

## State Misallocation and Housing Prices: Theory and Evidence from China<sup>†</sup>

By SHING-YI WANG\*

*This paper examines the equilibrium price effects of the privatization of housing assets that were previously owned and allocated by the state. I develop a theoretical framework that shows that privatization can have ambiguous effects on prices in the private market, and that the degree of misallocation of the assets prior to privatization determines the subsequent price effects. I test the predictions of the model using a large-scale housing reform in China. The results suggest that the removal of price distortions allowed households to increase their consumption of housing and led to an increase in equilibrium housing prices. (JEL L33, O18, P25, R31, R38)*

State participation in the housing market occurs in several forms in countries throughout the world. The provision of subsidized housing as a welfare benefit to low income households is common throughout the Western hemisphere. In addition, local governments in several cities in the United States have implemented regulations that limit the increase of rents charged by landlords.<sup>1</sup> This paper focuses on a form of state intervention in housing that occurs through the provision of subsidized homes to state employees. The economic consequences of this area of research are potentially large as employer-provided housing in the state sector is common throughout the developing world, particularly in Asia and sub-Saharan Africa.

Government regulation of the private market or the creation of a separate market ensures that certain households have access to housing at prices that are below market value. State interventions that aim to bring affordable housing to particular subsegments of the population can create economic inefficiencies. They distort the decisions that individuals make regarding residential mobility (Joseph Gyourko and Peter Linneman 1989; Gordon A. Hughes and Barry McCormick 1987) and employment (Michael Svarer, Michael Rosholm, and Jakob Roland Munch 2005; Wang forthcoming), and they lead to underinvestment in the construction and maintenance of housing (John C. Moorhouse 1972; Choon-Geol Moon and Janet G.

\*New York University, 19 W. 4th Street, 6th floor, New York, NY 10012 (e-mail: shingyi.wang@nyu.edu). This paper has benefitted from feedback from Santosh Anagol, A. V. Chari, Hanming Fang, Mark Rosenzweig, Kevin Thom, Chris Udry, Akila Weerapana, Alwyn Young, various seminar participants, and an anonymous referee. All errors are my own.

<sup>†</sup>To view additional materials, visit the article page at <http://www.aeaweb.org/articles.php?doi=10.1257/aer.101.5.2081>.

<sup>1</sup>See Richard Arnott (1995) for an overview of research on rent control in North America. He also presents a brief history of the evolution of rent control in the United States and Europe.

Stotsky 1993). I analyze this topic in the context of a large-scale housing reform that occurred in urban areas of China. Beginning in 1994, privatization of state-owned housing was implemented by allowing existing residents the opportunity to purchase the homes that they had been renting from their state employers. Similar types of programs to privatize state-owned housing have occurred in a few other Asian countries and in the transition economies of Eastern Europe.

The theoretical framework presented in this analysis builds on existing models of rent control. J. R. Gould and S. G. B. Henry (1967) challenged the popular belief that the introduction of rent control would unambiguously increase housing prices in the uncontrolled sector. They developed a general equilibrium model to demonstrate that the introduction of price controls can either raise or lower the price of a substitute good. George Fallis and Lawrence B. Smith (1984) introduced a model of housing prices that includes common features of rent control. Their model also found that the impact on housing prices in the uncontrolled market is ambiguous and depends on the response of demand. The theoretical framework in my paper introduces the importance of the degree of misallocation of assets in the controlled sector on housing prices in the uncontrolled sector.<sup>2</sup> I use the term mismatch to capture the difference in the consumption of housing services under the state allocation of housing and under the efficient allocation that results from private market mechanisms.<sup>3</sup> I estimate the degree of misallocation of housing prior to the privatization in China and the equilibrium price effects of removing the system of state allocation. Furthermore, I calculate the welfare losses associated with this type of housing misallocation.

In my framework, the price of state housing services is highly subsidized and its allocation is controlled by the state. The private market is not controlled by the state in any direct way. The two types of housing are substitutes for a subset of the population that is allowed to reside in state housing. The model shows that the privatization of state-owned housing has an ambiguous effect on equilibrium housing prices in the private market. The intuition behind the ambiguous price effect is that the privatization leads to shifts in both the supply of and the demand for housing. The model offers insight into misallocation as a key determinant of the relative sizes of the shifts in supply and demand. In particular, the model predicts that the direction and the magnitude of the price impact depend on the degree of misallocation of state housing before the reform.

Using panel data from the China Health and Nutrition Survey (CHNS), I test the predictions of the model using the large-scale housing reform that ended the state provision of subsidized housing in China. My estimates of mismatch suggest that households living in state-owned housing units prior to the reform were consuming approximately 15 percent less housing services than they would have chosen in the private market. The empirical results suggest that the removal of price distortions

<sup>2</sup>The economic importance of housing misallocation under rent control is emphasized in the existing literature that provides methods for estimating the degree of misallocation in the housing market (Edward L. Glaeser and Erzo F. P. Luttmer 2003; Edgar O. Olsen 1972).

<sup>3</sup>The theoretical approach used to model the housing market follows a standard approach in the housing literature introduced by Richard F. Muth (1960) and Olsen (1969). While every house is unique in its location and amenities, the model deconstructs the market into homogenous and divisible units of housing services. Residences differ only in the amount of housing services that they provide; thus, this approach abstracts away from further distinctions between quantity and quality of homes. In this framework, price refers to the price of a single unit of housing services.

allowed households to increase their housing consumption. The shift in demand for housing led to a significant increase in the equilibrium price of housing in the private market of 7.5 percent.

This paper contributes to the existing literature that examines the impact of the subsidized sale of state-owned housing on the prices of private market housing in Hong Kong (Lok Sang Ho and Gary Wai-Chung Wong 2006) and in Singapore (Tien-Foo Sing, I. Chun Tsai, and Ming-Chi Chen 2006; Ashok Bardhan et al. 2003). Several of these papers have drawn on the theoretical models of Jeremy C. Stein (1995) and Francois Ortalo-Magné and Sven Rady (2006). The theoretical model developed by Ortalo-Magné and Rady (2006) focuses on households that want to trade up into higher quality homes but are constrained by the down-payment requirement. While credit constraints may also be a limiting factor in housing consumption in China, this paper focuses on the distortions in housing consumption that result from the subsidized rental prices of employer-provided housing. Furthermore, the credit constraints framework only predicts that housing prices should fall after the sale of state-owned housing (Sing, Tsai, and Chen 2006); it cannot explain the experience in China where equilibrium housing prices in the private market *rose* after the privatization of state housing.

## I. Background

### A. Privatization of Public Housing Units

Upon gaining control of the government in 1949, the Communist Party nationalized the ownership of land in China. Households that already possessed private ownership of homes were allowed to retain ownership of their residences, but the government established public ownership over all new housing stock. State-owned housing units were allocated to employees of state-owned enterprises by their work units. The rents charged were highly subsidized. Following the death of Chairman Mao Zedong in 1976, the new leadership initiated a gradual reform of the socialist system towards a mixed economy. A reform of the housing system was considered because the government recognized serious problems in the state provision of housing, including shortages, poor management, and corruption in the distribution (Ya-ping Wang and Alan Murie 1999). There were substantial waiting lists for state-owned housing, and allocation was determined by the availability of housing units and worker characteristics, including job tenure, rank, and social connections (Min Zhou and John R. Logan 1996). Private construction of housing was allowed, and the supply of private housing expanded.<sup>4</sup> In 1993, approximately 40 percent of urban households in China were residing in state-owned housing.

In July 1994, the State Council of China outlined procedures for state employers to sell public housing units to sitting tenants in urban areas throughout the country. Households living in state-owned housing were given the opportunity to buy either

<sup>4</sup>While the state owned all land during this period, private sector firms were able to purchase land use rights for 70 years. Land use rights included the right to participate in secondary markets and rent out the use of the land to others. These initial prices were set by public tender, auction, or negotiation. See Samuel P. S. Ho and George C. S. Lin (2003) for more details on the land use rights.

full or partial property rights to their current homes. Partial property rights included use rights for perpetuity, the right to bequeath, the right to rent out the home, and the right to use it as collateral for loans. After five years of ownership, households with partial property rights gained the right to sell the home but shared the profits from the sale with their work units. In contrast, those purchasing full property rights faced no restrictions in the use or sale of their homes and retained all profits earned. In the data used in this analysis, only 18 percent of households that had been occupying state-owned housing had partial property rights following the reform.

Interviews conducted by Deborah S. Davis (1993) of urban residents in China confirm that the central and municipal governments were successful in hiding their plans for privatization of urban housing assets from most of the population through the early 1990s. In addition to qualitative evidence from interviews, empirical evidence by Wang (forthcoming) also supports the idea that reform was unanticipated prior to 1994. Furthermore, the results in this paper in Section IIIC also provide evidence against the idea that anticipation of the reform impacted the relationship between misallocation and housing consumption or prices.

The prices charged for state-owned housing units were far below market value, and the vast majority of households in state-owned housing chose to purchase private property rights over their homes. The housing reform that began in 1994 transformed China into a country with one of the highest rates of home ownership in the world. The success of the reform in increasing private ownership of housing is demonstrated in Figure 1, which displays the rates of home ownership among households living in urban areas. Home ownership rates increased from around 55 percent in the early 1990s to over 80 percent following the housing reform.

### *B. Institutional Context*

Individual mortgage lending by formal banking institutions is less common in China than in a developed country such as the United States. However, evidence confirms that informal sector lending was very common around the time of the reform (Gershon Feder et al. 1992). A 2004 survey by the Beijing Central University of Finance and Economics in 20 provinces estimated the amount of underground lending in China at \$101 billion, equivalent to 28 percent of the funds lent through formal sources (Jianjin Li 2005).

Since 1958, the Chinese state has controlled residential mobility through the household registration system, or hukou system. Households must have official registration to live in a specific city to live permanently in that city and to have access to social services there. The system's main impact is the reduction of migration of rural residents to urban areas. For a household that is registered to live in a given city, the system has no restrictions on residential mobility within the city.

## **II. Theoretical Framework**

I develop a model to determine the impact of the privatization of state-owned housing on the equilibrium relationship between the market for state-owned housing and the market for private housing. This model builds on the framework for rent control used in Fallis and Smith (1984). Their model demonstrates how the housing

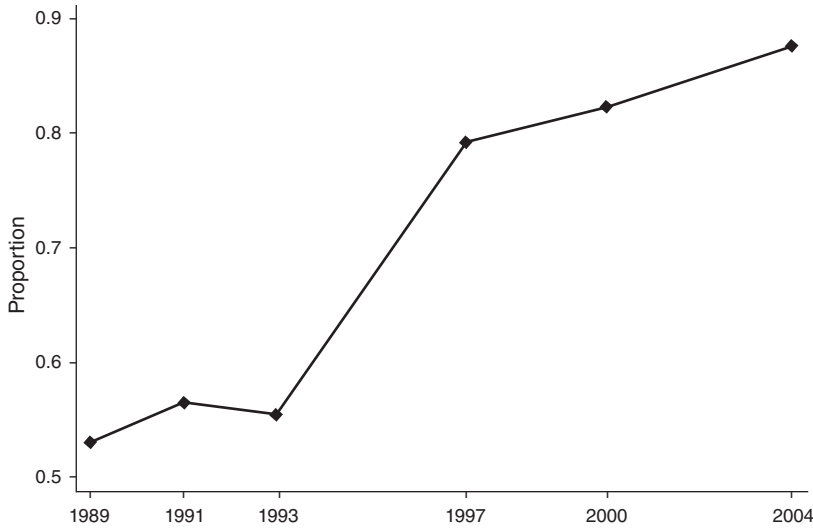


FIGURE 1. URBAN RATES OF HOME OWNERSHIP (Data: CHNS)

market changes with the introduction of price controls, which can be thought of as the stage prior to the initial equilibrium presented in my framework.

#### A. Initial Equilibrium

Consider an economy with two markets for housing: the controlled market for state-owned housing ( $c$ ) and the uncontrolled market for private housing ( $u$ ). While most units of private housing are owner occupied and almost all units of state-owned housing are rented, the model does not directly embed the difference between purchasing a home and renting. For simplicity, I consider the rental value of a privately owned home as the price. Households cannot freely enter the market for state-owned housing because the state determines who receives an offer to reside in a state-owned unit and which housing unit to offer each household. While housing units vary in location, size, and quality, I model differences across homes in terms of a single index of the quantity of housing services that they provide.<sup>5</sup> Households offered a state-owned unit have the option to refuse and enter the market for private housing.

There are a total of  $q$  households in the private market, and consumers in the private market comprise two groups. First, there are  $n$  households that are either not employed by state-owned enterprises or are employed by the state but have not been offered a state-owned home to rent at a subsidized price.<sup>6</sup> These  $n$  households do not have the option to participate in the price controlled market. The second group of consumers in the private market are the  $q - n$  households that were offered a state-owned unit. For these  $q - n$  households, housing in the two markets are substitutes,

<sup>5</sup>Muth (1960) and Olsen (1969) introduced the idea that residences differ only in the quantity of housing services that they provide and that housing services are homogeneous and divisible.

<sup>6</sup>The latter group may be on a waiting list for a state-owned housing unit.

and their decision between state housing and private housing depends on the relative prices and the quantities of housing services.

Aggregate demand in the private sector,  $D_u$ , is the sum of each household  $i$ 's demand for private housing services, and is given by

$$(1) \quad D_u = \sum_{i=1}^n d(R_u, \mathbf{X}_i) + \sum_{i=n+1}^q g(R_u, \bar{R}_c, \mathbf{X}_i, \bar{S}_{ci}),$$

where  $\mathbf{X}_i$  denotes a vector of demographic characteristics that affect household demand,  $R_u$  is the equilibrium price of a unit of housing services in the private market,  $d$  is the demand function for households without the option to rent in the state market, and  $g$  is the demand function for households with the option of renting in the state market. The total quantity and price of state-owned housing services, denoted by  $\bar{S}_c$  and  $\bar{R}_c$ , respectively, are exogenously chosen by the government. Furthermore, the amount of housing services that a specific household  $i$  is offered by a state employer is denoted by  $\bar{S}_{ci}$  and is also chosen by the government. The price charged and quantity offered in the state housing market,  $\bar{R}_c$  and  $\bar{S}_{ci}$ , are relevant only for the households, indexed  $i \in [n+1, q]$ , that were employed in the state sector and received an offer to rent a subsidized home. All households offered a subsidized housing unit have the option to participate in the market for private housing, but for households that prefer state-owned housing, their demand for private housing,  $g(R_u, \bar{R}_c, \mathbf{X}_i, \bar{S}_{ci})$ , equals zero.

Figure 2 depicts the prereform market for state-owned housing. Supply is perfectly inelastic and the state supplies a total of  $\bar{S}_c$  units of housing services.<sup>7</sup> The demand curve represents the willingness to pay of households in the market. The state chooses to subsidize housing, so  $\bar{R}_c < R_c^*$ .

The supply of housing in the private market is a function of price,  $R_u$ , and a vector of variables that affect supply,  $\mathbf{F}$ , such as local regulations on construction or land sales:

$$(2) \quad S_u = f(R_u, \mathbf{F}).$$

The value of  $R_u$  must be such that state employees living in private or state-owned residences do not want to move. The equilibrium price of housing in the private market,  $R_u$ , solves

$$(3) \quad \sum_{i=1}^n d(R_u, \mathbf{X}_i) + \sum_{i=n+1}^q g(R_u, \bar{R}_c, \mathbf{X}_i, \bar{S}_{ci}) = f(R_u, \mathbf{F}).$$

### B. Impact of the Housing Reform on Prices

By giving households the opportunity to purchase private property rights to the state-owned units that they had been renting at subsidized prices, the housing reform

<sup>7</sup>This assumes that supply of state-owned housing did not respond to the size of the waiting list for housing. Using province-level data available in the China Statistical Yearbooks 1985–1988 and 1993–1994, I find no correlation between growth of state employment and subsequent construction of state residential housing. These results are available from the author upon request. This is consistent with the general consensus that prereform shortages and poor management of state housing were a large problem and motivated the reform (Wang and Murie 1999).

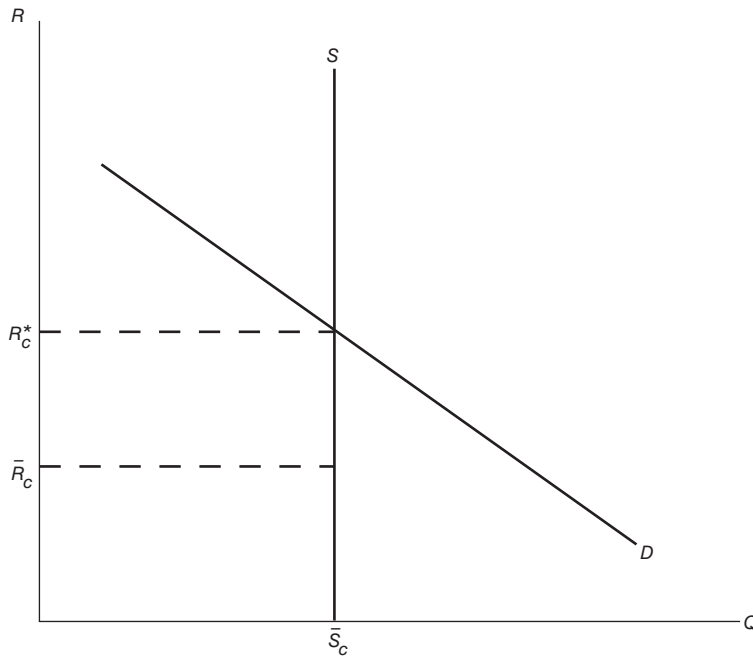


FIGURE 2. PREREFORM MARKET FOR STATE HOUSING SERVICES

alters the equilibrium in the housing markets. It shifts out the supply of housing in the private market as the stock of state-owned housing enters the private market. Thus, the postreform supply in the private market,  $S'$ , increases by the exact amount of the housing services owned by the state before the reform, and is given by

$$(4) \quad S' = f(R'_u, \mathbf{F}) + \bar{S}_c,$$

where  $R'_u$  is the postreform equilibrium price of a unit of housing services in the private market. The proportional shift out of the housing supply that occurs as a result of the privatization of the stock of state-owned homes is upward sloping as shown in Figure 3. The increase in supply deriving from the former state-owned housing units moves with price due to improvements in the state-owned homes.

The state-owned market has now combined with the private market, so the demand function in the private sector must include households that were formerly in the state housing market. Postreform aggregate demand is

$$(5) \quad D' = \sum_{i=1}^z d(R'_u, \mathbf{X}_i) + \sum_{i=z+1}^q d(R'_u, \mathbf{X}_i),$$

where households indexed by  $i \in [z + 1, q]$  are the previous inhabitants of state-owned housing. The shift out of the demand curve from  $D$  to  $D'$  is delineated in Figure 3.

To understand the impact of the housing reform on the equilibrium price of housing, I make several assumptions. The model assumes that there is no transactions cost to moving. A large transactions cost to moving would dampen shifts in the

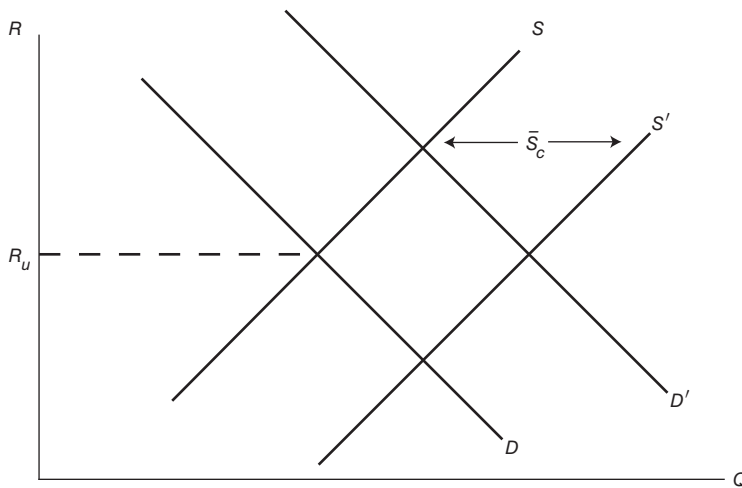


FIGURE 3. IMPACT OF THE REFORM ON THE PRIVATE MARKET

demand for housing that correspond to the removal of price distortions for residents of state-owned housing. In addition, I assume that, conditional on differences in observable characteristics,  $\mathbf{X}$ , the demand functions of households,  $g$  and  $d$ , are the same regardless of whether the household lived in private or state-owned housing. I discuss the plausibility of this assumption and present empirical support for it in Section CB. This assumption produces the proportional shift out of the demand curve at each price.

The postreform equilibrium price,  $R'_u$ , is given by

$$(6) \quad \sum_{i=1}^z d(R'_u, \mathbf{X}_i) + \sum_{i=z+1}^q d(R'_u, \mathbf{X}_i) = f(R'_u, \mathbf{F}) + \bar{S}_c.$$

The impact of the reform on the equilibrium housing price in the private market depends on the relative shifts in demand among households in the controlled market, given by  $\sum_{i=z+1}^q d(R'_u, \mathbf{X}_i)$ , and in supply,  $\bar{S}_c$ . While Figure 3 depicts a situation where supply and demand both shift out by the same amount, this does not have to be the case. The net impact of the shifts of supply and demand on the price of housing is ambiguous and depends on the size of the relative shifts as well as on the elasticities of supply and demand.

The magnitude of the shift in demand relative to the shift in supply is determined by the system of allocation of state housing before the reform. The distortion in prices associated with state housing could induce households to occupy either more or less than the amount of housing they would choose to consume in the private market. If on average households were allocated to homes that were smaller (larger) than what they would consume at price  $R'_u$ , then the magnitude of the shift out in demand will be larger (smaller) than the shift in supply, and prices will rise (fall). The next section formalizes the impact of the system of allocation on equilibrium prices.



C. Implications of Misallocation in Prereform State Allocation

Before the housing reform, households living in state-owned housing could not choose the amount of housing services to consume because the unit was assigned to them by their state employers. Households may have been willing to consume a vastly different bundle of housing in the state market than they would in the absence of price controls. I use the term mismatch to refer to the difference between the amount of housing services that households consume in the state market and the amount that they would consume if they were in the private market.<sup>8</sup> The quantity of mismatch experienced by household  $i$ , given by  $\delta_i$ , is equal to  $d(R_u, \mathbf{X}_i) - \bar{S}_{ci}$ , where  $\bar{S}_{ci}$  is the amount of state-owned housing allocated to the household. For household  $i$ , its household level of the cost of mismatch at prices  $R_u$ , denoted by  $\Delta_i$ , equals  $R_u \delta_i$ . The aggregate cost of mismatch of households in state-owned housing,  $\Delta$ , at prereform prices is given by

$$(7) \quad \Delta = \sum_{i=z+1}^q \Delta_i = R_u \sum_{i=z+1}^q \delta_i = R_u \sum_{i=z+1}^q d(R_u, \mathbf{X}_i) - R_u \bar{S}_c,$$

where households indexed  $i \in [z + 1, q]$  lived in state-owned housing prior to the reform (so,  $\bar{S}_{ci} > 0$  for  $i \in [z + 1, q]$  and  $z \geq n$ ). The value of  $\Delta$  equals zero if, on average, the state succeeded in allocating to households homes that were equivalent to the ones that they would have chosen in the private market. A positive (negative) value of  $\Delta$  indicates that households living in state-owned housing generally preferred more (less) housing services than the amount they were allocated by the state.

To examine the relationship between prereform misallocation and the change in the equilibrium price of private housing, consider the case where  $\Delta > 0$ . This means that

$$(8) \quad \bar{S}_c < \sum_{i=z+1}^q d(R_u, \mathbf{X}_i),$$

and households in state-owned housing preferred more housing services than they were given by their state employers. Combining this with the postreform equilibrium given by equation (6) yields

$$(9) \quad \sum_{i=1}^z d(R'_u, \mathbf{X}_i) + \sum_{i=z+1}^q d(R'_u, \mathbf{X}_i) < f(R'_u, \mathbf{F}) + \sum_{i=z+1}^q d(R_u, \mathbf{X}_i).$$

<sup>8</sup>Another potential type of misallocation derives from a mismatch in housing characteristics. For example, a household living in a state-owned home worth 1,000 RMB per month may prefer a private market home worth 1,000 RMB but with more floor space and without a flushing toilet. This analysis abstracts away from this trade-off along hedonic attributes because it is likely to be second order to the type of misallocation that is the focus of this analysis.

Now suppose that the prereform price in the uncontrolled market is higher than the postreform price ( $R'_u < R_u$ ). Because demand is downward sloping in price, this would imply

$$(10) \quad \sum_{i=z+1}^q d(R_u, \mathbf{X}_i) < \sum_{i=z+1}^q d(R'_u, \mathbf{X}_i).$$

Given that equation (3) holds for  $R_u$ , then at a lower price,  $R'_u < R_u$ , the quantity supplied will fall and the quantity demanded will rise, and

$$(11) \quad f(R'_u, \mathbf{F}) < \sum_{i=1}^z d(R'_u, \mathbf{X}_i).$$

However, adding equations (10) and (11) leads to a contradiction of equation (9). Thus, the case of  $\Delta > 0$  must imply that  $R'_u > R_u$ . Similarly, it is straightforward to show that  $\Delta = 0$  implies that  $R'_u = R_u$ , and  $\Delta < 0$  leads to  $R'_u < R_u$ . This result is quite intuitive. If residents of state-owned housing prefer to consume more housing services after the removal of price distortions, then demand will shift out by more than supply and the equilibrium price of housing will rise. If state employers were able to determine households' willingness to pay and allocated state units accordingly before the reform, then there would be no misallocation and households would not need to move after the reform. If no households change their consumption of housing, there will be no effect on prices. This corresponds to the Figure 3 where supply and demand shift out by the same amount, and the housing price in the private market remains constant.

#### D. Testable Implications

The model demonstrates the economic implications of state misallocation of housing resources. In Section IIIB, I present a method for estimating misallocation that is consistent with the theoretical framework. In Section IIIC, I use the measures of misallocation to test three implications of the model. The first two empirical tests evaluate the idea that households responded to the changes associated with the housing reform by realigning their consumption of housing. First, households with higher absolute levels of prereform mismatch should be more likely to change residences or to upgrade their existing homes after the reform. Another postreform option for households in former state-owned units was to alter the size or quality of their existing homes. Thus, the second test is that any change in the quantity of housing services consumed by a household after the reform should have moved positively with the household's prereform mismatch. Finally, the model suggests that price movements after privatization depend on the prereform level of misallocation. I test this prediction by examining whether areas where the average level of prereform mismatch (across all households) was higher also experienced greater increases in housing prices after the privatization.

### III. Microeconomic Evidence

#### A. Data

The data used in this analysis come from the CHNS. The CHNS covers nine provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong), which vary considerably in their geography and levels of economic development. The survey was sampled with a multistage, random cluster design. Counties were stratified into three levels of income, and a weighted sampling technique randomly selected four counties in each province. In addition, the data include the provincial capital and one low-income city. The panel dataset covers approximately 4,400 households in the years 1989, 1991, 1993, 1997, 2000, and 2004. Thus, the data include three waves before and three waves after the beginning of the housing reform in 1994. While the survey contains both urban and rural households, the sample used in this analysis is limited to the urban sample because the housing reform was implemented only in urban areas. I define urban areas as neighborhoods where the majority of households have urban registrations.

I create a proxy for the quantity of housing services provided by a household's residence by using the market rental value that the household reports for its residence.<sup>9</sup> The rental value is converted into real 1990 RMB using a price deflator from the United Nations. The survey reports several dimensions of housing quality, including floor space, presence of a flushing toilet, and electric and water utilities. The survey provides information about the current ownership status of the household's residence, but there is no information about whether a household received an offer to rent a state subsidized home.

Table 1 presents prereform characteristics of housing in the private market and the state-controlled sector. Households occupying homes provided by their state employers lived in homes that were worth on average 18 RMB, or 17 percent, less per month than households in private housing. At an average of 44.35 square meters (equivalent to 478 square feet), the floor space of state-owned housing was less than half the size of the average private home. However, state-owned housing units were more likely to have modern amenities, such as drinking water accessible in the housing unit, a flushing toilet in the home and less excreta around the dwelling.<sup>10</sup>

Table 1 also displays characteristics of the households living in the two types of housing prior to the large-scale privatization. The two groups are similar in the age of the household head and in the value of durable nonhousing assets owned in real 1990 RMB. Durable nonhousing assets are calculated as the sum of a household's self-reported market value of durable goods but do not include housing or financial assets. Households in private housing have an average of 0.46 more members. The statistics suggest that state-provided residences were much smaller than private homes, and the difference in household size may reflect a response to the limited floor space offered in employer-provided housing. The education of

<sup>9</sup>For a detailed discussion of the validity of this measure see Appendix 1.

<sup>10</sup>The data on excreta around the residence is based on the interviewer's observations, whereas the other characteristics are reported by the survey respondent.

TABLE 1—SUMMARY STATISTICS OF URBAN HOUSEHOLDS IN 1993

	In private housing	In state-owned housing
Housing characteristics		
Market rental value	107.75* (99.42)	89.42 (68.22)
Floor space	96.49* (76.61)	44.35 (25.37)
Drinking water	0.78* (0.42)	0.90 (0.29)
Flushing toilet	0.30* (0.46)	0.67 (0.47)
Electricity	0.99 (0.06)	0.99 (0.06)
No excreta around dwelling	0.77* (0.42)	0.94 (0.24)
Water source from plant	0.79 (0.41)	0.84 (0.36)
Age under 20 years	0.80* (0.41)	0.67 (0.47)
Household characteristics		
Household size	3.80* (1.33)	3.34 (1.15)
Durable nonhousing assets	3,729 (5,353)	3,720 (7,875)
Monthly income	624* (1,012)	456 (472)
Age of head	49.06 (14.00)	49.85 (12.83)
Education of head	6.64* (3.98)	9.66 (5.07)
Observations	319	296

*Notes:* Standard deviations in parentheses, and \* denotes the average is significantly different from the other group at the 5 percent level. The data for whether the age of home under 20 years are from the 1991 wave.

the household head was higher and the monthly income lower for families living in state-owned homes.

### B. Estimation of Misallocation

I estimate misallocation by comparing housing consumption for households living in subsidized units assigned by their state employers with households with similar characteristics living in private housing. It is estimated in terms of a single index of housing services, measured in rent prices. This measure yields the level of housing mismatch experienced by households in state-owned residences under the equilibrium conditions in the prereform market for private housing. It is not equivalent to the level of misallocation under a scenario where state-owned housing did not exist at all.

This methodology is similar to the one used by Glaeser and Luttmer (2003) in their estimation of the misallocation of housing under rent control in New York City. They compare housing consumption in New York City with 103 cities without rent control. The key assumption to their methodology is that the distribution of demand

across demographic subgroups is constant over space in their comparison of New York City with cities without rent control in the United States. For example, if the average college graduate in a city without any rent controls lives in a home that is twice as large as the average high school graduate, then they assume that an average college graduate in a rent-controlled city would prefer to live in a home that is twice the size of the residence of the average high school graduate. In contrast, I estimate misallocation by comparing households in state housing with households in private housing in the same cities. I do not need to make assumptions about the distribution of preferences within demographic subgroups across cities, but my methodology relies on the assumption that unobserved preferences for housing quality do not differ across groups. Because I am exploiting a change in the housing system in China and can observe housing consumption of the same households before and after the reform, I have the opportunity to empirically test the key assumption that underlies my construction of misallocation in a way that Glaeser and Luttmer (2003) could not. Finally, I measure misallocation in terms of the quantity of housing services rather than in the size of the residence. This offers the advantage of capturing the potential trade-offs between amenities and size.

Over a sample of households living in private housing in the years 1989, 1991, and 1993, I estimate the following equation of the logarithm of the monthly market rental value of housing,  $V_{ijt}$ , occupied by household  $i$  in province  $j$  and year  $t$ :

$$(12) \quad V_{ijt} = \alpha_0 + \alpha_1 \mathbf{X}_{ijt} + \tau_{jt} + \epsilon_{ijt},$$

where the vector  $\mathbf{X}_{ijt}$  includes a cubic in age of the household head, the logarithm of the household's monthly income, and the logarithm of the household's total assets.  $\tau_{jt}$  are province-year indicators. The estimated coefficients from equation (12) combined with the values of  $\mathbf{X}_{ijt}$  for households in state-owned housing before the reform yield a predicted value of the amount of housing services that households in state-owned housing would consume if they had not received subsidized housing from their employers. A household's level of mismatch is calculated as the difference between the household's predicted consumption of housing in terms of the market rental value and the actual amount ( $\Delta_{ijt} = \hat{V}_{ijt} - V_{ijt}$ ). This measure corresponds with the theoretical definition of  $\Delta_i$  given by equation (7). By construction, the average prereform level of mismatch among households living in private housing, denoted by  $\Delta_p$ , must be zero. A positive (negative) estimate of the prereform cost of mismatch among households living in state-owned housing,  $\Delta_s$ , would suggest that these households are living in lower (higher) quality housing than they would choose if they were not receiving subsidized homes from their employers.

This construction of household-level mismatch relies on the assumption that there are not unobservable differences in the preferences for housing between households who were living in state-owned housing and households living in private housing. While the assumption is strong, it may be plausible given that the decision to live in private housing may not be driven by housing preferences for the majority of households in private housing. Among households that are not employed in state-owned enterprises, the decision to be in private housing may be driven in large part by job preferences rather than housing preferences. Furthermore, many households that are employed in state-owned enterprises in 1993 live in private housing because they are

on a waiting list for state housing; these households are likely to have similar preferences for housing as those who are already in state homes. However, households that declined the option to live in state housing are likely to have different housing preferences than those living in state housing. The data do not allow me to determine which households declined the option for a state housing unit, so it is not clear if these households represent a sizable portion of the households living in private housing. The key advantage of the data is that they provide information about the same households before and after the reform. Thus, I develop an empirical test to evaluate the validity of the assumption that exploits the panel structure of the data.

Consider the case where the true equation for the value of housing consumption is

$$(13) \quad V_{ijt} = \alpha_0 + \alpha_1 \mathbf{X}_{ijt} + \tau_{jt} + \gamma_i + \epsilon_{ijt},$$

where  $\gamma_i$  captures household  $i$ 's unobserved, time-invariant preferences for housing. If  $\hat{V}_{ijt}$  is constructed with equation (12), then  $\Delta_{ijt} = \hat{V}_{ijt} - V_{ijt} = M_{ijt} + \gamma_i$  where  $M_{ijt}$  is the true cost of mismatch in the allocation of housing. If housing preferences ( $\gamma$ ) for residents in state-owned housing are different from those of residents of private housing, I may find  $\Delta_s \neq 0$  even if  $M_s = 0$  and estimation of equation (12) will yield biased estimates of mismatch. To test for this possibility, I calculate the postreform mismatch of households that were living in state-owned housing in 1993,  $\Delta'_s$ . The model predicts that the true mismatch in housing consumption for former residents of state-owned housing should go to zero ( $M'_s = 0$ ) as the distortions associated with state-subsidized housing are removed. Thus, a finding that  $\Delta'_s = 0$  would suggest that differences in preferences are not driving the calculation of  $\Delta_s$ . In other words, if postreform levels of mismatch are zero for those who were previously living in state-owned housing, then we have evidence that the housing tastes for the two groups are not different.

Column 1 of Table 2 presents the estimates of equation (12) with a sample that includes the prereform waves of data (1989, 1991, and 1993) and households that were living in private housing during that period. The sample in column 2 includes the postreform waves of data (1997, 2000, and 2004) and households that were already living in private housing in 1993. The coefficients on the logarithm of household income imply an income elasticity of demand for housing of 0.14 to 0.18. While this number is quite low relative to standard estimates of the income elasticity of housing consumption in the United States, it is in line with elasticities calculated for some other developing countries, including Egypt and Columbia (Stephen Malpezzi and Stephen K. Mayo 1987), and for low income residents in the United States (Julia L. Hansen, John P. Formby, and W. James Smith 1998).

The coefficient estimates in column 1 are used to calculate the prereform measure of  $\Delta_s$ , while the estimates in column 2 are used to calculate the postreform measure of  $\Delta'_s$ . The results indicate that housing consumption increases with income and wealth in both samples.

Table 3 shows the levels of housing mismatch before and after the reform. By construction, the average level of mismatch for households residing in private housing is zero. Before the reform, households in state-owned units occupied housing that was 15 percent less valuable than they would have chosen in the private housing market. The difference in housing mismatch is significant at the 1 percent level.

TABLE 2—ESTIMATION OF HOUSING CONSUMPTION AMONG HOUSEHOLDS IN PRIVATE HOUSING

	Prereform (1)	Postreform (2)
Log household income	0.142 [0.035]***	0.183 [0.051]***
Log assets	0.053 [0.011]***	0.138 [0.028]***
Age of head	0.081 [0.059]	-0.032 [0.105]
Age of head <sup>2</sup>	-0.001 [0.001]	0.001 [0.002]
Age of head <sup>3</sup>	0.000 [0.000]	-0.000 [0.000]
Education of head	0.003 [0.007]	-0.018 [0.010]
Observations	1,212	535
Adjusted $R^2$	0.17	0.35

*Notes:* The dependent variable is the logarithm of the market rental value of the household's home. Regressions also include province-year indicators and a constant term. Standard errors clustered by household in brackets.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

TABLE 3—AVERAGE COSTS OF MISMATCH ( $\Delta$ )

	Prereform	Postreform
State-housing residents	0.150** [0.854]	-0.003 [0.713]
Private-housing residents	0.000 [0.776]	0.000 [0.694]

*Notes:* Standard deviations in brackets, and \*\* denotes that the within-column difference with private housing residents is significant at the 1 percent level.

The postreform results in column 2 provide support for the assumption that households in state-owned housing in 1993 do not have different preferences for housing than households in private housing in 1993. The estimate of  $\Delta'_s$  is quite small in magnitude and not statistically different from zero. Furthermore, the estimate of  $\Delta'_s$  indicates that the level of housing mismatch for former residents of state-owned housing is 0.3 percent *lower* than for households residing in private housing before the reform. This suggests that any bias in the prereform estimate of mismatch in state-owned housing from time-invariant preferences is not only quite low but actually downward.

### C. Empirical Results

*Misallocation and Household Residential Mobility.*—According to the theoretical framework, by allowing prereform residents of state-owned housing to adjust to their optimal bundle of housing consumption, the reform should increase residential mobility following the privatization among households in public housing units. More specifically, the probability of a household changing residences should be

TABLE 4—PROBIT ESTIMATES OF MOVING OR ATTRITING

	Prereform (1)	Postreform (2)
$ \Delta_i $	0.030 [0.018]	0.092 [0.024]***
Age of head	-0.007 [0.005]	-0.021 [0.007]***
Age of head <sup>2</sup>	0.000 [0.000]	0.000 [0.000]***
Education of head	-0.003 [0.003]	0.011 [0.003]***
Year 1991	0.020 [0.016]	
Year 2000		-0.046 [0.028]
Year 2004		-0.086 [0.027]***
Observations	1,080	831

Notes: Average marginal effects shown. Bootstrapped standard errors clustered by household in brackets. Regressions also include province fixed effects. The sample in column 1 is limited to households in state-owned housing in the previous period. The sample in column 2 is limited to households in state-owned housing in 1993.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

increasing in the amount of its absolute level of prereform mismatch. I estimate the effect of  $\Delta_i$  on the propensity to move in the following probit regression:

$$(14) \quad Pr(m_{it} = 1) = g(|\Delta_i| + \beta_2 \mathbf{X}_{it} + \tau_t + \epsilon_{it}),$$

where  $m_{it}$  is a dummy variable for whether household  $i$  either moved residences or attrited from the survey in period  $t$ ,  $\mathbf{X}_{it}$  is a vector of control variables,  $\tau_t$  are year indicators, and  $\epsilon_{it}$  is the error term.<sup>11</sup> The appropriate measure is the absolute value of mismatch,  $|\Delta_i|$ , because households that were assigned too much housing should want to move to a lower quality home and have higher levels of nonhousing consumption, and households who received too little housing from their state employers will also be likely to move to consume homes with greater levels of housing services. The estimate of  $\beta_1$  should be positive in the postreform period for households living in state subsidized housing prior to the reform. As a robustness check, I also examine the impact of  $|\Delta_i|$  on the propensity to move or attrite in the prereform periods over a sample of households in state-owned housing.

The results corresponding to equation (14) are displayed in Table 4.<sup>12</sup> The estimates in column 2 suggest that households with higher absolute values of prereform

<sup>11</sup> Because attrition from the survey is mostly due to residential mobility, it is included in the dependent variable. Attrition of households in the sample of analysis averaged 6 percent in the waves prior to the reform and jumped to 14 percent following the reform. The rate of attrition between 1993 and 1997 was approximately 5 percent higher among households that had been living in state-owned housing in 1993.

<sup>12</sup> Because  $\Delta_i$  is a generated regressor, it is necessary to adjust the standard errors to account for sampling variation in the estimation of  $\Delta_i$  (Adrian Pagan 1984). To address this issue in the equations that include an estimated



mismatch are more likely to either move or attrite. A doubling of the absolute value of prereform mismatch corresponds with an average increase in the probability of residential mobility or attrition of 9.2 percent. While statistically significant, the magnitude of the impact is fairly small. This may be explained by large transactions costs to moving. Another explanation, which is consistent with the large effects on housing consumption and prices presented in the next section of the paper, is that households in formerly state-owned units chose to invest in renovations to their existing homes. This can explain sizable increases in housing consumption and in prices without substantial changes in residential mobility.

The magnitude of the corresponding estimate in the prereform period is 3 percent, and it is not statistically significant at the 10 percent level. The small and insignificant effect in the prereform waves provides additional support for the validity of the test because the mobility of households in state-owned housing was discouraged by the flow rental subsidy that households received.

*Misallocation and Household-Level Consumption.*—In addition to increasing residential mobility, higher prereform household levels of mismatch should also correspond with increases in the amount of housing services that a household consumes. To examine this prediction, I estimate the following equation over a sample of households that were living in state-owned housing in 1993:

$$(15) \quad F_{it} = \alpha_0 + \alpha_1 Post_t \times \Delta_i + \alpha_2 Post_t + \alpha_3 \Delta_i + \alpha_4 \mathbf{X}_{it} + \epsilon_{it},$$

where  $F_{it}$  is a measure of the quantity of housing services of household  $i$ 's residence in year  $t$ . These measures are the logarithm of the floor space (in meters squared) and indicators for a flushing toilet in the housing unit, drinking water available in the home, electricity, and lack of excreta around the dwelling.  $Post_t$  is a dummy that equals one in the waves following the reform. The vector  $\mathbf{X}_{it}$  includes household characteristics that may shift demand for housing services, including the logarithm of household income, the logarithm of total assets, a cubic in the age of the head, the education of the head, and province-year indicators. The inclusion of  $\mathbf{X}_{it}$  controls for changes in demand for size and quality driven by other changes, such as increases in household income or changes in the local prices of these housing amenities.

This specification includes  $\Delta_i$  rather than the absolute value of  $\Delta_i$  used in the previous regressions. In this specification, the coefficient of  $\alpha_1$  captures the impact of the prereform level of mismatch on that household's increase in housing consumption after the reform.<sup>13</sup> We expect the coefficient estimate of the interaction term,  $\alpha_1$ , to be positive. This would imply that households with negative values of mismatch should be moving to homes with lower levels of housing services, and households with greater positive values of mismatch should consume higher levels of household services after the reform.

---

measure of mismatch as a regressor, I present bootstrapped standard errors with 200 repetitions. See Peter Kennedy (1992) for more discussion of bootstrapping in the context of generated regressors.

<sup>13</sup>The coefficient on the interaction of  $\Delta_i$  and  $Post_t$  captures the differences in the impact of  $\Delta_i$  on  $F_{it}$  before and after the reform. For more information on the difference-in-differences estimator, see Jeffrey M. Wooldridge (2002).

I also allow the time effect to have a more flexible form by estimating the following equation over a sample of households that were living in state-owned housing in 1993:

$$(16) \quad F_{it} = \alpha_0 + \sum_{t \geq 1991} \beta_t \times \Delta_i + \beta_{1989} \Delta_i + \alpha_4 \mathbf{X}_{it} + \epsilon_{it}.$$

Relative to equation (15), the flexible specification allows us to examine time variation in the impact of a household's prereform level of mismatch.

Table 5 presents the estimates that correspond with equations (15) in panel A and (16) in panel B. In column 1, the estimate of  $\alpha_1$  corresponding to equation (15) is positive and significant at the 1 percent level. A doubling of a household's prereform mismatch led to a 21 percent increase in the amount of housing occupied by a household after the reform as compared with before the reform. The results suggest that there was a positive relationship between the prereform value of a household's mismatch and the postreform change in the quantity of housing consumed among households that had been living in state-owned housing.

The estimates of the flexible equation displayed in panel B are similar to the estimates of equation (15). The relevant categories that are omitted from the regression are the interaction  $year1989 \times \Delta_i$  and an indicator for 1989. The coefficient estimates of  $year1991 \times \Delta_i$  and  $year1993 \times \Delta_i$  are not statistically different from  $year1989 \times \Delta_i$ . The magnitude and the significance of the coefficients of the interaction terms shift immediately after the privatization of housing. The interaction of  $\Delta_i$  with each of the three waves following the reform are significant and suggest an impact that is similar in magnitude to the estimates in panel A.

The regressions on housing quality presented in Table 5 tell a similar story. In the parsimonious specifications, a doubling of the prereform level of mismatch corresponds with a 14 percent increase in the postreform probability of upgrading to a flushing toilet and with a 6 percent increase in the postreform probability of adding access to drinking water at the residence. These results are significant at the 5 percent level. The corresponding estimates of the flexible specifications generally display the same pattern of shifting immediately following the reform in both magnitude and significance. The exception is on the coefficient on  $year1993 \times \Delta_i$  in column 2, which is statistically different from  $year1989 \times \Delta_i$  at the 5 percent level. However, *F*-tests demonstrate that the coefficients on  $year1997 \times \Delta_i$ ,  $year2000 \times \Delta_i$ , and  $year2004 \times \Delta_i$  are statistically larger than the coefficient on  $year1993 \times \Delta_i$  at the 5 percent level. The results for the removal of excreta around the dwelling suggest that a doubling of prereform mismatch reduced the probability that the household still had excreta around the home after the reform by 5 percent. The results indicate that prereform mismatch had no effect on postreform changes in the electrification of homes. This is not surprising given that electricity was already available in 99 percent of urban homes in 1993 (Table 1).

The estimates in Tables 4 and 5 provide support for the prediction of the model that the postreform shifts in demand for housing were driven by the prereform levels of housing misallocation of state-owned units. The results in Table 5 suggest that households living in state-owned units prior to the reform were residing in houses that were larger and higher quality following the reform. This was driven in part by

TABLE 5—IMPACT OF HOUSEHOLD-LEVEL MISMATCH  
ON HOUSING SIZE AND QUALITY

	Log floor space (1)	Flushing toilet (2)	Drinking water (3)	Electricity (4)	No excreta (5)
<i>Panel A. Parsimonious specification</i>					
Post $\times \Delta_i$	0.21 [0.05]***	0.14 [0.03]***	0.06 [0.02]**	-0.00 [0.00]	0.05 [0.02]***
Post	0.43 [0.13]***	0.13 [0.05]**	-0.02 [0.02]	-0.00 [0.00]	0.16 [0.04]***
$\Delta_i$	-0.19 [0.03]***	-0.20 [0.03]***	-0.07 [0.02]***	0.00 [0.00]	-0.03 [0.02]**
Year 1991	-0.09 [0.07]	-0.10 [0.03]***	-0.03 [0.02]	0.00 [0.00]	0.03 [0.03]
Year 1993	-0.11 [0.07]	0.00 [0.05]	-0.03 [0.02]*	0.00 [0.00]	0.09 [0.04]**
Year 1997	-0.55 [0.35]	0.19 [0.13]	0.27 [0.10]***	0.00 [0.00]	0.16 [0.10]
Year 2000	-0.06 [0.12]	0.00 [0.00]	0.00 [0.00]	0.00 [0.00]	-0.00 [0.01]
Year 2004	0.00 [0.13]	-0.03 [0.04]	0.00 [0.01]	0.00 [0.00]	0.00 [0.00]
Observations	1,867	1,919	1,918	1,914	1,903
Adjusted $R^2$	0.25	0.34	0.35	0.02	0.05
<i>Panel B. Flexible specification</i>					
$\Delta_i \times 1991$	0.05 [0.04]	-0.03 [0.03]	0.05 [0.04]	0.00 [0.00]	0.01 [0.03]
$\Delta_i \times 1993$	0.10 [0.06]	0.09 [0.04]**	0.03 [0.03]	0.00 [0.00]	-0.01 [0.03]
$\Delta_i \times 1997$	0.26 [0.06]***	0.15 [0.04]***	0.07 [0.04]*	0.00 [0.00]	0.06 [0.03]**
$\Delta_i \times 2000$	0.20 [0.07]***	0.18 [0.05]***	0.12 [0.04]***	0.00 [0.00]	0.03 [0.02]
$\Delta_i \times 2004$	0.33 [0.07]***	0.14 [0.05]***	0.05 [0.04]	-0.00 [0.01]	0.05 [0.02]**
$\Delta_i$	-0.23 [0.04]***	-0.21 [0.04]***	-0.10 [0.03]***	0.00 [0.00]	-0.03 [0.02]
Year 1991	-0.07 [0.08]	-0.12 [0.04]***	-0.01 [0.03]	0.00 [0.00]	0.03 [0.03]
Year 1993	-0.07 [0.08]	0.04 [0.05]	-0.03 [0.02]	0.00 [0.00]	0.08 [0.04]*
Year 1997	-0.17 [0.34]	0.31 [0.12]**	0.24 [0.09]**	-0.00 [0.00]	0.32 [0.092]***
Year 2000	0.37 [0.12]***	0.14 [0.05]**	-0.00 [0.02]	0.00 [0.00]	0.15 [0.04]***
Year 2004	0.46 [0.12]***	0.10 [0.07]	-0.02 [0.02]	-0.00 [0.00]	0.16 [0.04]***
Observations	1,867	1,919	1,918	1,914	1,903
Adjusted $R^2$	0.26	0.34	0.35	0.02	0.05

Notes: Bootstrapped standard errors clustered by household in brackets. Regressions also include log household income, log assets, a cubic in the head's age, the head's education, province-year indicators, and a constant term. The sample is limited to households that were living in state-owned housing in 1993.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

improvements to their existing homes and in part by residential mobility towards housing units that were more aligned with the preferences of households.

*Province-Level Mismatch and Market Housing Prices.*—The previous two sections presented evidence in support of the demand-side implications of the model. This section examines the equilibrium implications on prices. According to the theoretical framework, the positive estimates of mismatch in the state sector in Table 3 indicate that the equilibrium price of a unit of housing services should increase following the sale of state-owned housing units. Given the lack of province or city level data on housing prices that extend prior to the housing reform in China, I test this prediction of the model with the CHNS data. I estimate the following regression:

$$(17) \quad R_{ijt} = \alpha_0 + \alpha_1 Post_t \times \Delta_j + \alpha_2 Q_{it} + \tau_t + \gamma_i + \epsilon_{ijt},$$

where  $R_{ijt}$  is the measure of the value per square meter of the residence of household  $i$  in province  $j$  and year  $t$ . I allow the regression disturbance terms to be correlated across years for the same province. This regression differs from equation (15) in three key ways. First,  $\Delta_j$  is the average level of prereform mismatch over all households in province  $j$  rather than the household level of prereform mismatch.<sup>14</sup> Postreform changes in local housing prices are driven by the average amount of prereform mismatch in the local area.

Second, the dependent variable is the logarithm of the market value of housing per square meter rather than a measure of the quantity of housing services. The dependent variable in equation (17) contains both price and quantity. To isolate the impact of mismatch on the change in housing prices after the reform, the inclusion of household fixed effects,  $\gamma_i$ , removes the impact of any time invariant quality characteristics of each household's residence. Furthermore, the specification controls for changes in housing quality,  $Q_{it}$ , including the presence of a flushing toilet, access to drinking water, the age of the home, dummy variables for water source (plant, ground water, well, spring, and other), electricity, and the amount of excreta around the home. Because the coefficient estimates of  $\alpha_2$  are time-invariant, they do not reflect price changes in particular housing attributes; they only capture changes in the quantity of housing services, while the remaining variation in  $R_{ijt}$  is prices.

Third, I run this regression over a sample of households that were living in private housing in 1993, whereas equation (15) was estimated over a sample of households residing in state-owned housing in 1993. These three distinctions allow me to isolate the impact of misallocation in state housing on postreform changes in equilibrium price levels rather than the impact on the quantities consumed by former residents of subsidized employer-provided housing. The model predicts that  $\alpha_1$  will be positive. Households living in areas with greater average levels of mismatch prior to the reform should experience higher appreciation in housing prices. I also allow for a flexible specification of the time-varying effects of province-level mismatch.

One concern with the specification in equation (17) is that the coefficient on  $\alpha_1$  may reflect differences across provinces that are correlated with the prereform level

<sup>14</sup>  $\Delta_j$  in the empirical results correspond to  $\Delta$  in the theoretical framework.

TABLE 6—IMPACT OF PROVINCE-LEVEL MISMATCH ON THE MARKET PRICE OF HOUSING

	(1)	(2)	(3)	(4)
Post $\times \Delta_j$	0.551 [0.265]**		0.500 [0.208]**	
Year 1991 $\times \Delta_j$		0.125 [0.200]		0.000 [0.000]
Year 1993 $\times \Delta_j$		0.108 [0.493]		0.017 [0.283]
Year 1997 $\times \Delta_j$		0.509 [0.471]		0.187 [1.166]
Year 2000 $\times \Delta_j$		0.658 [0.211]***		0.464 [1.120]
Year 2004 $\times \Delta_j$		0.755 [0.312]*		0.469 [0.463]
Year 1991	0.420 [0.104]***	0.373 [0.085]***	0.421 [0.115]***	2.409 [4.050]
Year 1993	-0.411 [0.246]	-0.458 [0.229]**	-0.432 [0.234]*	-4.946 [14.124]
Year 1997	-0.633 [0.128]***	-0.609 [0.262]**	2.307 [9.067]	4.89 [10.899]
Year 2000	-0.692 [0.152]***	-0.743 [0.160]***	2.254 [9.207]	2.358 [6.911]
Year 2004	-1.193 [0.149]***	-1.275 [0.181]***	1.739 [9.264]	-1.569 [10.266]
Post $\times \log GDP_j$			0.365 [1.275]	
Post $\times \log Population_j$			-0.639 [1.825]	
I(year) $\times \log GDP_j$	No	No	No	Yes
I(year) $\times \log Population_j$	No	No	No	Yes
Observations	2,130	2,130	2,130	2,130
Adjusted $R^2$	0.44	0.44	0.44	0.45

Notes: The dependent variable is the logarithm of the market value of the home divided by the floor space. Bootstrapped standard errors clustered by province in brackets. Regressions also include the age of home, the source of water, indicator variables for whether the home had running water, a flushing toilet, electricity, excreta around the property, household fixed effects, and a constant term. The sample is limited to households living in private housing in 1993. The fourth column includes the interactions between an indicator for years 1991, 1993, 1997, 2000, 2004, and the logarithm of province-level GDP as well as the logarithm of province-level population.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

of mismatch in an area. For example, high rates of population growth in a province may increase housing mismatch if state employers do not respond at all or respond slowly to changes in the household composition of its employees. High rates of population growth may also increase the demand for private housing. To address this issue, I include other prereform characteristics of provinces into the regression. Specifically, I include interactions between time and the logarithm of the province's GDP in 1993 as well as the interaction between time and the logarithm of the population in the province in 1993.

Table 6 displays the impact of the prereform, province-level mismatch of state housing on changes in the per square meter value of housing. The first column corresponds to equation (17), and the second to the flexible specification. The results confirm the model's prediction that the postprivatization appreciation in housing

prices increased in areas with greater mismatch of housing among state employees prior to the reform. A doubling of a province's prereform mismatch increased the postreform level of housing prices per square meter by approximately 55 percent. Two of the estimates of the interaction between the year indicators and province-level mismatch in column 2 are significant at the 10 percent level or higher. Furthermore, there is a substantial jump in the magnitude of the coefficients starting in 1997. The large coefficients on the interaction terms persist until 2004. The coefficients on the interaction of province-level mismatch with 1991 and with 1993 suggest that province-level mismatch did not have any significant impact on prices of private housing prior to the reform. The last two columns in Table 6 correspond with the first two columns but control for time-varying effects of other province-level characteristics. The inclusion of these additional variables does not substantially alter the magnitude of the results and suggests that the regional variation in the mismatch of state employees to housing was a driver of regional differences in price changes.

#### IV. Welfare Effects

I calculate the welfare costs associated with the prereform system of state allocated housing to employees of state-owned enterprises. I measure the additional utility that households in state-owned housing would have experienced if they had received the market rental value of their subsidized apartments as wages and were able to choose how to divide their income between housing and nonhousing consumption.

Estimation of the efficiency loss of housing misallocation requires information on households' utilities. Household preferences are represented by the following Cobb-Douglas utility function:

$$(18) \quad \max_{c,h} (c + \beta x + \epsilon)^\alpha h^{1-\alpha}$$

such that  $y = c + p_h h$ ,

where  $c$  is consumption of nonhousing goods,  $h$  is housing consumption,  $y$  is household income,  $p_h$  is the normalized price of housing, and  $\epsilon \sim N(0, \sigma^2)$ . There is a vector  $x$  of observable characteristics of the households that affect their preferences for the goods.

Maximizing the utility function subject to the budget constraint yields the following equation:

$$(19) \quad p_h h^* = (1 - \alpha)y^* + \beta(1 - \alpha)x + \epsilon(1 - \alpha).$$

Using equation (19), I estimate the parameters of the model over a group of households that were living in private housing over all waves of the CHNS. The dependent variable is the household's self-reported monthly rental value of its residence. As in the estimation of quantity mismatch, the assumption for welfare calculation is that, conditional on observable characteristics,  $x$ , the utility that households get from housing and nonhousing consumption is the same for prereform state housing residents and private housing residents. The results are presented in Table 7. The

TABLE 7—ESTIMATION OF THE MONTHLY MARKET RENTAL VALUE OF HOUSING

Monthly household income	0.054 [0.009]***
Total assets	0.001 [0.000]***
Age of head	0.889 [3.037]
Age of head <sup>2</sup>	0.023 [0.057]
Age of head <sup>3</sup>	-0.000 [0.000]
Education of head	0.505 [0.463]
Observations	4,507
Adjusted $R^2$	0.12

*Notes:* Robust standard deviations in brackets clustered at the household level. The regression also includes province-year fixed effects and a constant term. The sample is limited to households living in private housing.

\*\*\*Significant at the 1 percent level.

TABLE 8—AVERAGE WELFARE OF HOUSEHOLDS

	Observed		Counterfactual
	Prereform	Postreform	
State housing	193.1	290.0	241.5
Private housing	214.4	273.7	
All residents	204.0	281.2	

relationship between household income and the rental value of housing is significant at the 1 percent level and implies an estimate of  $\alpha$  equal to 0.946.

In order to calculate welfare gains, I need a measure of the quantity of housing services,  $h$ , that is separated from prices. I estimate province-year prices using the exponent of the coefficient estimates on province-year indicators from equation (12). I divide the market rental value of housing by this price measure to isolate the quantity of housing services of each household.

Combining the quantity of housing service with household level data on income and characteristics and the parameter estimates of  $\alpha$  and  $\beta$ , I calculate the average welfare of households in state-owned housing and in private housing. As shown in Table 8, the average prereform welfare of households living in homes that were allocated by their state work units was 193. The average prereform welfare of households living in private housing was 214. The average welfare of urban households in China increased approximately 40 percent in years 1997–2004 over the prereform period of 1989–1993 (column 2). However, this is not surprising given that real wages were increasing substantially over this period.

I implement the counterfactual to estimate the welfare implications of misallocation of housing. I calculate the increase in welfare that would result if the state sector had paid the value of the rent subsidies as wages, and households were able to choose their optimal amount of housing and nonhousing consumption. This thought experiment assumes no changes in prereform prices and no tax implications of transferring the in-kind housing benefit into income. This results in a 25 percent increase in the average utility of prereform residents of state-owned housing (column 3) at no additional cost to the state.

The results suggest that the misallocation of housing by the state sector had substantial effects on the welfare of state sector employees living in subsidized housing. These equilibrium estimates for the welfare gains of removing the system of state allocated housing are lower bounds for several reasons. First, these estimates do not take into account the labor misallocation associated with the prereform system (Wang 2008). Second, the framework does not take into account other possible distortions in behavior, such as the investment of time and resources into improving political connections. We may also think that these are overestimates because housing is also a financial asset, but this framework treats housing solely as a consumption good where the capital gains associated with increases in housing prices are not taken into account.

## V. Conclusion

This paper provides a framework for understanding how the distortions associated with the system of state employer-provided housing affect housing prices in equilibrium. The theoretical framework describes a direct linkage between misallocation in the distribution of housing to state employees and the impact of privatization on equilibrium housing prices. I found that on average households in state-owned housing prior to the reform were occupying housing that was worth approximately 15 percent less than the kind of housing that they would have chosen to consume in the private market. This misallocation implied a greater shift out in the demand for housing than in the supply as these households entered the private housing market. Households living in state-owned housing that was very different from their preferences changed residences and increased consumption of housing to get to their optimal levels. The net effect was a rise in the equilibrium price of housing of 7.5 percent. The system of state allocation of housing reduced the welfare of state-owned residents by 25 percent relative to a system in which housing benefits were paid as additional wages and households were able to choose their optimal consumption of housing.

This paper presents one unintended effect of the privatization of state-owned housing. Data from the United Nations Human Settlement Indicators (2001) suggest that residents in state-owned housing, which includes welfare housing and employer-provided housing, represent 18 percent of households in Africa, 15 percent in Asia, 8 percent in Latin America, and 2 percent in the United States. Many countries continue to provide housing to particular segments of the population, and this paper demonstrates that the economic consequences of privatizing state property can be substantial. While, in the case of China, the housing reform increased equilibrium housing prices, the model demonstrated that the effect is ambiguous and depends on the prereform misallocation of housing. This analysis can also shed some light on other types of state involvement in the housing market. The framework can be adapted to apply to the general equilibrium effects of welfare housing or rent control.

### APPENDIX: ASSESSING SELF-REPORTED VALUES OF HOUSING IN CHINA

There is a literature in the United States that evaluates the accuracy of households' reported values of their houses (Katherine A. Kiel and Jeffrey E. Zabel 1999; Philip



APPENDIX TABLE A.1—DETERMINANTS OF SELF-REPORTED MARKET RENTAL VALUE (*log*)

	Pooled sample (1)	Private housing (2)	State controlled (3)
Log floor space	0.374 [0.021]***	0.310 [0.023]***	0.265 [0.048]***
Age 2–4 years	–0.070 [0.062]	0.004 [0.060]	–0.298 [0.158]*
Age 5–9 years	–0.151 [0.064]**	–0.100 [0.062]	–0.303 [0.175]*
Age 10–19 years	–0.130 [0.066]**	–0.113 [0.062]*	–0.254 [0.188]
Age 20+ years	–0.126 [0.061]**	–0.062 [0.058]	–0.317 [0.193]
Electricity	0.265 [0.256]	0.352 [0.387]	0.084 [0.139]
No excreta around home	0.019 [0.036]	0.060 [0.040]	0.077 [0.087]
Running water	0.119 [0.034]***	0.089 [0.039]**	0.195 [0.068]***
Flushing toilet	0.459 [0.028]***	0.468 [0.035]***	0.512 [0.056]***
Water source: Well	–0.029 [0.082]	–0.022 [0.092]	–0.058 [0.195]
Water source: Spring	0.366 [0.092]***	0.497 [0.100]***	0.023 [0.202]
Water source: Plant	0.198 [0.031]***	0.244 [0.036]***	0.197 [0.059]***
Water source: Other	–0.386 [0.198]*	–0.363 [0.299]	–0.574 [0.165]***
$R^2$	0.26	0.24	0.30
Observations	5,423	3,987	1,429

Notes: Robust standard errors clustered by household in brackets. The regressions also include year and province indicators and a constant term. The omitted category for water source is groundwater.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

K. Robins and Richard W. West 1977). Unfortunately, to my knowledge, no comparable literature exists in China. In the absence of external measures of housing values in the dataset, I use a hedonic approach to assess whether households' self-reported market rental values are reasonable. I regress the logarithm of the market rental values that households report on characteristics of the home. In column 1 of Appendix Table A.1, the results demonstrate that households' reported values are increasing in measures of the size and quality of their homes. A doubling of floor space corresponds with a 37 percent increase in the value of the home. Having running water in the home increases the home's value by 12 percent. Older homes were worth less than newer homes.

Another potential concern is that households in private housing know the market value of the property, but households in state subsidized homes do not. I estimate the same regression separately for households living in private housing and households living in state-owned housing. These results are presented in columns 2 and 3. There is no statistical difference between the coefficients on the characteristics

in the two samples with the exception of the returns on the value of a spring as the home's source of water. However, less than 3 percent of households report a water source from a spring. These results suggest that households in state housing gave the same value to housing characteristics as households in private housing. Overall, the results of Appendix Table A.1 provide assurance that households in the CHNS dataset gave reasonable estimates of the market values of their homes.

## REFERENCES

- Arnott, Richard.** 1995. "Time for Revisionism on Rent Control?" *Journal of Economic Perspectives*, 9(1): 99–120.
- Bardhan, Ashok, Rajarshi Datta, Robert H. Edelstein, and Lum Kim.** 2003. "A Tale of Two Sectors: Upward Mobility and the Private Housing Market in Singapore." *Journal of Housing Economics*, 12(2): 83–105.
- Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention.** 1989–2004. "China Health and Nutrition Survey: Household and Individual-Level Dataset." <http://www.cpc.unc.edu/projects/china> (accessed 2006).
- Davis, Deborah S.** 1993. "Urban Households: Applicants to a Socialist State." In *Chinese Families in the Post-Mao Era* Davis, ed. Deborah Davis and Stevan Harrell, 50–76. Los Angeles: University of California Press.
- Fallis, George, and Lawrence B. Smith.** 1984. "Uncontrolled Prices in a Controlled Market: The Case of Rent Controls." *American Economic Review*, 74(1): 193–200.
- Feder, Gershon, Lawrence J. Lau, Justin Y. Lin, and Xiaopeng Luo.** 1992. "The Determinants of Farm Investment and Residential Construction in Post-Reform China." *Economic Development and Cultural Change*, 41(1): 1–26.
- Glaeser, Edward L., and Erzo F. P. Luttmer.** 2003. "The Misallocation of Housing under Rent Control." *American Economic Review*, 93(4): 1027–46.
- Gould, J. R., and S. G. B. Henry.** 1967. "The Effects of Price Control on a Related Market." *Economica*, 34(133): 42–49.
- Gyourko, Joseph, and Peter Linneman.** 1989. "Equity and Efficiency Aspects of Rent Control: An Empirical Study of New York City." *Journal of Urban Economics*, 26(1): 54–74.
- Hansen, Julia L., John P. Formby, and W. James Smith.** 1998. "Estimating the Income Elasticity of Demand for Housing: A Comparison of Traditional and Lorenz-Concentration Curve Methodologies." *Journal of Housing Economics*, 7(4): 328–42.
- Ho, Lok Sang, and Gary Wai-Chung Wong.** 2006. "Privatization of Public Housing: Did It Cause the 1998 Recession in Hong Kong?" *Contemporary Economic Policy*, 24(2): 262–73.
- Ho, Samuel P. S., and George C. S. Lin.** 2003. "Emerging Land Markets in Rural and Urban China: Policies and Practices." *China Quarterly*, 175: 681–707.
- Hughes, Gordon A., and Barry McCormick.** 1987. "Housing Markets, Unemployment and Labour Market Flexibility in the UK." *European Economic Review*, 31(3): 615–41.
- Kennedy, Peter.** 1992. *A Guide to Econometrics*. Sixth ed. Hoboken, NJ: Wiley.
- Kiel, Katherine A., and Jeffrey E. Zabel.** 1999. "The Accuracy of Owner-Provided House Values: The 1978–1991 American Housing Survey." *Real Estate Economics*, 27(2): 263–98.
- Li, Jianjin.** 2005. *Zhongguo dixia jinrong guimo yu hongguan jingji yingxiang wanjiu [Research on the scale of underground financing and its economic effects]*. Beijing: Zhongguo jingrong chubanshu.
- Malpezzi, Stephen, and Stephen K. Mayo.** 1987. "The Demand for Housing in Developing Countries: Empirical Estimates from Household Data." *Economic Development and Cultural Change*, 35(4): 687–721.
- Moon, Choon-Geol, and Janet G. Stotsky.** 1993. "The Effect of Rent Control on Housing Quality Change: A Longitudinal Analysis." *Journal of Political Economy*, 101(6): 1114–48.
- Moorhouse, John C.** 1972. "Optimal Housing Maintenance under Rent Control." *Southern Economic Journal*, 39(1): 93–106.
- Muth, Richard F.** 1960. "The Demand for Non-Farm Housing." In *The Demand for Durable Goods*, ed. Arnold C. Harberger, 29–96. Chicago: University of Chicago Press.
- Olsen, Edgar O.** 1969. "A Competitive Theory of the Housing Market." *American Economic Review*, 59(4): 612–22.

- Olsen, Edgar O.** 1972. "An Econometric Analysis of Rent Control." *Journal of Political Economy*, 80(6): 1081–1100.
- Ortalo-Magne, Francois, and Sven Rady.** 2006. "Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints." *Review of Economic Studies*, 73(2): 459–85.
- Pagan, Adrian.** 1984. "Econometric Issues in the Analysis of Regressions with Generated Regressors." *International Economic Review*, 25(1): 221–47.
- Robins, Philip K., and Richard W. West.** 1977. "Measurement Errors in the Estimation of Home Value." *Journal of the American Statistical Association*, 72(358): 290–94.
- Sing, Tien-Foo, I. Chun Tsai, and Ming-Chi Chen.** 2006. "Price Dynamics in Public and Private Housing Markets in Singapore." *Journal of Housing Economics*, 15(4): 305–20.
- Stein, Jeremy C.** 1995. "Prices and Trading Volume in the Housing Market: A Model with Down-Payment Effects." *Quarterly Journal of Economics*, 110(2): 379–406.
- Svarer, Michael, Michael Rosholm, and Jakob Roland Munch.** 2005. "Rent Control and Unemployment Duration." *Journal of Public Economics*, 89(11–12): 2165–81.
- Wang, Shing-Yi B.** Forthcoming. "Credit Constraints, Job Mobility and Entrepreneurship: Evidence from a Property Reform in China." *Review of Economics and Statistics*.
- Wang, Shing-Yi B.** 2011. "State Misallocation and Housing Prices: Theory and Evidence from China: Dataset." *American Economic Review*. <http://www.aeaweb.org/articles.php?doi=10.1257/aer.101.5.2081>.
- Wang, Ya-ping, and Alan Murie.** 1999. *Housing Policy and Practice in China*. New York: St. Martin's Press.
- Wooldridge, Jeffrey M.** 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.
- Zhou, Min, and John R. Logan.** 1996. "Market Transition and the Commodification of Housing in Urban China." *International Journal of Urban and Regional Research*, 20(3): 400–21.