and the size of Chonsei deposits – grow at rate g. Let p_t represent the price of purchased housing; prices in period t are thus:

$$p_{t+1} = (1+g)^t p_0$$

Thus, on a balanced growth path, there will be a time-invariant price-rent ratio:

$$\frac{p_0}{n_0}$$

Homebuyers. There is a unit measure of homebuyers. Potential buyers in period t have some monetary wealth:

$$W_t = (1+g)^t W_0$$

where W_0 is an exogeneous constant. Buyers discount utility at rate β, and have CRRA utility over consumption each period:

$$u(c) = \frac{c^{1-\eta}}{1-\eta}$$

Hence, buyers' utility over period 1 and 2 consumption is:

$$u(c_t) + \beta u(c_{t+1})$$

Buyers can save at exogeneous rate r, but cannot borrow unsecured. In Appendix B.1, we show that if these conditions are satisfied in period 0, they are also satisfied in all future periods, so these conditions indeed define a balanced growth path. Homebuyers have three choices: save in bonds, buy a house with cash and rent out the house, or buy a house and borrow using a Chonsei deposit. As is standard in lifecycle models, housing is unattractive because houses are indivisible investments: when rents are high, buying a house will require households to violate their consumption Euler equation, and the equilibrium total return on housing can thus exceed r_S. Chonsei deposits are attractive because they allow households to smooth consumption by borrowing part of the cost of the house.

Formally, homebuyers have three choices. If a homebuyer does not buy, she chooses savings s_0 to maximize:

$$V_S(W_0) = \max_{s_0 \geqslant 0} u(W_0 - s_0) + \beta u(s_0(1 + r_S)) \tag{2}$$

where r_S is the interest rate on one-period bonds. If a homeowner buys a house outright at price p_0, she pays p_0 in the first period and receives n in rent, and $p_0(1+g)$ from the sale of the house, in the second period. The homeowner thus chooses savings s_0 to solve:

$$V_B(p_0, W_0) = \max_{s_0 \geqslant 0} u(W_0 - s_0 - p_0) + \beta u(s_0(1 + r_S) + p_0(1+g) + n_0) \tag{3}$$

If the homeowner buys using Chonsei, she does not receive rent, but she only needs to pay $p_0 - L_0$ upfront for the house, and receives $p_0(1+g) - L_0$ in the second period. She thus chooses savings to solve:

$$V_J(p_0, L_0, W_0) = \max_{s_0 \geqslant 0} u(W_0 - s_0 - (p_0 - L_0)) + \beta u(s_0(1 + r_S) + (p_0(1+g) - L_0)) \tag{4}$$

Homeowners' demand is the following. Homeowners buy houses if the utility from buying outright, or using a Chonsei deposit, is greater than her utility from saving:

$$\max\left[V_B\left(p_0, W_0\right), V_J\left(p_0, L_0, W_0\right)\right] \geqslant V_S\left(W_0\right)$$

Home buyers use Chonsei if the utility from using a Chonsei deposit exceeds buying outright:

$$V_J\left(p_0, W_0\right) \geqslant V_B\left(p_0, W_0\right)$$

Tenants. Tenants in period 0 choose between paying rent n_0 in order to rent a house, or lending the homeowner L_0 interest-free. As we discussed above, we assume that the rent price n_0 is exogeneous; for example, it may be pinned down by broader labor market and productivity conditions. If the tenant chooses to use a Chonsei deposit to rent the house, we assume she funds the entire deposit by borrowing from a bank: she borrows L_0, and repays $\left(1 + r_J\right) L_0$ in period 1.[2] We allow r_J, the interest rate borrowers pay on Chonsei deposits from banks, to differ from r_S, the interest rate that owners receive on savings. Since landlords do not pay interest on Chonsei deposits, a Chonsei deposit costs the tenant a net amount $r_J L_0$ in period 1. Tenants use Chonsei if and only if the present value of Chonsei is lower than the cost of paying rent, that is:

$$\beta L_0 r_J \leqslant n_0 \tag{5}$$

In equilibrium, there are exactly enough total properties to satisfy demand from all tenants. However, some tenants will rent and some will use Chonsei deposits, so the Chonsei deposit size must make tenants indifferent between Chonsei and rental. Since tenants' discount rates will generally be fairly close to 1, (5) is approximately equal to (1), which is simply:

$$L_0 r_J \leqslant n_0$$

[2]For simplicity we assume that tenants must fund the entire Chonsei deposit using a bank loan. In practice, some tenants may be able to fund Chonsei deposits partially through their own funds; however, they still pay an opportunity cost, equal to the interests they would have earned from saving their Chonsei deposit in assets with positive yields.

3.1 Equilibrium

Equilibrium requires that the markets for Chonsei deposits and housing clears. Since renters have the option to either use Chonsei deposits, or rent from inelastic landlords, renters must be indifferent between renting and using Chonsei deposits. This implies that:

$$L_0 r = n_0 \tag{6}$$

That is, the periodic interest payment on Chonsei deposits must equal the exogeneous rent n_0.

Since the quantity of houses Q_H is less than the mass of homebuyers, some buyers must not buy houses. Thus, in equilibrium, homeowners must be indifferent between purchasing a house, and saving in cash:

$$\max\left[V_B\left(p_0, W_0\right), V_J\left(p_0, L_0, W_0\right)\right] = V_S\left(W_0\right)$$

Generically, homeowners will either all purchase with cash, or using Chonsei deposits. We will consider equilibria in which Chonsei deposits are preferred to buying with cash. Thus, the housing market clearing condition is:

$$V_J\left(p_0, L_0, W_0\right) = V_S\left(W_0\right) \tag{7}$$

The next proposition states that, if a Chonsei-rent ratio $\frac{L_0}{n_0}$ and price-rent ratio $\frac{p_0}{n_0}$ solve (6) and (7), then stationary ratios $\frac{L_t}{n_t}, \frac{p_t}{n_t}$ are determined by $\frac{L_0}{n_0}, \frac{p_0}{n_0}$ respectively.

We search for equilibria of the model characterized by time-invariant price-rent and Chonsei-rent ratios.

Proposition 1. *Overlapping generations equilibrium is described by a Chonsei-rent ratio $\frac{L_0}{n_0}$ and a price-rent ratio $\frac{p_0}{n_0}$ which are constant for all t:*

$$\frac{L_t}{n_t} = \frac{L_0}{n_0}, \frac{p_t}{n_t} = \frac{p_0}{n_0}$$

such that period-0 tenants are indifferent between renting and using Chonsei deposits:

$$\beta L_0 r_J = n_0 \tag{8}$$

and period-0 homeowners are indifferent between Chonsei and saving:

$$V_J(p_0, L_0, W_0) = V_S(W_0) \tag{9}$$

Any values of $\frac{L_0}{n_0}, \frac{p_0}{n_0}$ *which satisfy period-0 tenants' and homeowners' indifference conditions will also satisfy the indifference conditions of tenants and homeowners in all future periods.*

The intuition behind proposition 1 is as follows. The core equilibrium condition of the model is (8). Renters in period t must be indifferent between paying flow rent n_t, and borrowing L_t from a bank, lending it interest-free to the homeowner as a Chonsei deposit, and repaying $L_t(1 + r_J)$ next period, which has a net present value cost of $\beta L_t r_J$. Rearranging (8), we have:

$$\frac{L_t}{n_t} = \frac{1}{\beta r_J} \tag{10}$$

In words, the ratio of Chonsei deposit size to rent payments is a function of renters' discount rates and interest rates. Chonsei deposits are larger relative to rents when renters are less patient, and when interest rates are lower. Since β is close to 1 and r_J is close to 0, generally the majority of variation in (10) will be driven by changes in interest rates.

Expression (9) states that the size of Chonsei deposits then affects house prices through a standard credit channel. Houses are large and indivisible investments, so homebuyers will tend to be liquidity constrained. In order for housing markets to clear, landlords must be indifferent between saving using bonds and purchasing housing using Chonsei deposits. If landlords are liquidity-constrained, the levered rate of return on housing will exceed the risk-free rate, to compensate landlords for sacrificing consumption in period 1 to purchase housing. Increasing the size of Chonsei deposits relaxes landlords' liquidity constraints. The equilibrium price-rent ratio must then increase, in order to decrease homeowners' levered returns, maintaining landlords' indifference between housing and bonds in (9).

Our model makes a number of predictions about how interest rates affects Chonsei-rent and price-rent ratios in the cross-section and in the time series.

Prediction 1. *Chonsei-rent ratios and price-rent ratios are higher in areas where renters have higher credit scores, and lower Chonsei interest rates.*

Prediction 1 follows from varying the Chonsei interest rate r_J in the equilibrium conditions. The Chonsei-rent ratio is always equal to $\frac{1}{r_J}$. In areas where r_J is lower, the market-clearing Chonsei deposit size is larger. Since homeowners can borrow more, this generates upwards pressure on house prices, increasing the price-rent ratio.

Note that, a unique feature of this mechanism, relative to mortgages, is that it is *renters'* creditworthiness, rather than homeowners' creditworthiness, which determines the equilibrium size of mortgages. This is because of the peculiar feature of the Chonsei deposit that the homeowner pays no interest to the renter, but renters pay interest to banks who they use to fund the Chonsei deposit.

Prediction 2. *When the monetary policy rate decreases, Chonsei-rent and price-rent ratios increase.*

Prediction 2 follows similarly: when the central bank decreases policy rates, both r_S and r_J will decrease. There are thus two channels through which monetary policy affects house prices in our model. The first is a *valuation* or *substitution* channel, through homeowners' housing demand: homeowners receive lower rates on their savings r_S, so demand lower returns on their houses, driving prices for houses upwards. The second is a *credit* channel: decreasing the rate r_J at which tenants can borrow from banks to fund Chonsei loans increases equilibrium Chonsei deposit sizes L_0. Since homeowners have more credit, this increases willingness-to-pay for houses, driving house prices upwards.

3.2 Discussion of model assumptions

Our model is purposefully stylized in order to illustrate the main intuitions behind our results. We briefly discuss possible extensions here.

Differentiated homeowners and renters. In the baseline model, homeowners and renters are undifferentiated. This allows us to state the equilibrium conditions, (8) and (9), in terms of the representative homeowner or renter's indifference condition. If potential homeowners were differentiated by wealth, there would be potentially three kinds of buyers: the poorest buyers would opt out of the market, buyers with moderate wealth would purchase using Chonsei deposits, and high-income buyers would purchase houses using cash. The equilibrium condition in the housing market, (9), would then depend on the indifference condition of the marginal homebuyer, who is just indifferent between buying a house using a Chonsei deposit, and saving using bonds.

Renters may also be differentiated: certain tenants may have better credit and lower interest rates from banks than others. Tenants might also have some exogeneous disutility from borrowing, perhaps due to the impact on their credit score, or the effect of Chonsei deposits on tenants' ability to access other kinds of consumer credit. Similarly, the equilibrium condition (8) in the Chonsei market would then depend on the marginal renter's Chonsei deposit rate, and her disutility of borrowing.

Elasticity of housing supply. We assume perfectly inelastic housing supply for simplicity. Greenwald and Guren (2021) point out that increases in mortgage credit may increase homeownership rates as well as prices, if housing supply is somewhat elastic.

Other factors. We also abstract away from owner-occupancy, and as a result, regular mortgages and owner-occupants' creditworthiness. Accounting for owner-occupancy would be important to construct a quantitatively realistic model of housing markets.

4 Results

We proceed to test the predictions of our model.

4.1 Cross-sectional predictions

First, we test prediction 1, regarding the cross-sectional relationship between renters' credit scores, Chonsei-rent ratios, and price-rent ratios. In Figure 3, we plot binscatters of Chonsei-rent ratios and price-rent ratios against average credit scores at the city-month level. Consistent with prediction 1, city-months in which renters have higher average credit scores have higher Chonsei-rent ratios and price-rent ratios.

We estimate specifications of the following form:

$$\mathtt{ChonseiRent}_{ipt} = \beta_1 \mathtt{CreditScore}_{i,2011} + \mu_p + \eta_t + \epsilon_{ipt} \tag{11}$$

$$\mathtt{PriceRent}_{ipt} = \beta_2 \mathtt{CreditScore}_{i,2011} + \mu_p + \eta_t + \epsilon_{ipt} \tag{12}$$

where i indicates city, p indicates province, and t indicates month. $\mathtt{ChonseiRent}_{ipt}$ and $\mathtt{PriceRent}_{ipt}$ are respectively the median Chonsei-rent and price-rent ratios. $\mathtt{CreditScore}_{i,2011}$ is the average credit score of renters in July 2011, and μ_p and η_t are province and year-month fixed-effects. In the richest specification, we add province-year-month fixed effects, using variation across cities within provinces to identify the coefficient of interest β.

The results are shown in Table 1. Again, across all specifications, the coefficient on credit scores is positive and significant both for Chonsei-rent and price-rent ratios, and the magnitude of the coefficients is stable across specifications. The magnitude is fairly large: a one standard deviation increase in credit score is associated with a 1.49 increase in Chonsei-to-rent ratio, and a 2.38 increase in price-to-rent ratio. The Chonsei-rent ratio has a mean of 17.7 and a standard deviation of 4, and the price-rent ratio has a mean of 24.9 and an SD of 5.9, so both effects are fairly large.

4.2 Time series predictions

Next, we test prediction 2, regarding the effect of monetary policy on Chonsei-rent and price-rent ratios. The left panel of Figure 4 shows the Bank of Korea's base interest rate, the primary monetary policy target rate in Korea, against the Chonsei-rent ratio and the price-rent ratio. The lines display very similar patterns. As interest rates fell from 2012 to 2016, Chonsei-rent and price-rent ratios rose. All three series were fairly flat from 2016 to 2020, and then Chonsei-rent and price-rent ratios rose.

The right panel of Figure 4 breaks the ratios into their components–rents, Chonsei deposit sizes, and prices–and plots the index of each component. For house price and Chonsei deposit size, we report the indices provided by the KREB. For rent, since the KREB has announced the rent index only since 2015, we report the Case-Shiller rent index we compute from the MOLIT's apartment transaction data. We see that rents were fairly stable over time, and the ratios moved mainly because average Chonsei size and average prices rose significantly over this time period.

To show how monetary policy differentially affected cities with different renter credit scores, Figure 5 separately plots Chonsei-rent and price-rent ratios for three quantile buckets of cities, sorted by average renter credit score in 2012. We see that the lines move essentially in parallel, so the changes in Chonsei-rent ratios over time were fairly uniform across cities: higher credit score cities had higher Chonsei-rent ratios throughout, and the entire distribution of Chonsei-rent ratios shifted upwards over time as interest rates decreased. The findings for price-rent ratios are similar.

To test prediction 2 in regression form, we estimate the following specifications:

$$\Delta ChonseiRent_{it} = \beta_1 \Delta BaseRate_{it} + \mu_i + \epsilon_{it} \tag{13}$$

$$\Delta PriceRent_{it} = \beta_2 \Delta BaseRate_{it} + \mu_i + \epsilon_{it} \tag{14}$$

In (13), $\Delta ChonseiRent_{it}$ is the year-over-year difference in the Chonsei-rent ratio for city i, $\Delta PriceRent_{it}$ is the year-over-year difference in prices, $\Delta BaseRate_{it}$ is the year-over-year difference in the cost of fund index (COFIX) rate, which is used as a benchmark interest rate for the mortgage and Chonsei loans, and μ_i are city fixed effects. The results are shown in Table 2. Again, consistent with prediction 2, increases in the base interest rate are associated with decreases in Chonsei-rent and price-rent ratios.

Next, we estimate the impulse response functions of the Chonse-rent and price-rent ratios using the local projection method (Jordà (2005)) and show how different lags of interest rates affect price-rent and Chonsei-rent ratios. Specifically, we estimate specifications of the form:

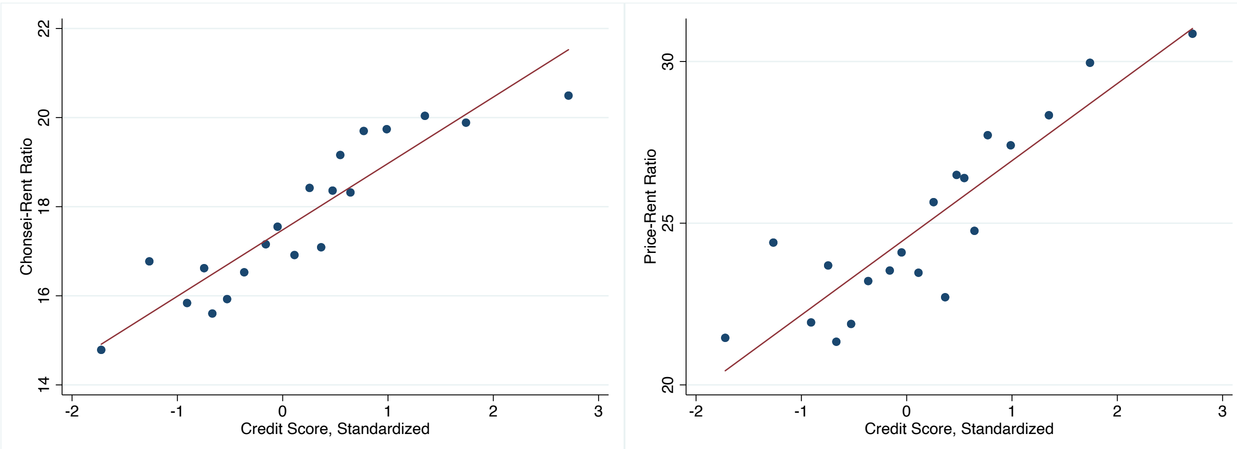
$$\Delta \ln(PriceRent)_{i,t+k} = \beta^k \Delta BaseRate_t + \mu_i^k + \varepsilon_{it} \tag{15}$$

for lags $k = 0, 1, ..., 36$, where i indicates city, t indicates month, and:

$$\Delta X_{i,t+k} \equiv X_{i,t+k} - X_{i,t+k-12}$$

is the year-over-year first difference in variable $X_{i,t+k}$. Similarly, for Chonsei deposits, we

Figure 3: Credit scores, Chonsei-rent ratios, and price-rent ratios



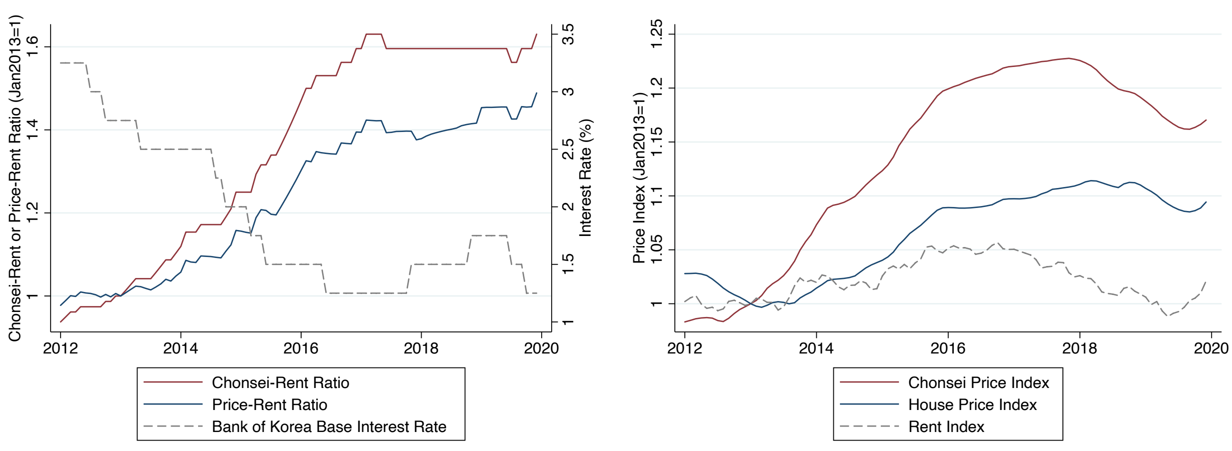
Notes. This figure uses the KREB's city-level monthly Chonsei-rent (left panel) and price-rent (right panel) ratios and plots the binscatters of ratios against the average credit score. The sample period of the Chonsei-rent and price-rent ratios spans from January 2012 to December 2019. The average credit score is provided by the KCB and is measured as of July 2011. The binscatter plots include the year-month fixed effects to explore the cross-sectional relationship.

estimate:

$$\Delta \ln(ChonseiRent)_{i,t+k} = \beta^k \Delta BaseRate_t + \mu_i^k + \varepsilon_{it} \tag{16}$$

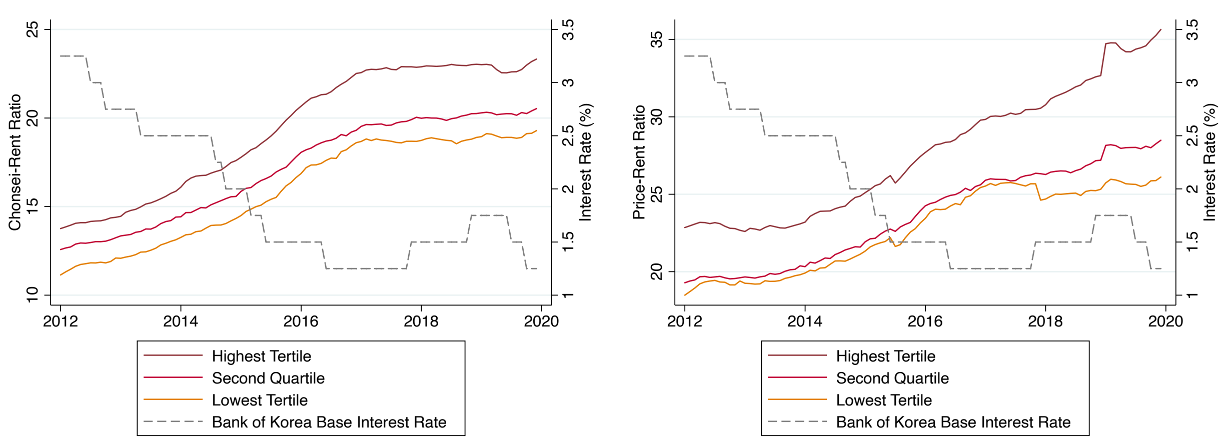
We show the results from estimating specifications (15) and (16) in Figure 6. Consistent with the panel regression results, we find that an interest rate increases is associated with a decrease in Chonsei-rent and price-rent ratios. The effect is somewhat stronger for Chonsei-rent ratios. The effect is fairly persistent, peaking in magnitude at around 11 months for the Chonsei-rent ratio and 13 months for the price-rent ratio.

Figure 4: Interest rates, Chonsei-rent ratios, and price-rent ratios



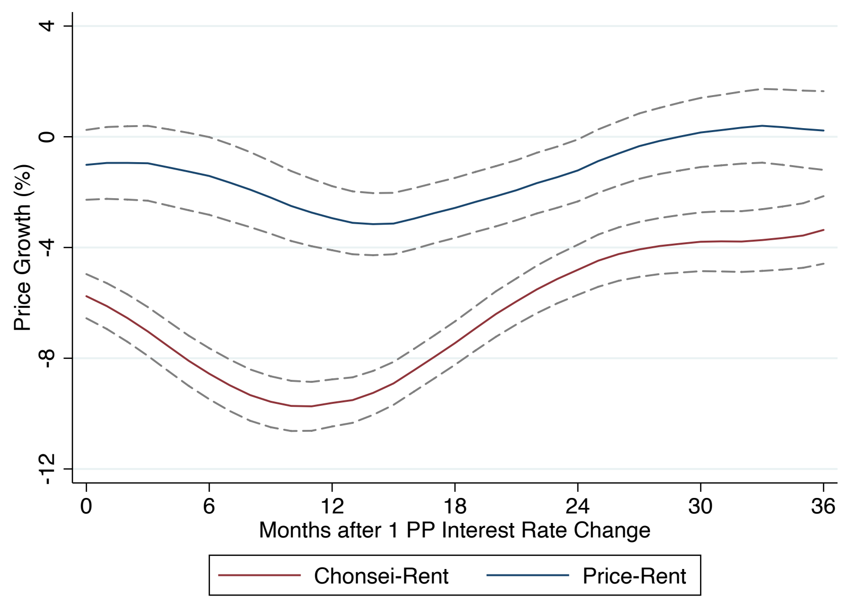
Notes. The left panel of this figure shows the Bank of Korea base interest rate (dashed green line, right axis) and indexed Chonsei-rent (red, left axis) and price-rent (blue, left axis) ratios. The right panel shows prices indices for Chonsei deposit sizes, house prices, and rents. The national-level Chonsei-rent and price-rent ratios and house price and Chonsei deposit size indices are collected from the KREB. Since the KREB has announced the rent index only since 2015, we directly compute the Case-Shiller rent index using the MOLIT's housing transaction data.

Figure 5: Chonsei-rent ratios and price-rent ratios over time, by average credit score



Notes. The left panel of this figure shows the Bank of Korea base interest rate (dashed grey line, right axis) and Chonsei-rent ratios (solid lines, left axis) separately for three quantile buckets of cities, sorted by the average credit score of renters in 2011. The right panel shows the base interest rate and price-rent ratios (solid lines, left axis) separately for three quantile buckets of cities by 2011 credit score. The city-level Chonsei-rent and price-rent ratios are from the KREB.

Figure 6: Chonsei-rent ratios, price-rent ratios, and interest rates: Jorda projections



Notes. This figure shows the impulse response functions of Chonsei-rent (solid red) and price-rent (solid blue) ratios to the 1 percent point interest rate shock. The functions are computed using the local projection method in specifications (15) and (16). The city-level Chonsei-rent and Price-rent ratios are from the KREB. The interest rate is the COFIX rate, which is a base interest rate for mortgage and Chonsei loans. Standard errors are clustered at the city level.

Table 1: Renter creditworthiness, Chonsei-rent ratios, and price-rent ratios

Panel A: Chonsei-Rent Ratio					
	(1)	(2)	(3)	(4)	(5)
Credit Score, Standardized	1.4833***	1.4901***	1.2102***	1.2102***	1.2102***
	(0.1378)	(0.1386)	(0.1132)	(0.1137)	(0.1201)
Year-Month FE		Yes		Yes	
Province FE			Yes	Yes	
Province x Year-Month FE					Yes
Adjusted R^2	0.1465	0.7225	0.2606	0.8427	0.8613
# Obs	12,516	12,516	12,516	12,516	12,516

Panel B: Price-Rent Ratio					
	(1)	(2)	(3)	(4)	(5)
Credit Score, Standardized	2.3784***	2.3852***	1.8362***	1.8362***	1.8362***
	(0.3244)	(0.3262)	(0.2627)	(0.2637)	(0.2787)
Year-Month FE		Yes		Yes	
Province FE			Yes	Yes	
Province x Year-Month FE					Yes
Adjusted R^2	0.1713	0.4706	0.4083	0.7136	0.7413
# Obs	12,516	12,516	12,516	12,516	12,516

Notes. This table reports the cross-sectional relationship between renter's credit scores, Chonsei-rent ratios, and price-rent ratios. The dependent variable in Panel A is the city-level Chonsei-rent ratio, and the dependent variable in Panel B is the price-rent ratio. The independent variable in both panels is the average credit score. The city-level Chonsei-rent and price-rent ratios are collected from the KREB. The average credit score is provided by the KCB and measured as of July 2011. The unit of observation in this analysis is the city-year-month. The sample period spans from January 2012 to December 2019. Standard errors are clustered at the city level.

Table 2: Monetary policy, Chonsei-rent ratios, and price-rent ratios

	Chonsei-Rent Ratio Growth			Price-Rent Ratio Growth		
	(1)	(2)	(3)	(4)	(5)	(6)
Interest Rate Growth	-6.5503***			-1.0134		
	(0.4267)			(0.6379)		
L12.Interest Rate Growth		-9.6596***			-3.0099***	
		(0.4684)			(0.6219)	
L24.Interest Rate Growth			-2.1472***			-3.4473***
			(0.3059)			(0.3804)
City-Gu FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.1292	0.2695	0.036	0.049	0.067	0.083
# Obs	11,131	11,131	11,131	11,131	11,131	11,131

Notes. This table shows the time-series relationship between monetary policy rates, Chonsei-rent ratios, and price-rent ratios. The dependent variable in the first three columns is the year-over-year difference of log median Chonsei-rent ratio in a city-Gu. The dependent variable in the fourth, fifth, and sixth columns is the year-over-year difference in the log median price-rent ratio. "Interest growth" is the year-over-year difference in the COFIX rate, which is used as a benchmark interest rate for the mortgage and Chonsei loans. The city-level Chonsei-rent and price-rent ratios are collected from the KREB. The KOFIX rate is collected from the Korea Federation of Banks. The unit of observation in this analysis is a city-year-month. Standard errors are clustered at the city level.

5 Calibration and policy counterfactuals

5.1 Chonsei-rent ratios in the model and in the data

We now do a simple back-of-the-envelope calculation to show that our theory can quantitatively rationalize the levels of Chonsei-rent ratios, and the magnitude of their changes over time. Our theory takes a strong quantitative stance on the relationship between Chonsei-rent ratios and interest rates: expression (8) of Proposition 1 states that the interest payments made on bank loans to fund Chonsei deposits should exactly be equal to rents. The Chonsei interest rate was approximately 6.25% to 6.75% in year 2012. The KREB Chonsei-rent index was 12.95 in 2012, so the inverse was 7.72%. At interest rates of 6.25% to 6.75%, annual interest payments on Chonsei deposits would be equal to 81.0% to 87.4% of annual rents; at a Chonsei interest rate of 7.72%, interest payments would exactly equal rents.

In 2016, the Korean central bank base rate decreased to 1.35%, and the Chonsei-rent index increased to 20.45, so the inverse was 4.89%. If we assume the spread between Chonsei interest rates and the base rate remained constant, rates on bank loans to fund Chonsei depositswould have been in the range of 4.75% to 5.0%. Thus, annual interest payments on these loans would be equal to 97.1% to 102.2% of annual rents; at a Chonsei interest rate of 4.89%, interest payments exactly equal rents. Thus, our theory suggests that the Chonsei-rent ratio increase can be quantitatively explained by the Korean Central Bank's decision to lower the policy rate.

To quantify this further, in Figure 7, we plot the Chonsei-rent index in the data against the model-predicted ratio of Chonsei deposit sizes to rent, where we set the Chonsei interest rate equal to the base rate plus a time-invariant spread of 3.5%. In 2016, this predicts a Chonsei-rent ratio of 20.61, which is in the middle of range of Chonsei-rent ratios in 2016. Figure 7 shows that the model-predicted Chonsei-rent ratio matches the data fairly closely. The model is able to explain roughly 60% of the rise in the Chonsei-rent ratio from 2012-2016, as well as the relative flattening from 2016 to 2019. However, our model predicts a sharp further increase in the Chonsei-rent index in 2019, as the central bank base rate dropped sharply; this did not materialize in the data.

5.2 Taxing Chonsei deposits

This calculation also illustrates that monetary policy pass-through is quantitatively very large under the Chonsei system. When renter-facing interest rates half, from 3% to 1.5%, the equilibrium size of Chonsei deposits *doubles* relative to rents. This is much larger than what pass-through would be under, for example, 30-year term mortgages: if a homebuyer faces a binding payment-to-income constraint, and the interest rate on a 30-year mortgage decreases from 3% to 1.5%, the maximum mortgage the homebuyer can afford increases by only 22%. Intuitively, this is because fixed-term mortgage payments largely go towards paying down principal when interest rates are low, so mortgage payments are nonzero even as interest rates approach zero. In contrast, under the formula

$$\frac{L_t}{n_t} = \frac{1}{\beta r_J} \tag{17}$$

when interest rates decrease towards 0, Chonsei deposits must become unboundedly large in order for renters to be indifferent between renting and using Chonsei deposits.

Regulators may view the extremely high pass-through of interest rates into Chonsei deposits as undesirable. A simple way to reduce the size of Chonsei deposits, and also the pass-through of interest rates to Chonsei deposits, is to introduce an additional tax wedge that Chonsei tenants must pay, on top of the Chonsei interest rate r. Suppose, for example, that the government simply charges a proportional tax on Chonsei deposits at annual rate s: when renters borrow L from banks, they must make an annual payment of Ls to governments, in addition to the interest payment of Lr to banks. Tenants' indifference condition then becomes:

$$\frac{L_t}{n_t} = \frac{1}{\beta (r_J + s)} \tag{18}$$

Comparing (18) to (17), the tax reduces the size of Chonsei deposits; moreover, even when r_J decreases towards 0, loan sizes converge towards the finite quantity $\frac{n_t}{\beta s}$.

There are a number of ways to implement similar outcomes to this proportional tax. For example, policymakers could require Chonsei deposits to be accompanied by side payments to landlords, which serve as reduced rental payments, of at least a fraction s of the Chonsei deposit size. Policymakers could also require banks to charge interest rates on loans to fund Chonsei deposits at a certain spread above the central bank base rate, setting the spread so that equilibrium loan rates are above the minimum rates banks are willing to accept. These policies differ from the tax in terms of their distributional implications: the side-payment scheme causes the tax revenue to effectively accrue to landlords, and setting minimum loan rates effectively allows banks to collect some rents from making loans at rates above their marginal costs. However, the impact of both policies on the equilibrium size of Chonsei deposits sizes is still described by (18).

We proceed to quantitatively estimate how much such a policy could have decreased the pass-through of interest rates to Chonsei deposit size. To do so, we assume that Chonsei deposit sizes in the data are generated by the following process:

$$\frac{L_t}{n_t} = \underbrace{\frac{1}{\beta\left(r_J + s\right)}}_{\text{Tenant indifference condition}} + \underbrace{\mu_t}_{\text{Time-varying unobservables}} \tag{19}$$

Expression (19) simply decomposes variation in Chonsei rates in Figure 7 into a component $\frac{n_t}{\beta(r_J+s)}$ which is driven by our model, and a residual component μ_t which captures all other factors which may affect loan size, such as time-varying bank credit conditions, aggregate shocks to tenants' creditworthiness, and other such factors. We will set μ_t so that (19) perfectly matches the path of $\frac{L_t}{n_t}$ in the data, setting spread $s_t = 0$. That is, we set μ_t exactly equal to the gap between the black line and the red line in Figure 7. We then simulate different values of the spread s, and calculate counterfactual paths for the Chonsei-rent ratio, holding μ_t fixed. Effectively, this exercises changes the tenant indifference component of (19), while holding fixed the path of time-varying unobservables μ_t.

We show results from this exercise in Figure 8. The black line shows the baseline empirical Chonsei-rent ratio, which we match perfectly using (19). The blue line shows the counterfactual Chonsei-loan ratio with $s = 3\%$, and the purple line shows $s = 6\%$. Imposing small taxes on Chonsei deposits can substantially decrease the size of Chonsei deposits, as well as the pass-through of interest rates. At a spread of 3%, the Chonsei-rent ratio decreases to 8.2 on average in 2012. Moreover, Chonsei deposit size only increases by 5.7× annual rents from 2012-2018, compared to 8.3× times in the original data. At a larger tax of 6%, the Chonsei-rent ratio decreases to 5.66, and only increases by 4.8×

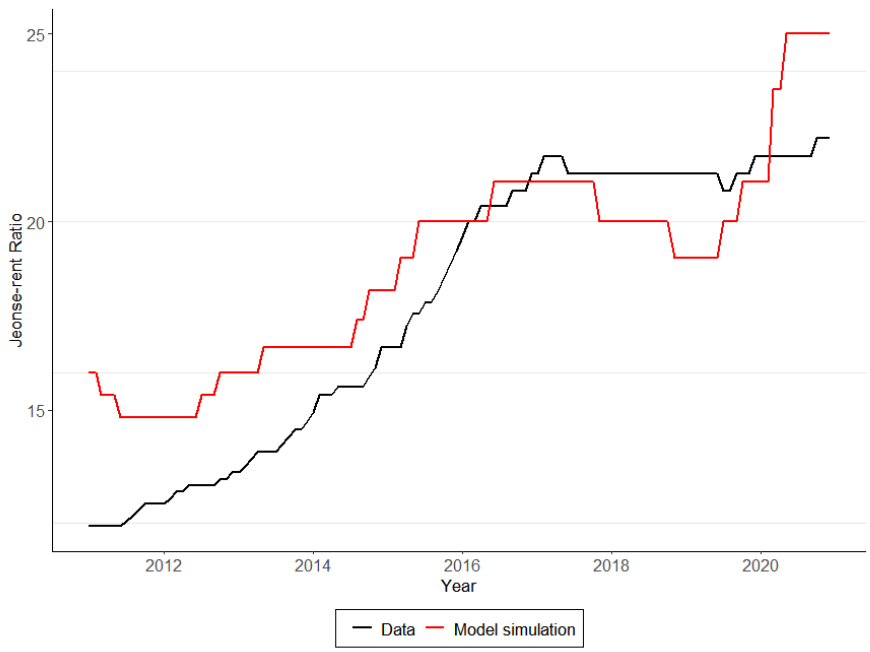
times annual rents from 2012-2018.

We note that these policies are not designed to make housing more affordable to tenants. In the model, tenants are always indifferent between renting and Chonsei deposits; imposing taxes on Chonsei deposits does not change renters' welfare. Instead, the goal of these policies is to decrease the amount of credit that homeowners can access through Chonsei deposits, and how sensitive this credit source is to overall interest rates. If homeowners using Chonsei deposits are marginal buyers in the housing market, such policies would have the potential to limit Chonsei-credit-induced booms in house prices, which may be valuable from the perspective of financial stability.

6 Conclusion

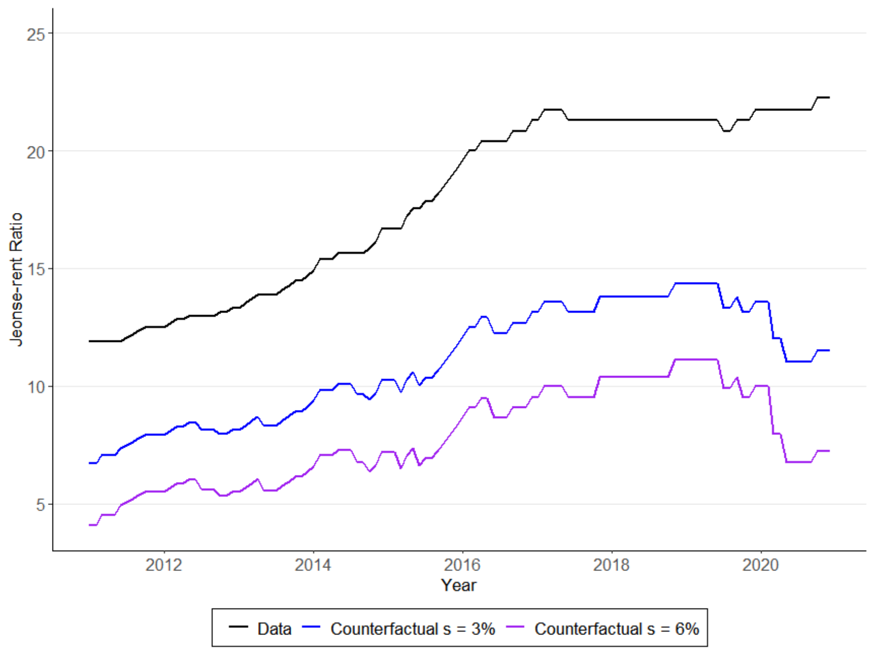
In this paper, we have constructed a simple equilibrium model of the Chonsei system of credit provision in the Korean housing market. Chonsei deposit size is pinned down by requiring tenants to be indifferent between paying rent, and borrowing from a bank at positive rates to fund a zero-interest loan to homeowners. The model makes predictions about the cross-sectional and time-series behavior of Chonsei-rent ratios, which are verified in the data. The model quantitatively fits Chonsei deposit sizes fairly well. We explore simple policy counterfactuals aimed at reducing the size of Chonsei deposits, and the pass-through of rate decreases on loan size. Our findings have implications for understanding the behavior of Chonsei deposits, and also for policymakers aiming to regulate credit provision within the Korean housing market.

Figure 7: Chonsei-rent ratios: model and data



Notes. This figure shows Chonsei-rent ratios in the model and in the data. The black line is the inverse of the Chonsei-rent ratio index calculated by the Conversion Rate, which is calculated as the median ratio of annual rents to Chonsei deposit size to annual rents, for a sample of Chonsei and rental apartments designed to have similar characteristics. The red line is Chonsei-rent ratio predicted by our model, calculated as $\frac{L}{n} = \frac{1}{r_{mpt}+s}$, where r_{mpt} is the Korean Central Bank base rate, and s is a time-invariant spread between Chonsei deposit rates and the base rate, which we set to 3.5%.

Figure 8: Chonsei-rent ratios: counterfactual policy simulations



Notes. Chonsei-rent ratios in the simulated model and in the data. The black line is the Chonsei-rent ratio index calculated by the conversion rate, which is calculated as the median ratio of annual rents to Chonsei deposit size to annual rents, for a sample of Chonsei and rental apartments designed to have similar characteristics. The blue line and purple lines are Chonsei-rent ratio predicted by our model under counterfactual policy, calculated as $\frac{L}{n} = \frac{1}{r_{mpt}+s_0+s} + \mu_t$, where r_{mpt} is the Korean Central Bank base rate, and s_0 is a time-invariant spread between Chonsei deposit rates and the base rate, which we set to 3.5%. Residuals are calculated with our baseline model predictions, $\mu_t = \frac{L}{n}_{index,t} - \frac{1}{r_{mpt}+s_0}$. Blue line shows predicted values under $s = 3\%$ and purple line shows predicted values under $s = 6\%$.

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Appendix

A Data Appendix

In this appendix, we describe datasets that we use, and data cleaning steps.

Housing market data. We collect housing market data from the Korea Real Estate Board (KREB). The KREB is a government agency under the Ministry of Land, Infrastructure and Transport (MOLIT) that monitors the real estate markets in South Korea. Among their public data, we mainly use the monthly Chonsei-to-rent and price-to-Chonsei ratios for apartments at the nation and Gu-level. We obtain the price-to-rent ratio by multiplying the two ratios.

We focus on the Chonsei-to-rent and price-to-Chonsei ratios for apartments rather than those for single houses and other types of multiplex because apartments are crucial for understanding housing markets in South Korea. They account for the largest share of housing stocks (77.2% as of 2019 Census) and have been the main target of important housing market regulations (Jung and Suh, 2010; Igan and Kang, 2011; Moon, 2018*b*). Apartments in South Korea are also highly standardized, and thus, the Chonsei-to-rent and price-to-Chonsei ratios are credibly measured compared to the ratios for the other housing types.

To estimate the Chonsei-to-rent ratio at the nation and city-Gu level, the KREB uses rental and Chonsei transaction data and collects rent and Chonsei price information for apartments of the same floor plan in the same block. If the KREB observes multiple rents and Chonsei prices for the apartment of the same floor plan due to a large volume of Chonsei and rental transactions, they use the median Chonsei price and compute the Chonsei-to-rent ratio for each rental transaction. They then take the median value of the ratios to estimate the Chonsei-to-rent ratio at the city-Gu level. The nation-level Chonsei-to-rent ratio is computed by averaging the city-Gu-level Chonsei-to-rent ratios weighted by the city-Gu level apartment stocks. The price-to-Chonsei ratio is computed in the same manner.

Credit report data. To compute average credit scores for different areas, we use a snapshot of credit report microdata from the Korean Credit Bureau (KCB), as of July 2012. The microdata contains individual-level credit rates, which range from 1 (lowest) to 10 (highest), covering 98% of the population.[3] We then aggregate the data to calculate average credit scores of all individuals in each city-Gu. While we do only observe a snapshot of credit report data, the relative income levels of different city-gus by income is quite stable over our time period, suggesting that the relative credit scores of different areas also should not shift substantially over time.

Household characteristics. We use the Korean Housing Survey (KHS) microdata to examine the household characteristics by housing tenure. The KHS is conducted by the MOLIT and interviews around 30,000 households to investigate housing conditions by housing tenure and household income. It has been a biannual survey until 2016 and then conducted annually since. We use the 2012, 2014, 2016, 2017, and 2018 waves of the survey and restrict the sample to households living in the apartment.

Other data sources. We collect the central bank policy rates, and the average interest rates for mortgage loans, from the Bank of Korea (BOK). We exploit the Korea Federation of Banks (KFB) database to collect data for the cost of fund index (COFIX)—a base interest rate for household loans. We use the MOLIT database to measure the aggregate numbers of housing and Chonsei transaction. We measure the total size of the housing stock in 2010 using the from Korean Statistical Information System (KOSIS).

Stylized facts on owner-occupants, Chonsei tenants, and renters. Appendix Table A.1 shows descriptive statistics of owner-occupants, Chonsei tenants, and renters. Owner-occupants tend to have the highest levels of income and wealth, followed by Chonsei tenants, followed by renters. Appendix Table A.2 shows descriptive statistics of owner-occupied, Chonsei-deposit, and rented housing units. Consistent with Table A.1, owner-occupied units tend to be largest, followed by Chonsei units, followed by rental units.

[3]Higher values of KCB credit ratings indicate that the subject is less creditworthy. In our results, for ease of interpretation, we rescale credit ratings so that the lower values indicate lower creditworthiness.

Table A.1: Characteristics of Chonsei tenants

	Income		Net Wealth	
	(1)	(2)	(3)	(4)
Chonsei	-80.08*	-79.46*	-92.31***	-91.76***
	(42.42)	(42.65)	(27.53)	(27.59)
Rent	-1442.4***	-1440.7***	-293.2***	-294.9***
	(59.87)	(59.55)	(40.52)	(40.81)
Own (Base)	3884.3***	3883.9***	379.4***	379.5***
	(12.35)	(12.31)	(9.519)	(9.595)
Year FE	Yes		Yes	
Province FE	Yes		Yes	
Year x Province		Yes		Yes
Adjusted R^2	0.0666	0.0677	0.1889	0.1935
# Obs	74,094	74,094	74,094	74,094

Notes. This table uses the Korean Housing Survey (KHS) for 2012, 2014, 2016, 2017, 2018 and shows the characteristics of Chonsei tenants relative to those of homeowners and renters. The unit of observation is a household. Monthly income is in 1,000 KRW, and net wealth is in 1,000,000 KRW. Standard errors are clustered at the province level.

Table A.2: Characteristics of Chonsei units

	Area of Apartment (SQM)			
	(1)	(2)	(3)	(4)
Chonsei	-0.000742	-1.178***	-1.803***	-0.563***
	(0.367)	(0.216)	(0.176)	(0.0767)
Rent	-11.15***	-11.53***	-10.60***	-2.562***
	(0.509)	(0.375)	(0.307)	(0.153)
Own (Base)	75.95***	76.44***	76.50***	74.64***
	(0.676)	(0.118)	(0.0943)	(0.0470)
City-Gu x Year-Month FE		Yes		
Dong x Year-Month FE			Yes	
APT Block x Year-Month FE				Yes
Adjusted R^2	0.02540	0.1174	0.2807	0.7047
# Obs	11,432,746	11,432,746	11,432,746	11,432,746

Notes. This table uses MOLIT's housing transaction data from 2011 to 2020 and reports the average apartment area for Chonsei, rental, and owner-occupant apartments. Dong is the smallest administrative division in South Korea. Standard errors are clustered at the City level.

B Supplementary material for Section 3

B.1 Proof of OLG equilibrium

In this appendix, we show that, if equilibrium conditions hold for period 0, they hold for all future periods. In period t, wealth and rents grow by a factor $(1+g)^t$:

$$W_t = (1+g)^t W_0,\ n_t = (1+g)^t n_0$$

We seek an equilibrium in which prices and loan size also scale by $(1+g)^t$:

$$p_t = (1+g)^t p_0,\ L_t = (1+g)^t L_0$$

Tenants. If $\beta L_0 r_J = n_0$, and

$$\frac{L_t}{n_t} = \frac{L_0}{n_0}\ \forall t$$

then we have $\beta L_t r_J = n_t$ for all t. Thus, rental market clearing in period $t = 0$ implies rental market clearing for all future periods.

Homeowners. We will also think of savings in period-0 equivalents. Thus, the households chooses s_t by choosing s_0 in:

$$s_t = (1+g)^t s_0$$

Plugging these into the three value functions (2), (3), and (4), we get:

$$V_S(W) = \max_{s_0 \geqslant 0} \frac{\left(W_0 (1+g)^t - s_0 (1+g)^t\right)^{1-\eta}}{1-\eta} + \beta \frac{\left(s_0 (1+g)^t (1+r_S)\right)^{1-\eta}}{1-\eta}$$

$$V_B\left(W(1+g)^t, p_0(1+g)^t\right) = \max_{s_0 \geqslant 0} \frac{\left(W_0(1+g)^t - s_0(1+g)^t - p_0(1+g)^t\right)^{1-\eta}}{1-\eta} + \beta\frac{\left(s_0(1+g)^t(1+r_S) + p_0(1+g)^{t+1} + n_0(1+g)^t\right)^{1-\eta}}{1-\eta}$$

$$V_J\left(W(1+g)^t, p_0(1+g)^t, L_0(1+g)^t\right) = \max_{s_0 \geqslant 0} \frac{\left(W_0(1+g)^t - s_0(1+g)^t - \left(p_0(1+g)^t - L_0(1+g)^t\right)\right)^{1-\eta}}{1-\eta} + \beta\frac{\left(s_0(1+r_S)(1+g)^t + \left(p_0(1+g)^{t+1} - L_0(1+g)^t\right)\right)^{1-\eta}}{1-\eta}$$

We can factor out $(1+g)^{t(1-\eta)}$from each formula, to get:

$$V_S\left(W(1+g)^t\right) = \max_{s_0 \geqslant 0} (1+g)^{t(1-\eta)}\left[\frac{(W_0 - s_0)^{1-\eta}}{1-\eta} + \beta\frac{(s_0(1+r_S))^{1-\eta}}{1-\eta}\right] = (1+g)^{t(1-\eta)} V_S(W) \quad (20)$$

$$V_B\left(p_0(1+g)^t, W_0(1+g)^t\right) = \max_{s \geqslant 0} (1+g)^{t(1-\eta)}\left[\frac{(W_0 - s_0 - p_0)^{1-\eta}}{1-\eta} + \beta\frac{(s_0(1+r_S) + p_0(1+g) + n_0)^{1-\eta}}{1-\eta}\right] = (1+g)^{t(1-\eta)} V_B(W, p_0) \quad (21)$$

$$V_J\left(p_0(1+g)^t, L_0(1+g)^t, W_0(1+g)^t\right) =$$

$$\max_{s\geqslant 0}(1+g)^{t(1-\eta)}\left[\frac{(W_0 - s_0 - (p_0 - L_0))^{1-\eta}}{1-\eta} + \beta\frac{(s_0(1+r_S) + (p_0(1+g) - L_0))^{1-\eta}}{1-\eta}\right] =$$

$$(1+g)^{t(1-\eta)} V_J(W, p_0, L_0) \quad (22)$$

In words, the above expressions state that, if prices and loan size grow at rate g, then value functions in period t are equal to time-0 value functions multiplied by $(1+g)^{t(1-\eta)}$. Thus, if (9) holds, we also have:

$$(1+g)^{t(1-\eta)} V_J(p_0, L_0, W_0) = (1+g)^{t(1-\eta)} V_S(W)$$

$$\implies V_J\left(p_0(1+g)^t, L_0(1+g)^t, W_0(1+g)^t\right) = V_S\left(W_0(1+g)^t\right)$$

$$\implies V_J(p_t, L_t, W_t) = V_S(W_t)$$

Thus, if the housing market clearing condition (7) holds in period $t = 0$, then it holds in every future period.

Together, we have shown that if the housing and rental market clearing conditions hold in time 0, (9) and (8), and the ratios $\frac{p_0}{n_0}, \frac{L_0}{n_0}$ they hold in every future period, completing our characterization of equilibrium.