Economic Effects of Upfront Subsidies to Ownership: the Case of the Prêt à Taux Zéro in France

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This paper analyses some effects of the French upfront subsidy to homeownership called *Prêt à Taux Zéro* (PTZ) introduced in 1996. The PTZ can be viewed as a downpayment subsidy to low and middle-income first-time buyers. The effects of the subsidy are modelled by simulating the introduction of the PTZ in an econometric model of mobility and tenure choice estimated on micro-data. Our results show that the PTZ significantly increases access to ownership by allowing some households to leave the rental sector sooner. However, the PTZ generates a large windfall effect. We estimate that 85% of the beneficiaries in a 4-year period would still have moved to own in the absence of the subsidy. As a consequence, the PTZ has a rather low multiplier effect, which we estimate at around 1.3. Our simulations also show that the PTZ may not help to improve the overall quality of new construction in France.

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1. Introduction

In many developed countries, homeownership is encouraged, either directly, for example in the form of subsidized loans that complement private market loans for some categories of households, or indirectly via provisions of the tax code which render ownership attractive versus rental (see Rosen, 1985 for a description of the U.S. case).

Other forms of State subsidies are aimed directly at improving housing affordability by contributing to the household's downpayment, thus loosening the borrowing constraints that prevent low and middle-income households from financing the purchase of a home on the credit market. This form of subsidy, also known as *upfront subsidy to ownership*, has been very popular in developing countries and in particular in South America, where Chile pioneered it in the 1970s.[4]

A subsidy called *Prêt à Taux Zéro* (PTZ henceforward), very similar in spirit to upfront subsidies to ownership used in South America, was introduced in France in December 1995. It consists in an interest-free loan of limited amount, granted only to first-time buyers. This loan is best viewed as a complement to loans obtained privately. In most cases, the PTZ amount can be repaid after all the other loans have been paid back, i.e. after 15 to 19 years. Because of this extended grace period, the PTZ, while technically a loan with an interest rate subsidy, is in practice considered by banks as a downpayment subsidy and does not affect the size of the loan (or mortgage).[5]

Even though the PTZ has been in place for eleven years, its effects on the mobility and tenure choices of French households and on housing markets in general have not yet been studied from an econometric perspective. This study intends to fill this gap and to provide a quantitative evaluation of some of the effects of the PTZ. We proceed in two steps. We first estimate a model of mobility and tenure choice with borrowing constraints on a sample dating from 1996, before the PTZ was implemented on a large scale. Then, we simulate the introduction of the PTZ in our sample in order to evaluate its impact on mobility, access to ownership, and the values of the dwellings bought by households.

[4]Since then, similar subsidies have been introduced in Colombia, Costa Rica, and other countries of the continent. For a review of the literature on the evaluation of these subsidies, see Gilbert (2004).

[5]A new version of the PTZ replaced the old one in 2004. This study focuses on the old version of the subsidy.

By loosening the borrowing constraints for first-time buyers, the introduction of the PTZ renders moving and owning more attractive with respect to the other options of the household, i.e. staying in its current dwelling and moving to rent. Thus, the introduction of the PTZ results in increased flows into ownership from renters who would have chosen one of the two other options in the absence of the subsidy. From our simulations, over a four-year period, 70% of the additional (or marginal) owners would have stayed in their current dwellings in the absence of the subsidy, while 30% would have moved within the rental sector. This confirms results obtained for the US by Zorn (1989).

Another outcome of interest is how well the PTZ is targeted. Our simulations indicate that 85% of PTZ beneficiaries would have moved and purchased a dwelling even in the absence of the subsidy, which signals an important windfall effect. As a consequence, the multiplier effect of the PTZ on housing investment, defined as the ratio between the extra investment in housing due to PTZ and its cost to the State, is low. We estimate it to be lower than 1.3.

A final question is the effect of the PTZ on the characteristics of the housing stock. While the change in the average value of dwellings bought by first-time buyers following the introduction of the subsidy is theoretically uncertain, we find empirically that the PTZ has led to a small decrease in this average purchase value.

The paper is organized as follows. Section 2 is devoted to a presentation of the salient features of the PTZ. Section 3 presents the data used for the analysis. In section 4, we expose the main features of the model and the econometric specification. The bulk of empirical results and the main insights from policy simulations are given in section 5. Section 6 concludes. The discussion of estimation and simulation issues is relegated to the appendix.

2. The PTZ: main characteristics

Homeownership has been an important policy concern for French governments since World War II. In 1977, the system of housing subsidies was reformed with the objective of reducing supply-side subsidies and introducing demand-oriented subsidies. Subsidies for first-time buyers were introduced in the form of subsidized loans called PAP (Prêt d'Accession à la Propriété) and PC

(Prêt Conventionné) provided by the State. Between 1977 and 1984, nearly 60% of home buyers who needed a mortgage benefited from one of these loans. During those years, the homeownership rate increased markedly, from 45% in 1970 to 54% in 1988. The success of the system could be attributed to the very low real interest rates of the PAP during this high inflation period. From 1984 onwards however, inflation fell from around 11% to 4% in 1987 and remained low afterwards. Meanwhile, the interest rates of the PAP and PC loans always remained above 7%. Thus, real interest rates increased sharply. This explains why the PAP system was used by only 15% of new mortgage owners at the beginning of the nineties. At the end of the eighties, default by homeowners who had gotten indebted at very high interest rates became quite common, and private lenders tightened access to housing credit (Lacroix, 1995). The ownership rate remained around 54% between 1988 and 1996. In a context where inflation stayed low at 1% or 2%, the new priority of the government was to loosen the borrowing constraints faced by low and middle-income households. From the end of 1995 onwards, a new system called Prêt à Taux Zéro (PTZ) gradually replaced the PAP. The PC and other demand subsidies remained unchanged after the reform.

The PTZ is a loan without interest that complements other loans obtained on the credit market. Only first-time buyers with low or medium income are eligible. At most one PTZ can be attributed to each household. The maximum value of the loan increases with family size and decreases with income, and also depends on the geographical area where the unit is located (Paris region or rest of France). The PTZ cannot exceed 20% of the dwelling value and 50% of the total amount of credit utilized to finance the purchase. Households located in the lowest income brackets can postpone the repayment of the loan until l5 to 19 years after the purchase date, after all other loans have been paid off. Finally, the PTZ mainly targets households who want to purchase a new dwelling.[6] During the period under study here, households buying used units could benefit from the PTZ, but only if they undertook repairs or upgrades worth at least 66% of the purchase value (excluding renovations). In practice, this threshold is very high and hardly any household used the PTZ to purchase old units.

Nearly 120,000 households benefited from the PTZ each year between 1996 and 1999 (Thomas

[6] Indeed, French housing policies are usually designed not only to help people to access ownership but also to support new construction.

and Grillon, 2001). This represents 35% of home purchases during the period. The average value of PTZ loans was nearly 15,000 euros. From 1999 onwards, the yearly number of households benefiting from PTZ varied between 100,000 and 110,000.

Unlike similar housing policies in other countries, the PTZ is not targeted at the poorest households. First, it applies to households able to access credit on the mortgage market. As in almost every country, these households are richer than many renters. Second, the criteria of access to the PTZ are not limited to low-income households, but rather reach middle and higher-middle income families. In 1998, according to the income survey *Revenus Fiscaux* run by INSEE, the income criteria made 94% of renters living outside the Paris region eligible to the PTZ. This lack of targeting does not stand as an exception in France, where many housing policies share the same feature.[7]

The cost of PTZ to the State corresponds to an actuarial subsidy paid to banks to compensate them for foregone interest on the PTZ amount. This cost lies between 800 and 900 million euros depending on years (Assemblée nationale, 2003). This represents between 7,000 and 8,000 euros per beneficiary, i.e. nearly half of the average amount of PTZ loan received by the households. For comparison, the average cost of housing subsidies to renters in the private sector (AL) is nearly 1,000 euros a year per beneficiary.

To conclude this section, we briefly sketch some of the economic effects of the PTZ that stem directly from its characteristics (a more formal exposition is given below in section 4). Consider that the main goal of residential mobility is to adjust housing consumption to changes in income, family events (e.g. separation, marriage, birth), as well as accumulation of wealth over time. For renters, the housing stock can generally be adjusted only through a move, but moving is costly so that adjustments of housing consumption occur infrequently. When a household moves, it can choose between renting and buying a new dwelling. For households wealthy enough not to be constrained on the credit market, this choice is based on the comparison of the rent and the user cost of ownership (Henderson and Ioannides, 1983). However, borrowing constraints can make the ownership option less attractive because only a suboptimal housing stock can be purchased. In such a case, staying in the current dwelling or moving-and-renting can constitute better

[7] For example, nearly 60% of households had access to PAP in the nineties. Similarly, the eligibility criteria for access to public rental housing apply to between 55% and 60% of households.

alternatives. Thus, borrowing constraints affect not only the choice between renting and owning, but also mobility itself.

The PTZ acts as a subsidy to downpayment and loosens the borrowing constraints associated with ownership. Hence, the PTZ renders the two alternatives, i.e. staying in one's current dwelling and moving-and-renting, less attractive. Measuring the importance of these shifts, in relation to the cost of the PTZ, will be the main focus of this article. The PTZ also clearly has dynamic effects, as it can modify the timing of residential transitions as well as their nature. As a consequence, one has to distinguish short-run effects from long-run effects occurring over the whole life-cycle.[8] This paper is concerned only with short-run effects. More specifically, we examine the effects of the PTZ on residential transitions over a four-year period.

3. The data

At this point, it is necessary to briefly discuss the structure of the data at our disposal. A correct evaluation of the effect of PTZ in the short-run and in the long-run would require longitudinal data including information on mobility, housing characteristics for each move, income and wealth over the life-cycle. Such data simply do not exist in France.

As a consequence, we chose to rely on two complementary cross-section datasets from sample surveys. The two surveys are undertaken by INSEE (the French National Institute of Statistics) on representative samples of the French population. The first one is the 1996 edition of the National Housing Survey (NHS). This survey is the French counterpart to the US American Housing Survey and covers the same range of topics. The main purpose of the NHS is to accurately describe the housing stock in France, as well as the housing conditions of French households. As a consequence, housing conditions are described in detail, together with socio-demographic characteristics of households, including a reliable income measure and the purchase price of the dwellings of recent mover-owners. However, the NHS contains no information on the households' wealth. Although a cross-section, the NHS also contains detailed retrospective

[8] In our sense, the main question in the long run is whether the PTZ has any positive effect on access to ownership, or if it only speeds up access to ownership for households who would have become owners later in their life cycle. Our data do not allow us to answer this question.

questions about mobility and past tenure between 1992 and 1996. We consider that the PTZ did not exist during this period.[9] For all the households who moved between 1992 and 1996, the survey includes detailed information regarding their situation (tenure, characteristics of the dwelling, professional status, etc.) in 1992 and the dwelling they occupied then. We define as *movers* households that did not live in the same dwelling four years before the survey.

The second dataset is the National Wealth Survey (NWS hereafter) conducted in 1997. The NWS aims at providing a representative picture of the amount and composition of French households' net wealth. As such, it surveys both financial and non-financial assets of households, including real estate. It includes exactly the same socio-demographic characteristics as the NHS, including income.[10]

Our estimation strategy consists in using both datasets to recover the unknown parameters of the econometric model. Common socio-demographic covariates are used to link the two samples. Broadly speaking, the NWS serves to identify the relationship between wealth and income, which is missing in the NHS; whereas the NHS serves to identify the rest of the parameters of the model.

We restrict our attention to the mobility and tenure choices of private sector renters. Owners are not eligible for the PTZ, which concerns only first-time buyers. Households living in public rental housing (HLM) pay rents much lower than market rents, and therefore their propensity to move is low compared with households renting in the private sector (see Le Blanc and Laferrère, 2001). We also exclude from the sample households just formed between 1992 and 1996. This is because we do not study the formation of households and the home-leaving decision. This would call for a specific economic model; in any case, the incentives to move are certainly very different for those households and already constituted households. Thus, we restrict the sample from both surveys to households who were private sector renters in 1992. This selection leaves us with 4,140 observations in the NHS sample and 3,360 in the NWS sample.

[9] The PTZ begun to be implemented, at a low scale, during the very last months of the period covered by the survey. However, in practice its importance was still negligible. In the whole sample of the NHS of 40,000 households, only 53 were found to have used a PTZ.

[10] Indeed, the data on income in the two surveys have been collected from exactly the same questionnaire, which ensures the comparability of the two samples.

4. The model

4.1. Framework

From the discussion above, it should be clear that the effects of the PTZ are best estimated within a framework of mobility and tenure choice incorporating borrowing constraints. Many studies have examined these topics, particularly for the US (see Linneman and Wachter, 1989; Linnemann et al., 1997; Duca and Rosenthal, 1994; Lafayette et al., 1995; Haurin et al., 1997). Most of the existing studies, however, neglect the impact of borrowing constraints on residential mobility. Two exceptions are Zorn (1989), and Ioannides and Kan (1996). Zorn (1989) recognizes the three-fold nature of the choice faced by households at each period: stay in the current dwelling, move and rent, move and own. Ioannides and Kan (1996) introduce a dynamic model involving the same three choices at each period. Unfortunately, their model is not analytically solvable, even without introducing borrowing constraints.

Our econometric model is based on a two-period model presented in Gobillon and Le Blanc (2004). Adopting a two-period model is the best we can do, given the nature of the data at our disposal. However, as discussed at length in the aforementioned paper and in the working paper version of this article (Gobillon and Le Blanc, 2002), this stripped-down model captures most of the tradeoffs faced by the households in a life-cycle perspective. It embeds both the discrete choices faced by the households at each period (staying, moving and renting, moving and owning) and the continuous choices of housing stock. We explicitly introduce borrowing constraints.[11]

We refer the reader to Gobillon and Le Blanc (2004) for a thorough discussion of the properties of the economic model, and present only the main features here. We focus on the behaviour of renters, as the PTZ is targeted at first-time buyers.

We consider a household endowed with financial assets A_t at the beginning of period t. It rents a dwelling with capital stock K_{t-1}. Its initial situation is fully described by (A_t, K_{t-1}).

[11] Our empirical model is the first, to our knowledge, to use all the information available from the data. Whereas Zorn (1989) and Ioannides and Kan (1996) explain jointly mobility and tenure choice in their empirical investigations, we explain mobility, tenure choice and the stock of housing capital simultaneously.

The household has an inter-temporal utility which depends on the consumption of a non-durable (Hicksian) composite good C_t assimilated to the numeraire, on the service flows derived from housing at period t, and on total net wealth at the beginning of the second period W_{t+1}. Housing service flows are assumed to be proportional to the level of housing stock at period t, denoted K_t. Hence, K_t directly enters the utility function. In this setting, the household is myopic: it cares only about the total amount of wealth available for use in the future. This wealth is derived from investment in two assets: housing capital and a riskless asset with return r_a.[12] The model does not allow for possession of housing capital for other uses than owner-occupancy.[13]

Then, future wealth can be written $W_{t+1} = A_{t+1} + p_{t+1}K_t$ for owners and $W_{t+1} = A_{t+1}$ for renters, where A_{t+1} are financial assets in period $t+1$ and p_{t+1} is the expected future unit price of housing capital. For simplicity, we suppose that households make point expectations on this unit price. We also impose future wealth to be non-negative, $W_{t+1} \geq 0$: the household can borrow only against housing collateral. We finally assume that the tenure mode does not affect the production of housing services.[14] Thus, the utility function can be written $U = U(C_t, K_t, W_{t+1})$.

At the beginning of period t, the household is endowed with exogenous income Y_t. It chooses between staying in its current dwelling ($d_t = s$), accessing ownership ($d_t = o$) and moving-and-renting ($d_t = r$).[15] Its complete set of decision variables is (d_t, C_t, K_t).

In case the household does not move, its housing capital remains unchanged,[16] and it only decides how much to consume today and how much wealth to transfer to period $t+1$. In comparison, a household deciding to move has an additional degree of freedom, since it also

[12] It is well known (see e.g. Henderson and Ioannides, 1986, Flavin and Yamashita, 2002) that in general, tenure choice is driven not only by consumption motives, but also by portfolio considerations. In our case the portfolio side of the problem is reduced to the comparison of the rate of return on the riskless asset and the expected return on housing.

[13] In 1996, 54% of French households owned their primary home. A much smaller proportion (between 7% and 10%) owned another dwelling (secondary home, vacant house or dwelling for rent).

[14] See Henderson and Ioannides (1983) for alternative assumptions on this point.

[15] Another option could be to purchase the dwelling where the household already lives. This practice is very uncommon in France. In 1996, only 2.8% of households owned a dwelling that they had previously rented. Therefore, we exclude the option staying and accessing to ownership from the model.

[16] Adding depreciation of the housing capital is straightforward but not essential to our point, in contrast with standard models of investment.

chooses a quantity of housing capital. This additional degree of freedom is obtained at a monetary cost C_0 (the moving cost). Moving households may rent or own. The unit rent and unit price of housing are denoted respectively as ρ_t and p_t.

Potential owners have limited access to the credit market. Specifically, households face two constraints imposed by lenders. The first one, which we call the *income constraint* or payment-to-income ratio, relates annual repayments P and current income Y_t through the inequality $P/Y_t \leq e$, with e the maximum payment-to-income ratio. Suppose the loan is a fixed-rate, constant annuity mortgage with rate r and duration N. Denoting M the value of the loan, we have $P = \tilde{r}M$ where $\tilde{r} = r\frac{(1+r)^N}{(1+r)^N - 1}$. The income constraint is then $M \leq eY_t/\tilde{r}$.

The second constraint, which we call the *downpayment constraint*, relates the downpayment D to the purchase price of the house V through the inequality $D \geq aV$, with a the minimum downpayment-to-value ratio. We have $V = D + M$, so the maximum value a household can finance is equal to:[17]

$$V_{\max} = A_t + \min\left(\frac{e}{\tilde{r}}Y_t, \frac{1-a}{a}A_t\right) \tag{1}$$

which corresponds to a housing stock of $K_{\max} = \frac{V_{\max}}{p_t}$.

We suppose that the first repayment occurs in the first period, so that the budget constraint of mortgage holders is:

$$A_{t+1} = (1+r_a)(A_t + Y_t - C_0 - C_t - D - P) - (M - P)(1+r)$$

We make the further simplifying assumption: $r = r_a$. Then households are indifferent to the mode of financing.[18] Considering that $V = D + M = p_t K_t$, the wealth evolution equation simplifies to:

$$W_{t+1} = (1+r_a)(A_t + Y_t - C_0 - C_t - \pi_t K_t)$$

where $\pi_t \equiv p_t - \frac{p_{t+1}}{1+r}$ can be interpreted as the user cost of housing for mover-owners.

The household maximizes its utility under constraints. Its maximization problem can be expressed sequentially. The household first computes the indirect utility levels reached in each of

[17] This form of constraint appears in Linnemann and Wachter (1989), Zorn (1989), and in many studies quoted in the introduction.

[18] This is clearly a simplifying assumption. In practice, households have the choice between different types of

the three options: staying, moving-and-renting, moving-and-owning, denoted respectively F_s, F_r and F_o. He then chooses the option yielding the highest utility.

The budget constraints associated to the three options are given by:

- Staying ($d_t = s$):

$$\begin{cases} K_t = K_{t-1} \\ W_{t+1} = (1+r_a)(A_t + Y_t - C_t - \rho_t K_{t-1}) \\ W_{t+1} \geq 0 \end{cases}$$

- Moving and renting ($d_t = r$):

$$\begin{cases} W_{t+1} = (1+r_a)(A_t + Y_t - C_0 - C_t - \rho_t K_t) \\ W_{t+1} \geq 0 \end{cases}$$

- Moving and owning ($d_t = o$):

$$\begin{cases} K_t \leq K_{\max} \\ W_{t+1} = (1+r_a)(A_t + Y_t - C_0 - C_t - \pi_t K_t) \\ W_{t+1} \geq 0 \end{cases}$$

4.2 Econometric setting

In order to obtain an estimable set of equations, we suppose that the utility function takes a log Cobb-Douglas form. Detailed calculations included in Gobillon and Le Blanc (2002) show that under this assumption, the differences in utility levels associated with each option (which determine the discrete choice of the household) may be approximated by:

$$F_s - F_r = \frac{C_0}{\rho_t K_r^{nc}} - \theta_1 \left(\ln K_r^{nc} - \ln K_{t-1}\right)^2 \tag{2}$$

$$F_r - F_o = \ln\left(\frac{\pi_t}{\rho_t}\right) + 1_{\{V_o^{uc} > V_{\max}\}} \theta_2 \left[\ln\left(V_o^{uc}\right) - \ln\left(V_{\max}\right)\right]^2 \tag{3}$$

where $1_{\{.\}}$ is the indicator function, V_o^{uc} is the optimal purchase value for mover-owners if borrowing constraints are not binding,[19] and K_r^{nc} is the optimal housing stock when moving-and-

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mortgages (e.g. FRMs versus ARMs), with different durations, points, etc.

[19] Note that V_o^{uc} is unambiguously defined in our two-period model. When more time periods are considered, a serious difficulty arises because the household has to consider the possibility of binding borrowing constraints at all

renting if there is no moving cost.

The first equation simply states that the utility associated to moving and renting, compared to staying in the current dwelling, involves two terms of opposite sign. The first one corresponds to a loss of utility due to moving cost. The second term corresponds to the utility gain associated with the adjustment of the housing capital. The household's ranking of the two options (staying and moving-and-renting) is determined by the relative importance of these two terms.[20]

The second equation states that the difference in utilities between moving-and-renting and moving-and-owning is composed of two terms. The first one involves the usual comparison of the unit rent and user cost of owning (Henderson and Ioannides, 1983). The second term reflects the presence of borrowing constraints and applies only to households for which the borrowing constraint is binding. It is always nonnegative and increases as the maximum housing value which the household can finance, $V_{\max}$, diverges from the optimal housing value that would be chosen in the absence of borrowing constraints, V_o^{uc}.

The first-order conditions obtained with a log Cobb-Douglas utility function also yield a relationship between the optimal purchase value for unconstrained mover-owners V_o^{uc}, and the optimal housing stock for mover-renters, K_r. We will impose this relationship in the empirical application. It states:

$$\pi_t V_o^{uc} = \rho_t p_t K_r \tag{4}$$

To further specify the econometric model, it is convenient to classify the endogenous variables according to their observability in our data.

First, some of the variables introduced above are never observable. It is the case for C_0, π_t, K_r^{nc} and V_o^{uc}.

Moving costs will be modelled as the first source of heterogeneity among the households. In fact, the only costs considered in the theoretical model are monetary. These costs are likely to vary

future periods (Zeldes, 1989).

[20] In many cases, this framework gives rise to a (s,S) rule familiar to the investment literature (Gobillon and Le Blanc, 2004): there exists an interval around the initial housing stock K_{t-1} such that if the optimal housing stock K_r lies in the interval, the household is better off staying in his current dwelling, whereas if the optimal housing stock lies outside the interval, the household prefers to move.

greatly among households. One obvious shifter of these costs is family composition: for example, the costs are likely to be lower for singles than, say, families with small children, for whom moving means finding new schools, new childcare arrangements, and so on. One could adopt a broader view of moving costs as well, and include in these costs all the psychological costs of moving (or at least the monetizable part of them). We specify:

$$\frac{C_0}{\rho_t K_r^{nc}} = X_1\gamma_1 + \varepsilon_1 \tag{5}$$

X_1 includes a constant term, age dummies, a dummy for being divorced and a dummy for living in couple, the number of children in 1992, and the number of children born after 1992.

In order to complete the specification of equation (2), we approximate the quadratic term by $\theta_1(\ln K_r - \ln K_{t-1})^2$, where θ_1 is a constant to be estimated. Making the approximation $K_r \approx K_r^{nc}$ amounts to neglecting the impact of moving costs in the determination of the optimal housing stock for renters. We obtain:

$$F_s - F_r = X_1\gamma_1 + \varepsilon_1 - \theta_1(\ln K_r - \ln K_{t-1})^2 \tag{6}$$

Looking at equation (3), we see that the choice between owning and renting is driven by the *expected* user cost of ownership. Many authors (for example Hendershott and Shilling, 1982, and subsequent studies mentioned above), when coming to empirical estimation, consider the user costs as certain and calculate them from historical changes in housing prices. But there are many reasons to think that households differ in their expectations about future housing prices. This could arise from differences in information (related to the education level, for example), location of the dwelling (some areas are booming whereas others are busting), as well as other idiosyncratic characteristics. Also, insofar as the tax code contains provisions on the deductibility of part of the mortgage repayments, households in different tax brackets will also have different user costs. So, in line with Henderson and Ioannides (1986), we directly specify:

$$\ln\left(\frac{\pi_t}{p_t}\right) = X_2\gamma_2 + \varepsilon_2 \tag{7}$$

X_2 includes a constant, age dummies, dummies for being a foreigner, being unemployed in 1992, living in a house, living in the Greater Paris area, as well as two local variables built from the 1990 Population Census: the local housing vacancy rate and the proportion of renters in the town of residence in 1990.

As for the second term of the right-hand side of equation (3), our specification includes the difference between the optimum purchase value and the maximum value in a linear way, instead of the quadratic term stemming from the theory. Results showed that a linear specification for this term performed better in practice than a quadratic specification. The estimable version of equation (3) is:

$$F_r - F_o = X_2\gamma_2 + \varepsilon_2 - \ln(\frac{\rho_t}{p_t}) + 1_{V_o^{uc} > V_{\max}}\,\theta_2\left(\ln V_o^{uc} - \ln V_{\max}\right) \quad (8)$$

Other variables are observed only for some endogenously selected subsamples in the NHS dataset. Indeed, we observe the desired rent $L_r \equiv \rho_t K_r$ for mover-renters only. Similarly, for stayers, we observe the rent corresponding to the dwelling occupied at period $t-1$, $L_{t-1} \equiv \rho_t K_{t-1}$. For mover-owners, we observe the purchase value of the dwelling V. Depending on the borrowing constraint being binding or not, V is equal either to $V_{\max}$, the maximum value, or to V_o^{uc}. However, our data contain no information about the prevailing regime. Thus, all we know is that $V = \min\left(V_o^{uc}, V_{\max}\right)$.

We suppose that the desired rent can be written:

$$\ln\left(L_r\right) = X_3\gamma_3 + \phi_1 \ln Y_t + \varepsilon_3 \quad (9)$$

In this equation, current income is used as a proxy for permanent income and the explanatory variables in X_3 account for taste heterogeneity. X_3 includes a constant, a dummy for the possession of a secondary home, the number of children in 1992, the number of children born after 1992, dummies for the size of the urban unit in 1992, a dummy for being a civil servant, a dummy for being divorced, and a socio-economic index of the town of residence in 1992 reflecting the socioeconomic composition of the municipality where the dwelling is located at the 1990 Population Census (see Tabard, 1993).

Using equation (4), we obtain $\ln\left(L_r\right) = \ln(\rho_t K_r) = \ln\left(\frac{\pi_t}{p_t}\right) + \ln(V_o^{uc})$, so that

$$\ln\left(V_o^{uc}\right) = X_3\gamma_3 - X_2\gamma_2 + \varepsilon_3 - \varepsilon_2 \quad (10)$$

Instead of specifying an equation for net wealth, we directly specify an equation for the maximum value $V_{\max}$:

$$\ln\left(V_{\max}\right) = X_5\gamma_5 + \phi_2 \ln Y_t + \varepsilon_5 \quad (11)$$

$V_{\max}$ is calculated from income and wealth by formula (1). We work on the basis of a composite loan reflecting the state of the market at the time the households decided on their new tenure. To select the term of the loan, we take the mean duration of the loans issued between 1993 and 1996, according to the NHS. We thus obtain a term $N = 14$. The interest rate chosen is the average value observed for State loans PAP in the year of the move, except for stayers for whom we consider the average value of this interest rate during the 1993-1996 period. The maximum payment-to-income ratio is taken to be $e = 30\%$, which was the official norm for State loans and the quasi official one for private loans at that time. The minimum downpayment is fixed at $a = 20\%$ of the dwelling value. Again, this value corresponds to current practice in France at the beginning of the nineties.

X_5 includes some variables common to the NWS and NHS samples: a constant, age dummies, a dummy for living in couple and a dummy for the woman's participation in the job market, two dummies for the possession of a secondary home and for the possession of other dwellings, the socio-economic index of the town of residence in 1992, dummies for the size of the urban unit in 1992, and the number of children born between 1992 and 1996. Ideally, information concerning the occurrence of events such as bequests, donations, etc., having affected the households during the 1993-1996 period should be included in equation (1). Unfortunately, this type of information is known only for mover-owners in the NHS, and thus cannot be used.

Finally, L_{t-1} is known only for stayers. However, detailed characteristics of the dwelling occupied in $t-1$ are available for all households. So we specify an imputation equation of the form:

$$\ln L_{t-1} = X_6 \gamma_6 + \varepsilon_6$$

X_6 includes variables relative to the dwelling occupied in 1992: dummies for the number of rooms, for the date of building, and for the size of the urban unit, the socio-economic index of the town, and a constant.

Due to the nature of our data which consist of two separate datasets containing different endogenous variables, we cannot hope to recover unrestricted correlations between all the residuals. Therefore, we impose some structure on those correlations. However, as income is observed in the two samples, we can identify the correlations between the residual of an income equation and all the other residuals. We thus introduce the following income equation:

$$\ln(Y_t) = X_4\gamma_4 + \varepsilon_4 \qquad (12)$$

X_4 includes a constant, age dummies, dummies for the size of the urban unit in 1992, the highest diploma obtained by the head of the household, a dummy for living in couple, and a dummy for the woman's participation in the job market. Since the NHS and the NWS may not have exactly the same sample structure, we allow the parameters γ_4 and the variance of the residual ε_4 to differ between the two surveys.

The vector of residuals $(\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4, \varepsilon_5, \varepsilon_6)'$ is supposed normal, with mean zero and covariance matrix to be defined in the next section. Denote $\varepsilon_i = \lambda_i\varepsilon_4 + \eta_i$, with $E(\eta_i\varepsilon_4) = 0$, and $V(\eta_i) = \sigma_i^2$ for $i \in \{1,2,3,5,6\}$. We make the following identifying restrictions:

$$E(\eta_i\eta_5) = 0 \quad \text{for } i \in \{1,2,3,6\}$$
$$E(\eta_i\eta_6) = 0 \quad \text{for } i \in \{1,2,3\}$$

The first set of restrictions states that the only correlations we allow between the residuals of quantities estimated from the NHS and quantities estimated from the NWS are due to the correlations of these residuals with the income variable, which is common to both datasets. Indeed, if we denote σ_4 the standard error of ε_4, we have $E(\varepsilon_i\varepsilon_5) = \lambda_i\lambda_5\sigma_4^2$, $i \in \{1,2,3,6\}$. The second set of restrictions is made for convenience. Its justification is the following: whereas X_1, X_2 and X_3 contain socio-demographic descriptors of the household, X_6 contains attributes of the dwelling (it is merely an imputation equation). ε_6 can then be interpreted as reflecting unobserved heterogeneity in quality that explains differences in rents. We suppose that all the correlations between this residual and the taste parameters are captured by the income residual.

To summarize, the econometric model includes the six following equations:

$$\begin{array}{lcll}
F_s - F_r & = & X_1\gamma_1 - \theta_1(\ln L_r - \ln L_{t-1})^2 + \lambda_1\varepsilon_4 + \eta_1 & \text{(moving equation)} \\
F_r - F_o & = & X_2\gamma_2 - \ln(\frac{\rho_t}{p_t}) & \\
 & & +1_{\{V_o^{uc} > V_{\max}\}}\theta_2(\ln V_o^{uc} - \ln V_{\max}) + \lambda_2\varepsilon_4 + \eta_2 & \text{(tenure choice equation)} \\
\ln L_r & = & X_3\gamma_3 + \phi_1 \ln Y_t + \lambda_3\varepsilon_4 + \eta_3 & \text{(rent equation)} \\
\ln Y_t & = & X_4\gamma_4 + \varepsilon_4 & \text{(income equation)} \\
\ln V_{\max} & = & X_5\gamma_5 + \phi_2 \ln Y_t + \lambda_5\varepsilon_4 + \eta_5 & \text{(maximum value equation)} \\
\ln L_{t-1} & = & X_6\gamma_6 + \lambda_6\varepsilon_4 + \eta_6 & \text{(previous rent equation)}
\end{array}$$

along with a redundant equation determining V_o^{uc}:

$$\ln V_o^{uc} = X_3\gamma_3 - X_2\gamma_2 + (\lambda_3 - \lambda_2)\varepsilon_4 + \eta_3 - \eta_2 \qquad \text{(unconstrained house value equation)}$$

Identification issues are discussed in the working paper version of this article (Gobillon and Le Blanc, 2002), and we refer the interested reader to it for details. The model is estimated by maximum likelihood. Due to the presence of a non-linear term in equation (6), which includes two residuals which are not always observed, evaluating the likelihood function requires either numerical integration or simulation. After trying both methods, we kept simulation, which turned out to be less computer-intensive. The details of the likelihood calculation are given in Appendix A.

5. Empirical results

5.1. Descriptive statistics

Table 1 gives some descriptive statistics on the NHS subsample that includes only households who rented their dwelling in 1992. This subsample represents about 3.34 million households. Nearly half of them (1.6 millions) moved during the four year period between 1992 and 1996. This corresponds to an annual mobility rate of 12%. This rate is higher than the mobility rate of the whole population, which is about 8%. Looking at the tenure mode chosen by movers, we see that rental (1.0 million) dominates ownership (0.6 million).

It is interesting to compare the characteristics of stayers with those of mover-renters and mover-owners. Related statistics are given in Table 1. On average, stayers are much older than movers. Whereas the average age in 1992 was 48 among the stayer group, it was only 35 for both mover-renters and mover-owners. Experiencing a birth during the 1993-1996 period constituted a strong incentive to move: this was the case for 56% of mover-owners and 34% of mover-renters, but only for 15% of stayers. The other socio-economic characteristics oppose mover-owners to both stayers and mover-renters. Whereas the proportion of single-headed households is high for stayers and mover-renters (between 40 and 50%), it is much lower for mover-owners (16%). Divorce is more frequent among stayers and mover-renters. These households also have fewer children on average, and are more often foreigners. Turning to labor-related features, we notice that mover-owners are on average better-off than the other households. Household heads have higher diplomas and a higher participation rate in the labor market. The participation rate in 1992 is 93% for mover-owners, but only 66% for stayers and 85% for mover-renters. For couples, the participation rate of women is also higher among mover-owners than among the other groups. Mover-owners are also the wealthiest group. Their average yearly income and net wealth are 34,000 and 46,000 euros respectively, against 24,000 and 37,000 euros for mover-renters, and 22,000 and 28,000 euros for stayers.[21] Finally, looking at the rents paid in the dwelling occupied at the beginning of the period, mover-renters paid higher rents than stayers.

$\left[\textit{Insert Table 1 here} \right]$

Age (like income or wealth, which are correlated with age) is a key determinant of mobility and tenure choice. Figures 1 and 2 show that staying becomes the most frequent choice only after age 30. Before 30, whereas 25% of households do not move during the 1992-1996 period, 47% and 29% are mover-renters and mover-owners, respectively. By contrast, the proportion of stayers is far higher in the 40-49 age bracket, reaching 61%. In that group, only 23% and 16% choose moving-and-renting and moving-and-owning, respectively. When moving, households mainly rent their new dwelling until around 45 (see Figures 1 and 2). Between 45 and 60, owning and renting are equally frequent. After 60, renting dominates again.

$\left[\textit{Insert Figures 1 and 2 here} \right]$

Figure 3 represents net wealth, the maximum affordable value ($V_{\max}$), and the observed purchase value of mover-owners as a function of age.[22] The median value of all these variables increases until 30. After that age, the maximum value and net wealth are nearly constant until 50 and then decrease. In fact, the wealth distribution is rather flat. This is not surprising, as we focus on a population of renters. The purchase value increases regularly until age 50, and becomes irregular for higher ages due to the small numbers of observations for these categories. At all ages, the average purchase value is higher than the maximum housing value. This is due to a selection

[21] The wealth used in the descriptive statistics of this section was imputed on the basis of the estimated coefficients of a wealth model run on NWS data.

[22] The maximum housing value ($V_{\max}$) was constructed using formula (1).

effect, the wealthier households being over-represented among mover-owners. It also suggests that a substantial proportion of households are constrained.

One of the key issues in choosing an adequate type of subsidy to help households access ownership is to know whether households in the target group are mainly constrained by income or by wealth. In our framework, this question boils down to finding out which of the income constraint and the downpayment constraint is binding in formula (1). Figure 4 aims at shedding some light on this issue. It shows the proportion of households for whom the income constraint is binding in formula (1), as a function of age and for different values of the parameters e and a.

In the baseline case ($a = .2$, $e = .3$), at all ages, more than 90% of the households are constrained by income. When the maximum payment-to-income ratio is raised to .35, the income constraint becomes less binding on average, especially for young households. When the minimum downpayment constraint is raised to 25% of the house value, the wealth constraint becomes binding for more than 30% of households under age 40. This simulation exercise suggests that subsidizing downpayment may not have been, given the distribution of income and wealth prevailing in 1992, the best way to help renters overcome borrowing constraints. However, it is hard to assess on *a priori* grounds for which households the mobility and tenure choices are affected most by changes in e and a. This issue is investigated more in detail below.

$$\left[\textit{Insert Figures } 3 \textit{ and } 4 \textit{ here} \right]$$

5.2. Estimation results

We now discuss the value and significance of the estimated coefficients (see Table 2 to Table 10). First, we examine the two coefficients θ_1 and θ_2 (see Table 2). As predicted by the theoretical model, θ_1 is positive: the further the current stock of housing capital from the optimal one, the more households are willing to move. The constraint coefficient θ_2 is very significant and positive, as expected. Thus, borrowing constraints have a strong impact on mobility and tenure choice.

$$\left[\textit{Insert Table } 2 \textit{ here} \right]$$

The estimated coefficients of the income equation for the NHS and NWS samples can be found in Tables 3 and 4. Overall, the two samples give estimates of the same magnitude, but some parameters are found to be statistically different in the two equations, indicating that allowing for two different sets of parameters is necessary to improve the fit of the model. The coefficients of both equations have the usual sign. Income first rises with age and then declines (after 50 years with our particular choice of age brackets), as usual in cross-section datasets; it also rises with diploma, and is higher in the Paris area than elsewhere. Couples have higher incomes, especially when the spouse works.

$$\left[\textit{Insert Tables } 3 \textit{ and } 4 \textit{ here} \right]$$

Table 5 provides the estimation results for the maximum value equation. Income has a positive effect on $V_{\max}$. Having a secondary home or possessing some other dwellings increases $V_{\max}$. The age effects as well as the family structure effects are, at first glance, more surprising. The age profile is U-shaped. Couples have a lower $V_{\max}$ than single households, whether the wife is working or not. These results stem from the fact that we control for total family income. If we rewrite the $V_{\max}$ equation in reduced form, replacing log-income by its expression as a function of the exogenous variables, living in couple and the fact that the wife works both have a positive effect on $V_{\max}$.

$$\left[\textit{Insert Table } 5 \textit{ here} \right]$$

The coefficients of the moving costs equation are shown in Table 6. In accordance with intuition, moving costs increase with the age of the household head and with the number of children born before 1993. A birth after 1992 reduces the moving cost.[23] Another variable, the dummy for living in couple, has a less intuitive coefficient: being in couple appears to lower moving costs, though the coefficient is not significant at 5%. The sign of this coefficient was robust to

[23] Note that births have two effects on the utility difference between staying and moving and renting: one via the moving cost, and another via the quadratic term in equation (6) since young children appear in the determination of the optimal housing capital (equation (9)). Thus, a birth shifts upwards the optimal stock of housing capital, and this in turn lowers the utility of staying.

alternative specifications.

$[\textit{Insert Table } 6 \textit{ here}]$

Table 7 shows the estimated values of the parameters of the user cost equation. Unsurprisingly, it is difficult to find explanatory variables with a significant effect. No significant age profile emerges, and the interpretation of other coefficients is not straightforward. Lastly, Tables 8, 9 and 10 report the estimated coefficients of the rent equation, the estimated coefficients of the previous rent equation, and the estimated variance and covariance parameters, respectively. They are not discussed here to save space.

$[\textit{Insert Tables } 7,\ 8,\ 9 \textit{ and } 10 \textit{ here}]$

5.3. Global fit of the model

To assess the global fit of the model, we first look at the predictions in term of aggregate flows. The results are presented in Table 11. The model accurately reproduces the overall aggregate flows, though it slightly overpredicts moving and owning. Splitting the sample by age brackets, we see that the accuracy of the predicted flows remains good, with a deterioration for the two higher age brackets, for which the model predicts too many mover-owners.

Another important issue concerns the goodness of fit of predicted purchase values for mover-owners with actual ones. The model slightly underestimates purchase values for all age brackets (by 4%), the worst fits being observed again for the two highest age brackets. The same thing happens for predicted rents of mover-renters. The overall rate of underestimation is 3.6%, the fit being nearly perfect for the younger households, and less good for higher age brackets. However, considering the restrictions imposed on the model (we have only two equations to fit L_r, V_o^{uc}, and the rental-ownership choice), the fit of the model seems quite good.

Next, we look at the predicted proportion of constrained households in the sample. This figure is 53%. Zorn (1989) found 61% for a sample representative of the U.S. population. Note however that Zorn considered all households, not only previous renters as we do. Preliminary versions of this paper considered also previous mortgage holders and previous outright owners; the proportion of constrained households in these two categories was found to be much lower (around 20%). Taking a life-cycle point of view, we also look at the proportion of constrained households as a function of age. We find no specific pattern. This is not surprising, as we study a population of renters. Indeed, the subsample of renters at any point in time results from a filtering process by which the wealthiest households have moved towards ownership in the previous periods.[24] This finding is also in line with the direct examination of the net wealth of French households in each tenure as a function of age, which shows no clear age pattern among renters, and an average net wealth at all ages much lower than that of owners (Lagarenne and Le Blanc, 2004).

[*Insert Table* 11 *here*]

5.4. Simulations

Using the estimated parameters, we simulate some changes in the borrowing constraints facing households. We focus on a uniform rise in $V_{\max}$ by 10% for the whole sample, to compare the predictions of our model with those of Zorn (1989). The overall proportion of constrained households falls by 3.5 percentage points. As Table 12 shows, this loosening of the borrowing constraint results in a 6% rise in the flow of owners. One-fourth of the additional owners would have moved and rented in the benchmark case, and 3/4 would not have moved during the period. Thus, switches from staying to moving-and-owning dominate switches from rental to ownership, as in Zorn's study.[25] Our model also allows one to simulate some changes in other parameters (e, a and r). Results are given in Gobillon and Le Blanc (2002) but are not reported here to save space.

[*Insert Table* 12 *here*]

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[24] Preliminary work on this model showed that when previous owners are included, the proportion of constrained households declines with age from 50% of the households under 30 years to 22% in the 40-49 age bracket, and rises again for households aged 50 or more.

[25] In Zorn's study, a 10% increase in $V_{\max}$ induced a 5% increase in the flow of mover-owners, 1/6 of them being mover-renters in the benchmark case, and 5/6 being stayers.

We now focus on the introduction of the PTZ. The PTZ is roughly equivalent to a downpayment subsidy, since it decreases the amount the household has to borrow on the credit market. The subsidy can be calculated by comparing the initial amount of the PTZ (which is computable from our data and the PTZ application rules) to the discounted value of the repayment. So, to simulate the reform, we simply add the amount of the subsidy to $V_{\max}$ for each household. We find that the introduction of the reform in our 1996 sample would have benefited 533,000 households in four years. Since we did not take into account the quasi restriction of the PTZ to new dwellings (see Section 2), and since a large proportion of mover-owners choose to buy old dwellings even though they lose the opportunity to avail of the PTZ, this number must be a loose upper bound for the actual one. From the Ministry of Housing, the actual figure over the 1996-1999 period on a comparable field (former public sector renters excluded) is 423,000. This result confirms our trust in the calibration of the model.

A selection of results from the simulation of the PTZ is shown in Table 13. Our model predicts that in four years, the PTZ would have induced nearly 75,000 additional households to turn to ownership. In the absence of the PTZ, 70% of these new households would have stayed in their dwelling whereas 30% of them would have moved and rented.

From an efficiency point of view, the PTZ thus suffers from a windfall effect of about 85%, that is, 85% of the recipients would have chosen to move and own even without PTZ. This figure is in line with other evaluations made by various organizations using totally different approaches. For instance, a recently published report estimates, based on real estate experts' assessment, that the windfall effect lies between 75% and 90% (Welhoff, 2004).

[*Insert Table 13 here*]

Another goal of the PTZ was to allow constrained households to purchase better dwellings. Our model allows us to look at the changes in the stock of housing capital chosen by owners. The response of the average dwelling value of mover-owners to a loosening of the borrowing constraint is the sum of two effects. On the one hand, households who would have moved and owned in the benchmark case keep doing so and buy more expensive dwellings. On the other hand, households who would not have chosen ownership now decide to move and own. These marginal households are less wealthy than supramarginal ones, and buy cheaper dwellings.

Empirically, either effect can dominate. These selection effects are well known in other fields, see for example Bjorklund and Moffit (1987) on the effect of welfare programs on wages. We find that the implementation of PTZ leads to a *decrease* in this average value by 3,000 euros (see Table 14). Thus, in the particular case of the PTZ, the selection effect dominates.

[*Insert Table* 14 *here*]

It is interesting to study the effects of the PTZ separately for the three groups of households defined by their observed choices in the absence of PTZ: stay, move-and-rent, move-and-own. The PTZ increases the average maximum value for the three groups respectively by 25%, 11% and only 3%. Thus, the effect of PTZ on supramarginal households (the move-and-own group) is small. For these households, the average purchase value increases by only 2,800 euros. The average purchase value for new households is about 45,000 euros, that is two times less than for supramarginal households.

This result can be interpreted in two ways. As the PTZ mostly concerns the purchase of new dwellings, one may conclude that it encourages the construction of low-quality dwellings. It could also lead to a shift in the location of new construction towards peripheral areas of cities where land prices are lower. It is often mentioned that since the implementation of the subsidy, developers have engaged in the construction of PTZ neighbourhoods, targeted at the lower end of the ownership market and located far from urban centers. Some figures support this statement. The spatial distribution of first-time buyers of new dwellings in the 1998-2002 period is very different depending on whether households benefited from PTZ or not. Among non-beneficiaries, 30% lived in rural areas and 34% lived in urban areas comprising more than 100,000 inhabitants (including the Greater Paris area). Among beneficiaries, these figures are 48% and 19%, respectively (Daubresse, 2003). From a public policy perspective, this question is important as construction far from city centers could eventually exacerbate spatial mismatch problems between jobs and workers for the least well-off owners.

At this point, we have some answers to questions related to short-run effects of the PTZ on housing demand and access to ownership. However, only demand is modelled and the results presented above neglect the impact of PTZ on housing prices. It is thought that this impact is not negligible, because the first-time buyer market is segmented. As mentioned above, developers have been able to market a range of housing products targeting only the least well-off first-time buyers, basically those whose move towards ownership is triggered by the PTZ.[26] It is thus probable that, at least in that submarket, a substantial part of the subsidies is captured by developers through higher housing prices. In a simpler version of our model, we simulated a uniform increase of 5% of housing prices. This figure looks mild for a four-year period. The increase in the number of mover-owners, compared to the baseline case discussed above, is then halved. As a consequence, results given in this paper should be considered as upper bounds of the effects of the PTZ.

From our results, it is possible to compute a multiplier effect for the PTZ, thus allowing us to compare the PTZ to other public investment programs in housing. We compute the multiplier as the value of the additional housing investment compared to a situation without PTZ, per euro of expenditure on the PTZ. The effect of the PTZ on housing investment is composed of two terms. The first term corresponds to the investment realized by new owners, that is to say those who access ownership only thanks to the PTZ. This effect at the extensive margin is equal to the number of households in that category, times the average value of dwellings they purchase. The second term corresponds to the extra investment made by first-time buyers who would have accessed ownership even without the subsidy. This effect at the intensive margin is equal to the number of households in this category, times the average increase in purchase value due to the PTZ.

The average purchase value of new owners is 45,000 euros. As these households represent 15% of PTZ beneficiaries and the total number of beneficiaries is nearly 110,000 per year, the effect at the extensive margin is about 750 millions euros. The increase in the purchase value of supra-marginal households is 2,800 euros. As these households represent 85% of beneficiaries, the effect at the intensive margin is nearly 260 million euros. As a consequence, total housing investment generated by the PTZ would be about 1,010 million euros. Given that costs to the State lie between 800 and 900 million euros depending on the year considered, the multiplier effect of the PTZ can be estimated to lie between 1.1 and 1.3.

These results call for a few comments. First, the multiplier effect is quite small. The international experience suggests that direct public investment in housing construction usually generates between 1.5 and 2 dollars per dollar spent, depending on countries. Second, the multiplier effect

[26]Nearly all transactions of individual houses at the lower end of the market are PTZ ones (Welhoff, 2004).

is very low for supra-marginal households. This happens because their purchase value is quite inelastic to the amount of downpayment, since they are less constrained than other groups. On the contrary, for infra-marginal households, the multiplier effect is nearly 6, as the cost for these households is only between 120 and 130 million euros per year. This suggests that a better targeting of the PTZ towards low income brackets would considerably increase the economic impact of the subsidy. Lastly, it should be kept in mind that the bounds for the multiplier effect may in fact be overestimated, since the effect of the introduction of the PTZ on housing prices was not taken into account. Overall however, our results suggest that a better targeting of the PTZ would lead to a better use of public spending.

6. Conclusion

This paper constitutes a first attempt to evaluate the economic effects of the zero-interest loan (PTZ) subsidy to first-time buyers in France. Our results show that the PTZ has a trigger effect on access to ownership and affects mainly the behavior of the most well-off among renters. However, the PTZ suffers from an important windfall effect. We estimate that 85% of beneficiaries would still have moved to own during the period without any incentive. As a consequence, the multiplier effect of the PTZ is relatively low. Lastly, the impact of the subsidy, which is targeted mostly at new construction, on the overall quality of the housing stock is ambiguous. These mixed results suggest that the effect of PTZ on the general welfare is not as positive and large as might be expected.

A limit to our approach, common to many studies in the field, is that only housing demand is modelled. Our simulations do not take into account price adjustments occurring as a response to the increase in housing demand induced by the PTZ. In practice, housing prices will rise, at least in the short run, as adjustment of the housing stock takes time (i.e. the short-run elasticity of construction is small). This precludes any attempt to evaluate precise welfare gains or losses. Also, we did not model the supply side of the credit market. Downpayment subsidies such as the PTZ may bring riskier borrowers to mortgage lenders, which may result in increased credit risk in the aggregate. A response from lenders in the form of higher interest rates could be a consequence of the policy worth further examination. Our model also neglects the choice between new and old dwellings. The PTZ can be viewed as a subsidy that makes new dwellings more attractive relative to used homes and distorts households' choices between those categories.

A number of questions would deserve further investigation. For example, it would be interesting to study the effects of the PTZ on public sector renters, which were excluded from our sample. Indeed, one of the initial justifications for creating the PTZ was that it would help push well-off renters of public housing towards ownership, thereby making room for a larger share of poor households in that sector. In practice, it appears that this mechanism has worked to a limited extent (see Welhoff, 2004). Former public renters have constituted one-fifth of PTZ beneficiaries. It turns out that the degree of competition between subsidized access to ownership and public housing depends a lot on local parameters. The PTZ has been more successful in areas where the gap between public and private rents is low. Another population of interest is that of recently formed households, which were excluded from the study. Moreover, one may think that the PTZ also has an impact on the formation of new households itself.

Finally, one of the conclusions of our simulations is that the introduction of the PTZ has likely resulted in the construction of dwellings smaller or located farther from city centers than would have been the case in the absence of the policy. One may ask why it matters, if individuals are better off as a result of the PTZ. We suspect that the introduction of the PTZ may generate social welfare losses that our simple model of individual choice cannot capture. For example, if the spatial equilibrium pattern of rents and densities is affected compared to a non-distorted situation, it might generate welfare losses in the form of increased average commuting times. Such effects would not prevent individual households from choosing to move in order to benefit from the subsidy. Incorporating subsidies like the PTZ into urban equilibrium models, as has been done in other contexts (see e.g. Arnott and McKinnon, 1977, for an analysis of building height restrictions) could shed light on this issue.

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Appendix A: likelihood calculation

The parameters of the model are estimated by maximizing the joint likelihood of our two samples, the NWS and the NHS samples. Due to the intricateness of the model, we proceeded in several steps. In the two preliminary steps, we jointly estimated equations (11) and (12) on the NWS sample and then treated the corresponding parameters as known when dealing with the NHS observations. To obtain a first set of coefficients on the NHS sample, we replaced the quadratic term in equation (6) by a proxy which was integrated to the other regressors in X_1 and a linear term. This left us with a model where only linear combinations of the residuals appeared, leading to straightforward estimation. Then, we estimated the model with the quadratic term, still treating the NWS parameters as known. Finally, we estimated the full model jointly on the two samples. The two sets of parameters where very close, the only significant changes concerning some of the parameters in equation (11). The comparison of the two sets of standard errors shows that proceeding in two steps leads to invisible (or at worst negligible) underestimation of the standard errors. So, the two procedures are practically equivalent, and proceeding in two steps, which is computationally quicker, does not lead in our case to erroneous conclusions about the significance of the parameters. This estimation from two complementary samples is close in spirit to the study of Arellano and Meghir (1992), who used data from the U. K. Family Expenditure Survey and the U. K. Labour Force Survey to estimate a model of labour supply and on-the-job search.

The contributions of observations to likelihood depend on the sample considered (NHS or NWS). In this section, we denote the variables with a star to distinguish them from their realizations.
Recall that $\varepsilon_i = \lambda_i \varepsilon_4 + \eta_i$, $i \in \{1,2,3,5,6\}$. In all the sequel, we denote $Z_4 \equiv X_4 \gamma_4$, and $Z_i \equiv X_i \gamma_i + \lambda_i (\ln Y_t - Z_4)$ for $i \in \{1,2,3,5,6\}$. We also denote φ_u and Φ_u respectively the pdf and the cdf of a normal variable u.
First consider the observations from the NWS sample. We observe draws of $(V_{\max}^*, Y_t^*)$. Thus, the contribution to the likelihood of the NWS observations is simply:

$$L_w = P\left(\ln Y_t^* = \ln Y_t, \ln V_{\max}^* = \ln V_{\max}\right)$$

Conditioning on ε_4 and using the independence between ε_4 and η_5, we obtain:

$$L_w = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_5}(\ln V_{\max} - Z_5)$$

Next, consider the observations from the NHS sample. The contribution of households to the likelihood function depends on their discrete decision (staying, moving and renting, moving and owning). Without the quadratic term $\left(\ln L_r^* - \ln L_{t-1}^*\right)^2$ in the moving equation, the likelihood would be quite easy to write down and to compute. In fact, we would split each likelihood contribution into two terms corresponding to $V_o^{uc} \leq V_{\max}^*$ and $V_o^{uc} > V_{\max}^*$ to get rid of the constraint dummy $1_{\{V_o^{uc} > V_{\max}^*\}}$, the two resulting probabilities being linear in the ε's. The presence of the quadratic term forces us to use either numerical integration or simulation. We choose to use the latter.

- Stayers: we observe $(d_t = s, Y_t^*, L_{t-1}^*)$. The corresponding probability is

$$L_s = P\left(F_s > F_r, F_s > F_o, \ln Y_t^* = \ln Y_t, \ln L_{t-1}^* = \ln L_{t-1}\right)$$

We split this probability into two parts as indicated above. The first part is given by:

$$L_1 = P\left(F_s - F_r > 0, F_s - F_o > 0, V_o^{uc} \leq V_{\max}, \ln Y_t^* = \ln Y_t, \ln L_{t-1}^* = \ln L_{t-1}\right)$$

Conditioning on ε_4 and η_6, and using the independence of η_6 from the other η_i, we get:

$$L_1 = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_6}(\ln L_{t-1} - Z_6)P(A_1)$$

where A_1 denotes the event:

$$\left\{\begin{array}{c} -\eta_1 < Z_1 - \theta_1\left(Z_3 + \eta_3 - \ln L_{t-1}\right)^2, \\ -\eta_1 - \eta_2 < Z_1 + Z_2 - \ln\left(\frac{\rho_t}{p_t}\right) - \theta_1\left(Z_3 + \eta_3 - \ln L_{t-1}\right)^2, \\ \eta_3 - \eta_2 - \eta_5 < -Z_s \end{array}\right\}$$

with $Z_s = Z_3 - Z_2 - Z_5$. The probability $P(A_1)$ is not linear in η_3. However, it can be written as $E_{\eta_3}\left[P(A_1 \mid \eta_3)\right]$, where the conditional probability in the expectation is now a standard cumulative of a trivariate normal. We approximate this expectation by the sum $\frac{1}{S}\sum_{s=1}^{S} P(A_1 \mid \eta_3 = \eta_3^s)$ where $\left(\eta_3^s\right)_{s=1,\ldots,S}$ are S realisations of the shock η_3. By the law of large numbers, the approximation converges to the true expectation at speed $\sqrt{S}$. In the context of our model, this method can be called hybrid simulation, because we only simulate one disturbance, and evaluate the probabilities conditional on this disturbance by standard procedures.

The second part of the likelihood is given by:

$$\begin{aligned} L_2 &= P\left(F_s - F_r > 0, F_s - F_o > 0, V_o^{uc} > V_{\max}, \ln Y_t^* = \ln Y_t, \ln L_{t-1}^* = \ln L_{t-1}\right) \\ &= \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_6}(\ln L_{t-1} - Z_6)P(A_2) \end{aligned}$$

where A_2 denotes the event:

$$\left\{ \begin{array}{c} -\eta_1 < Z_1 - \theta_1\left(Z_3 + \eta_3 - \ln L_{t-1}\right)^2, \\ -\eta_1 - \eta_2 + \theta_2(-\eta_3 + \eta_2 + \eta_5) \\ < Z_1 + Z_2 - \ln\left(\frac{\rho_t}{p_t}\right) - \theta_1\left(Z_3 + \eta_3 - \ln L_{t-1}\right)^2 + \theta_2 Z_s, \\ -\eta_3 + \eta_2 + \eta_5 < Z_s \end{array} \right\}$$

We approximate this term using the same technique as before.

- Mover-renters: we observe $(d_t = r, Y_t^*, L_r^*)$. The likelihood contribution is then:

$$L_r = P\left(F_r > F_o, F_r > F_s, \ln Y_t^* = \ln Y_t, \ln L_r^* = \ln L_r\right)$$

We split this probability into two parts L_3 and L_4 , corresponding to the cases $V_o^{uc} \le V_{\max}^*$ and $V_o^{uc} > V_{\max}^*$. The first part can be written:

$$L_3 = P\left(F_r > F_o, F_r > F_s, V_o^{uc} \le V_{\max}^*, \ln Y_t^* = \ln Y_t, \ln L_r^* = \ln L_r\right)$$

Conditioning on ε_4 and η_3 gives:

$$L_3 = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_3}(\ln L_r - Z_3)P(A_3 \mid \eta_3 = \ln L_r - Z_3)$$

where A_3 denotes the event:

$$\left\{ \begin{array}{c} \eta_1 < \theta_1\left(\ln L_r - Z_6 - \eta_6\right)^2 - Z_1, \\ -\eta_2 < Z_2 - \ln\left(\frac{\rho_t}{p_t}\right), \\ -\eta_2 - \eta_5 < Z_r \end{array} \right\}$$

with $Z_r = Z_2 + Z_5 - \ln L_r$.

We can rewrite the probability $P(A_3 | \eta_3 = \ln L_r - Z_3)$ as $E_{\eta_6}\left[P(A_3 | \eta_3 = \ln L_r - Z_3, \eta_6)\right]$, where the conditional probability in the expectation is now a standard cumulative of the trivariate normal. We approximate this expectation by the sum: $\frac{1}{S}\sum_{s=1}^{S} P(A_3 \mid \eta_3 = \ln L_r - Z_3, \eta_6 = \eta_6^s)$ where $(\eta_6^s)_{s=1,\dots,S}$ are S realisations of the shock η_6. Note that, whereas the method is the same as for the stayers, we now have to take into account the correlations between η_1, η_2 and η_3.

The second term of the likelihood is given by:

$$L_4 = P\left(F_r > F_o, F_r > F_s, V_o^{uc} > V_{\max}^*, \ln Y_t^* = \ln Y_t, \ln L_r^* = \ln L_r\right)$$

This term can be rewritten:

$$L_4 = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_3}(\ln L_r - Z_3) P\left(A_4 \middle| \eta_3 = \ln L_r - Z_3\right)$$

where A_4 denotes the event:

$$\left\{\begin{array}{c} \eta_1 < \theta_1\left(\ln L_r - Z_6 - \eta_6\right)^2 - Z_1, \\ -\eta_2 + \theta_2\left(\eta_2 + \eta_5\right) < Z_2 - \ln\left(\frac{\rho_t}{p_t}\right) - \theta_2 Z_r, \\ \eta_2 + \eta_5 < -Z_r \end{array}\right\}$$

We approximate this term using the same technique as before.

- Mover-owners: we observe $(d_t = o, Y_t^*, V^* = \min\left(V_o^{uc}, V_{\max}^*\right))$. The likelihood contribution is then:

$$L_o = P\left(F_o > F_r, F_o > F_s, \ln Y_t^* = \ln Y_t, \min\left(\ln V_o^{uc}, \ln V_{\max}^*\right) = \ln V\right)$$

We split this probability into two parts, L_5 and L_6, corresponding to the cases $V_o^{uc} \leq V_{\max}^*$ and $V_o^{uc} > V_{\max}^*$. The first part can be written:

$$L_5 = P\left(F_o > F_r, F_o > F_s, V_o^{uc} \leq V_{\max}^*, \ln Y_t^* = \ln Y_t, \ln V_o^{uc} = \ln V\right)$$

Conditioning on ε_4 and $\eta_2 - \eta_3$ gives:

$$L_5 = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_2 - \eta_3}(Z_3 - Z_2 - \ln V) P\left(A_5 \mid \eta_2 - \eta_3 = Z_o\right)$$

where $Z_o = Z_3 - Z_2 - \ln V$ and A_5 denotes the event:

$$\left\{\begin{array}{c}\eta_2 < -Z_2 + \ln(\frac{\rho_t}{p_t}), \\ -\eta_5 < Z_5 - \ln V, \\ \eta_1 + \eta_2 < -Z_1 - Z_2 + \ln(\frac{\rho_t}{p_t}) + \theta_1\left(Z_3 - Z_6 + \eta_3 - \eta_6\right)^2\end{array}\right\}$$

The probability $P(A_5 \mid \eta_2 - \eta_3 = Z_o)$ can be written: $E_{\eta_3,\eta_6}\left[P\left(A_5 \middle| \eta_2 - \eta_3 = Z_o, \eta_3, \eta_6\right)\right]$.

One should also notice that when η_3 is known, the knowledge of V^* implies that $\eta_2 - \eta_3$ is known, so that η_2 also is known. Thus, the probability in the expectation is zero if η_2 is such that $Z_2 - \ln\left(\frac{\rho_t}{p_t}\right) + \eta_2 < 0$. This in turn occurs for $\eta_3 > \ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$. In the reverse case, the condition $Z_2 - \ln\left(\frac{\rho_t}{p_t}\right) + \eta_2 \geq 0$ is always fulfilled, so it disappears from the probability. The simulation method consists in drawing realisations of the shocks (η_3, η_6), η_3 being drawn in a normal distribution truncated above by $\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$, and in approximating the expectation by:

$$\frac{1}{S}\Phi_{\eta_3}\left(\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)\right)\sum_{s=1}^{S} P\left(A_5 \middle| \eta_2 = \eta_3^s + Z_o, \eta_3 = \eta_3^s, \eta_6 = \eta_6^s\right)$$

The second part of the likelihood is given by:

$$L_6 = P\left(F_o > F_r, F_o > F_s, V_o^{uc} > V_{\max}^*, \ln Y_t^* = \ln Y_t, \ln V_{\max}^* = \ln V\right)$$

This term can be rewritten, using the assumption that η_5 is independent of the other residuals η_j, $j \in \{1,2,3,6\}$:

$$L_6 = \varphi_{\varepsilon_4}(\ln Y_t - Z_4)\varphi_{\eta_5}(\ln V - Z_5)P(A_6)$$

where A_6 denotes the event:

$$\left\{\begin{array}{c}\eta_2 - \theta_2(\eta_2 - \eta_3) < -Z_2 - \theta_2 Z_o + \ln(\frac{\rho_t}{p_t}), \\ \eta_2 - \eta_3 < Z_o, \\ \eta_1 + \eta_2 - \theta_2(\eta_2 - \eta_3) < -Z_1 - Z_2 - \theta_2 Z_o + \ln(\frac{\rho_t}{p_t}) + \theta_1\left(Z_3 - Z_6 + \eta_3 - \eta_6\right)^2\end{array}\right\}$$

When η_3 is known, the first two inequalities in A_6 express conditions on η_2. We have three cases:

- $\theta_2 < 1$: then the two conditions can be rewritten as $\eta_2 < C_1, \eta_2 < C_2$, so they melt down into one condition. Calculation shows that $C_1 < C_2$ iff $\eta_3 > \ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$. Then the probability

$P(A_6)$ can be expressed as:

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)} f_1(x,y)\varphi_{\eta_3}(x)\varphi_{\eta_6}(y)dxdy + \int_{-\infty}^{+\infty}\int_{\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)}^{+\infty} f_2(x,y)\varphi_{\eta_3}(x)\varphi_{\eta_6}(y)dxdy$$

where $f_1(.,.)$ and $f_2(.,.)$ are two functions of η_3 and η_6.

- $\theta_2 = 1$: the first condition is $\eta_3 < \ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$, the second $\eta_2 < C_2$, so only the first integral of the previous case remains and $P(A_6)$ is of the form

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)} f_1(x,y)\varphi_{\eta_3}(x)\varphi_{\eta_6}(y)dxdy$$

- $\theta_2 > 1$: then the two conditions can be rewritten as $\eta_2 > C_1, \eta_2 < C_2$. This gives a nonzero probability only when $C_1 < C_2$, which as calculation shows happens for $\eta_3 < \ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$. In that case, we can write the probability $P(A_6)$ as $\int_{-\infty}^{+\infty}\int_{-\infty}^{\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)} f_3(x,y)\varphi_{\eta_3}(x)\varphi_{\eta_6}(y)dxdy$, where $f_3(.,.)$ is a function of η_3 and η_6.

In all cases, the simulation method consists in estimating the integrals, drawing realisations of the shocks η_6 in a normal distribution and η_3 in a normal distribution truncated above or below by $\ln V - Z_3 + \ln\left(\frac{\rho_t}{p_t}\right)$ depending on the term to approximate.

Appendix B: simulation method

This section briefly describes our simulation method. We draw once for all $S = 1,000$ replications of the residuals η_i, $i \in \{1,2,3,5,6\}$ and ε_4 for the N observations. They are noted η_i^{ns} and ε_4^{ns}. With these draws, we construct $\varepsilon_i^{ns} = \hat{\lambda}_i \varepsilon_4^{ns} + \eta_i^{ns}$ and finally deduce the outcome of the discrete decision rule d_t^{ns}.

1) We first estimate the flows in each category predicted by the model that are given by $NP(d_t = j)$ with $j \varepsilon \{r,s,o\}$. We can write that:

$$P(d_t = j) = E_X\left[P(d_t = j | X)\right]$$

The frequency simulator of this quantity is then given by:

$$\hat{P}(d_t = j) = \frac{1}{NS}\sum_{n=1}^{N}\sum_{s=1}^{S}1_{\{d_t^{ns}=j\}}$$

The predicted flows, $N\hat{P}(d_t = j)$, are finally compared to the observed ones.

2) We next look at conditional expectations, that is: the expected maximum housing value and the desired value for each category, $E(V_{\max}|d_t = j)$ and $E(V_o^{uc}|d_t = j)$; the expected purchase value for mover-owners, $E(V|d_t = o)$; and the expected rent for mover-renters, $E(L_r|d_t = r)$. The simulation of all these quantities is based on the same principle. We write:

$$E(V_{\max}|d_t = j) = \frac{E(V_{\max}1_{\{d_t=j\}})}{P(d_t = j)}$$

In order to approximate $E(V_{\max}1_{\{d_t=j\}})$, we rewrite it as:

$$E(V_{\max}1_{\{d_t=j\}}) = E_X\left[E(V_{\max}1_{\{d_t=j\}}|X)\right]$$

An estimator of $E(V_{\max}1_{\{d_t=j\}})$ is then given by:

$$\hat{E}(V_{\max}1_{\{d_t=j\}}) = \frac{1}{NS}\sum_{n=1}^{N}\sum_{s=1}^{S}V_{\max}^{ns}1_{\{d_t^{ns}=j\}}$$

Where $V_{\max}^{ns} = X_5^n\hat{\gamma}_5 + \varepsilon_5^{ns}$. Finally, an estimator of $E(V_{\max}|d_t = j)$ is:

$$\hat{E}(V_{\max}|d_t = j) = \frac{\hat{E}(V_{\max}1_{\{d_t=j\}})}{\hat{P}(d_t = j)}$$

We use the same kind of method to compute estimators of $E(V_o^{uc}|d_t = j)$, $E(V|d_t = o)$, and $E(L_r|d_t = r)$.

TABLE 1
Summary Statistics for the NHS Sample (Weighted)

Variable	Mobility/Tenure Choice Between 1992 and 1996			
	All Households	Stayers	Mover-owners	Mover-renters
Number (million)	3.342	1.730	.605	1.008
Proportion in NHS Sample	1.000	.517	.181	.301
Household annual income (thousands of €)	25	22	34	24
	(18)	(16)	(21)	(17)
Computed Total Net Wealth in 1992 (thousands of €)	34	28	46	37
	(73)	(45)	(59)	(108)
Maximum Value (thousands of €)	98	84	135	98
	(104)	(79)	(100)	(135)
Dwelling value (thousands of €)	//	//	103	//
	//	//	(64)	//
Annual Rent (thousands of €)	//	4.0	//	5.3
	//	(3.0)	//	(2.6)
Detached House	.318	.320	.413	.259
	(.466)	(.466)	(.493)	(.438)
Housing Vacancy Rate in Town in 1990	7.465	7.548	7.114	7.532
	(2.814)	(2.828)	(2.878)	(2.736)
Socio-Economic Index of Neighbourhood	.096	.088	.061	.130
	(.416)	(.418)	(.406)	(.414)
Family Composition				
Male	.741	.676	.901	.757
	(.438)	(.468)	(.299)	(.429)
Married	.592	.509	.839	.585
	(.492)	(.500)	(.368)	(.493)
Divorced	.137	.148	.078	.154
	(.344)	(.355)	(.268)	(.361)
Number of children in 1992	.563	.558	.713	.483
	(.926)	(.948)	(.941)	(.865)
Number of children born between 1992 and 1996	.269	.144	.508	.341
	(.551)	(.412)	(.690)	(.603)
Foreigner	.080	.083	.050	.093
	(.271)	(.276)	(.217)	(.290)
Occupies a job in 1992	.763	.656	.932	.845
	(.425)	(.475)	(.251)	(.362)
Civil Servant	.081	.061	.118	.093
	(.273)	(.240)	(.323)	(.290)
Spouse being job occupied	.334	.252	.574	.330
	(.472)	(.434)	(.495)	(.471)
Age in 1992				
Less than 30 years	.272	.146	.355	.438
	(.445)	(.353)	(.479)	(.496)
From 30 to 34 years	.157	.120	.242	.168
	(.363)	(.325)	(.428)	(.374)
From 35 to 39 years	.122	.118	.130	.124
	(.327)	(.322)	(.336)	(.330)
From 40 to 49 years	.176	.208	.158	.132
	(.381)	(.406)	(.365)	(.339)
50 years and more	.274	.408	.116	.138
	(.446)	(.492)	(.320)	(.345)

Note: Variables concern the year 1996 except when specified

ESTIMATION RESULTS

TABLE 2
(s,S) rule and Borrowing Constraints Parameters

Parameter	Estimated value	Standard Err.	P> |T|
θ_1	0.0397	0.0141	0.0049
θ_2	0.5243	0.0395	0.0000

TABLE 3
NHS Income Equation

Variable	Parameter	Standard Err.	P> |T|
Constant	11.8548	0.0218	<0.001
No diploma – reference			
University diploma more than two year's study, engineer school diploma	0.8548	0.0218	<0.001
University diploma two years study	0.6200	0.0291	<0.001
High school diploma and equivalent	0.4134	0.0446	<0.001
Vocational training certificate	0.2716	0.0212	<0.001
School certificate (taken at 16 years)	0.4109	0.0231	<0.001
No spouse being job occupied – reference			
Spouse having a job	0.2980	0.0203	<0.001
Age in 1992: from 35 to 39 years – reference			
Less than 30 years	-0.1586	0.0244	<0.001
From 30 to 34 years	-0.0225	0.0269	0.4030
From 40 to 49 years	0.0617	0.0238	0.0096
More than 50 years	0.0144	0.0245	0.5576
Town size: 100,000 – 2,000,000 inhabitants - reference			
Rural	-0.0711	0.0240	0.0030
Less than 20,000 inhabitants	0.0021	0.0289	0.9430
20,000 – 100,000 inhabitants	-0.0200	0.0220	0.3624
Paris	0.1649	0.0181	<0.001
Living alone – reference			
Living in couple	0.4715	0.0175	<0.001

TABLE 4
NWS Income Equation

Variable	Parameter	Standard Err.	P>|T|
EP Income equation			
Constant	11.1214	0.0372	0.0012
No diploma – reference			
University diploma more than two year's study, engineer school diploma	0.6115	0.0300	<0.001
University diploma two years study	0.5142	0.0360	<0.001
High school diploma and equivalent	0.2685	0.0285	<0.001
Vocational training certificate	0.2709	0.0254	<0.001
School certificate (taken at 16 years)	0.2839	0.0368	<0.001
No spouse having a job – reference			
Spouse having a job	0.2820	0.0338	<0.001
Age in 1992: from 35 to 39 years – reference			
Less than 30 years	-0.4443	0.0362	<0.001
From 30 to 34 years	-0.1438	0.0403	0.0004
From 40 to 49 years	0.0537	0.0381	0.1590
More than 50 years	-0.0413	0.0368	0.2620
Town size: 100,000 – 2,000,000 inhabitants - reference			
Rural	0.0670	0.0306	0.0286
Less than 20,000 inhabitants	0.0634	0.0269	0.0182
20,000 – 100,000 inhabitants	0.0121	0.0222	0.5874
Paris	0.0766	0.0286	0.0074
Living alone – reference			
Living in couple	0.4082	0.0320	<0.001

TABLE 5
Maximum Value Equation

Variable	Parameter	Standard Err.	P>|T|
Constant	-5.4802	0.7388	<0.001
Logarithm of income	1.5512	0.0650	<0.001
No secondary house – reference			
Owns a secondary house	0.6706	0.0753	<0.001
Age in 1992: from 35 to 39 years – reference			
Less than 30 years	0.1796	0.0531	0.0008
From 30 to 34 years	0.0814	0.0580	0.1608
From 40 to 49 years	-0.0919	0.0523	0.0790
More than 50 years	0.2407	0.0499	<0.001
No house in hiring – reference			
Hires a house	0.9330	0.0926	<0.001
No spouse having a job – reference			
Spouse having a job	-0.0213	0.0461	0.6438
Living alone – reference			
Living in couple	-0.2523	0.0457	<0.001

TABLE 6
Moving Costs Equation

Variable	Parameter	Standard Err.	P>|T|
Constant	0.6131	0.0784	<0.001
Number of children in 1992	0.0688	0.0278	0.0134
Number of children born between 92 and 96	-0.1419	0.0483	0.0034
Living alone – reference			
Living in couple	-0.0212	0.0532	0.6894
Not divorced – reference			
Divorced	-0.2884	0.0645	<0.001
Age in 1992: from 35 to 39 years - reference			
Less than 30 years	-0.5770	0.0806	<0.001
From 30 to 34 years	-0.1133	0.0864	0.1900
From 40 to 49 years	0.3013	0.0823	0.0002
More than 50 years	0.6699	0.0846	<0.001

TABLE 7
User Cost Equation

Variable	Parameter	Standard Err.	P>|T|
Constant	-1.1955	0.1142	<0.001
Housing vacancy rate in town in 1990	1.0275	0.5786	0.0758
Proportion of renters in town in 1990	0.1561	0.2134	0.4646
Age in 1992: from 35 to 39 years - reference			
Less than 30 years	0.0114	0.0639	0.8590
From 30 to 34 years	-0.1411	0.0663	0.0332
From 40 to 49 years	-0.0000	0.0652	0.9998
More than 50 years	0.1113	0.0754	0.1398
Nationality: French – reference			
Foreigner	0.0249	0.0744	0.7384
Job occupation: not unemployed – reference			
Unemployed	-0.2837	0.0632	<0.001
House status: not a detached house - reference			
Detached house	-0.0883	0.0393	0.0246
Residential location: do not live in Paris - reference			
Living in Paris	-0.2219	0.0426	<0.001

TABLE 8
Rent Equation

Variable	Parameter	Standard Err.	P>|T|
Constant	7.4424	0.2686	<0.001
Logarithm of income	0.3421	0.0226	<0.001
Socio-economic index	0.2940	0.0296	<0.001
Number of children in 1992	0.0677	0.0107	<0.001
Number of children born between 92 and 96	0.0710	0.0174	<0.001
Town size: 100,000 – 2,000,000 inhabitants - reference			
Rural	-0.1052	0.0288	0,0002
Less than 20,000 inhabitants	-0.0516	0.0315	0.1008
20,000 – 100,000 inhabitants	0.0112	0.0275	0.6840
Paris	0.0081	0.0260	0.7540
Not divorced – reference			
Divorced	0.0880	0.0265	0.0008
No secondary house – reference			
Owns a secondary house	-0.0399	0.0297	0.1800
Job status : not a civil servant – reference			
Civil servant	0.0240	0.0321	0.4540

TABLE 9
Previous Rent Equation

Variable	Parameter	Standard Err.	$P>\lvert T\rvert$
Constant	11.2941	0.0883	<0.001
Socio-economic index	0.5560	0.0439	<0.001
Town size: 100,000 – 2,000,000 inhabitants - reference			
Rural	-0.2376	0.0420	<0.001
Less than 20,000 inhabitants	0.0061	0.0678	0.9284
20,000 – 100,000 inhabitants	-0.0528	0.0397	0.1834
Paris	0.1575	0.0420	0.0002
Year the occupied house was built :			
1982 and after – reference			
Before 1948	-0.5780	0.0778	<0.001
1949 – 1974	-0.3219	0.0795	<0.001
1975 – 1981	-0.0839	0.0911	0.3566
One room – reference			
Two rooms	0.2186	0.0475	<0.001
Three rooms	0.3984	0.0472	<0.001
Four rooms	0.5302	0.0492	<0.001
Five rooms	0.6568	0.0562	<0.001
Six rooms and more	0.9153	0.0618	<0.001

TABLE 10
Variance and Covariance Parameters

Parameter	Estimated value	Standard Err.	$P>\lvert T\rvert$
σ_1	0.1330	0.0446	0.0029
σ_2	0.5709	0.0577	0.0001
σ_3	0.3738	0.0090	0.0001
σ_4 (NHS)	0.4761	0.0037	0.0001
σ_4 (NWS)	0.5677	0.0040	0.0001
σ_5	0.7519	0.0070	0.0001
σ_6	0.5559	0.0087	0.0001
λ_1	0.0228	0.0097	0.0097
λ_2	-0.1078	0.0368	0.0017
λ_3	-0.0952	0.0276	0.0003
λ_5	-0.7162	0.0677	<0.001
λ_6	0.1291	0.0273	<0.001
ρ_{12}	-0.4964	0.1300	0.0001
ρ_{13}	-0.3531	0.0641	0.0001
ρ_{23}	0.3823	0.0742	0.0001

TABLE 11
Fit of the Model

	Whole sample	Age Bracket				
		Less than 30	30-34	35-39	40-49	50 or more
Stayers						
Simulated Number	1,726,121	254,884	209,018	204,167	354,119	703,932
Observed Number	1,729,846	252,172	208,160	203,607	359,440	706,467
Difference	-3,725	+2,712	+858	+560	-5,321	-2,535
Prediction Rate (%)[a]	99.8	101.1	100.4	100.3	98.5	99.6
Maximum Value (€)	103,174	87,446	106,938	112,258	111,550	100,904
Mover-renters						
Simulated Number	1,002,564	440,039	165,016	125,085	134,414	138,010
Observed Number	1,007,557	441,002	169,069	124,973	133,120	139,393
Difference	-4,993	-963	-4,053	+112	+1294	-1383
Prediction Rate (%)	99.5	99.8	97.6	100.1	101.0	99.0
Predicted Rent (€)	20,364	19,610	22,410	21,528	21,783	17,880
Observed Rent (€)	21,118	19,442	23,202	23,190	22,885	20,349
Maximum Value (€)	102,486	95,554	120,476	108,678	102,693	97,265
Mover-owners						
Simulated Number	614,159	213,426	149,459	77,749	99,660	73,865
Observed Number	605,441	215,175	146,265	78,421	95,633	69,947
Difference	+8,718	-1749	+3,194	-672	+4,027	+3,918
Prediction Rate (%)	101.4	99.2	102.2	99.1	104.2	105.6
Maximum Value (€)	191,784	156,662	198,594	222,193	223,731	204,375
Predicted Purchase Value (€)	98,670	87,598	108,595	106,006	109,377	88,415
Observed Purchase value (€)	102,811	88,674	110,671	109,382	122,570	95,482

[a]: Prediction rates are computed as the ratio of the predicted and observed numbers in each category.

TABLE 12
Deviations From Benchmark When V_{max} Is Increased by 10%

	Whole sample	By Age Bracket				
		Less than 30	30-34	35-39	40-49	50 or more
Stayers						
Simulated Number	-27,747	-7,112	-6,174	-3,910	-5,593	-4,958
Maximum Value (€)	+11,087	+9,729	+12,172	+12,223	+11,963	+10,467
% Constrained[a] (pts)	-3.6	-3.8	-3.6	-3.5	-3.3	-3.6
Mover-Renters						
Simulated Number	-10,506	-5,579	-2,477	-1,150	-895	-405
Maximum Value (€)	+10,731	+10,084	+12,904	+11,355	+10,546	+9,904
% Constrained[a] (pts)	-3.7	-3.9	-3.9	-3.6	-3.2	-3.5
Mover-owners						
Simulated Number	+38,252	+12,691	+8,651	+5,059	+6,488	+5,363
Maximum Value (€)	+10,714	+9,519	+11,799	+11,636	+11,745	+9,085
Purchase Value (€)	+1,439	+1,757	+1,800	+1,334	+1,246	+218
% Constrained[a] (pts)	-2.2	-2.3	-2.5	-1.8	-1.9	-1.7
All						
Maximum Value (€)	+11,925	+10,764	+13,737	+13,216	+12,853	+10,870
% Constrained[a] (pts)	-3.5	-3.6	-3.6	-3.4	-3.2	-3.5

[a]: The proportion of constrained households refers to the proportion of households for which the borrowing constraint is binding. It is simulated following the same method as for the other endogenous variables of the model, as detailed in Appendix B.

TABLE 13
Deviations From Benchmark When the PTZ Is Introduced

	Whole sample	By Age Bracket				
		Less than 30	30-34	35-39	40-49	50 or more
Stayers						
Simulated Number	-52,552	-14,569	-11,030	-7,084	-9,197	-10,672
Maximum Value (€)	+8,886	+10,087	+10,408	+9,314	+8,451	+8,028
% Constrained[a] (pts)	-8.0	-7.8	-6.3	-6.5	-6.0	-9.8
Mover-renters						
Simulated Number	-20,798	-11,761	-4,215	-2,119	-1,757	-947
Maximum Value (€)	+8,291	+8,733	+8,526	+8,121	+7,552	+7,519
% Constrained[a] (pts)	-8.4	-8.4	-6.9	-8.1	-7.9	-11.0
Mover-owners						
Simulated Number	+73,350	+26,330	+15,245	+9,203	+10,953	+11,619
Maximum Value (€)	-10,776	-6,836	-9,287	-14,194	-13,556	-17,091
Purchase Value (€)	-3,217	-1,964	-3,015	-3,949	-4,121	-4,331
% Constrained[a] (pts)	+1.2	+0.8	+0.9	+1.6	+1.9	+1.5
All						
Maximum Value (€)	+6,616	+6,883	+6,193	+6,436	+6,225	+6,924
% Constrained[a] (pts)	-6.4	-6.1	-4.5	-5.6	-5.3	-9.0

[a]: The proportion of constrained households refers to the proportion of households for which the borrowing constraint is binding. It is simulated following the same method as for the other endogenous variables of the model, as detailed in Appendix B.

TABLE 14
Maximum Value and Purchase Value for Households Choosing to Move and Own When the PTZ Is Introduced, Broken Down by Mobility and Tenure Choice Without the PTZ.

	Average Values			
	Without PTZ		With PTZ	
Mobility and tenure choice without PTZ (observed)	Maximum Value (€)	Purchase Value (€)	Maximum Value (€)	Purchase Value (€)
Stayers	36,000	//	45,100	45,000
Mover-renters	37,500	//	46,800	46,500
Mover-owners	191,700	98,600	197,100	101,400
All	175,200	92,200	181,000	95,400

FIGURE 1:
Mobility and Tenure Choice (numbers)

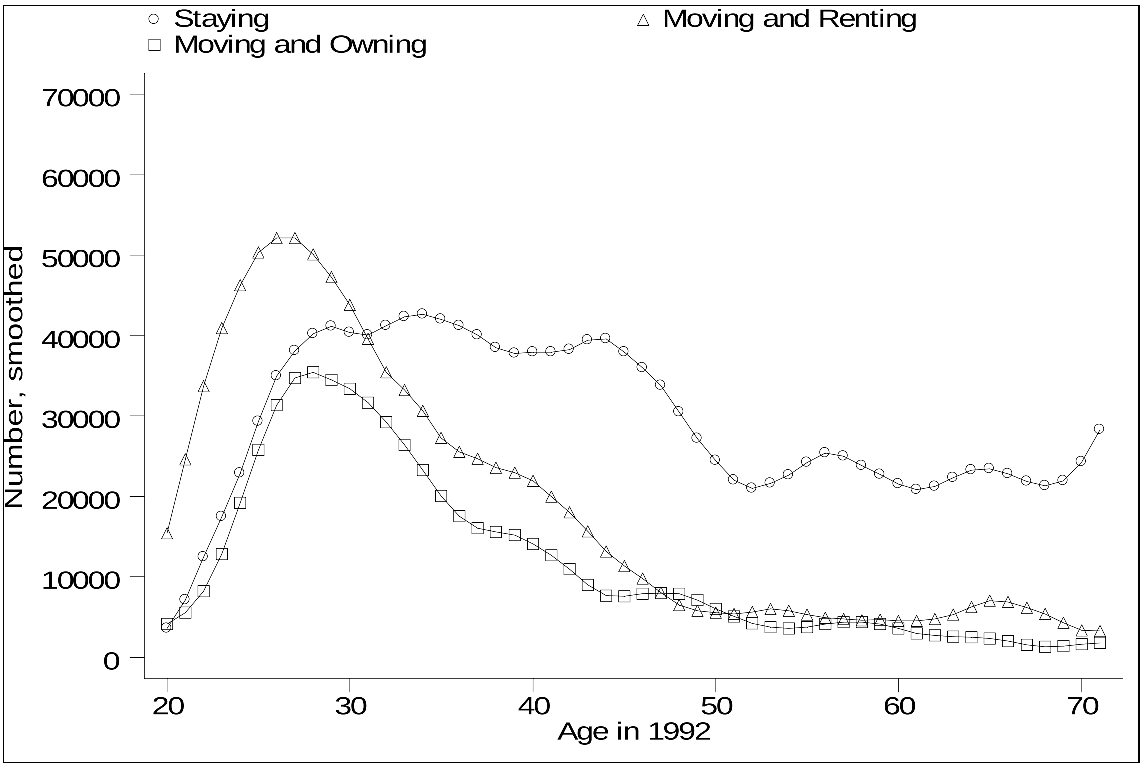

FIGURE 2:
Mobility and Tenure Choice (proportions)

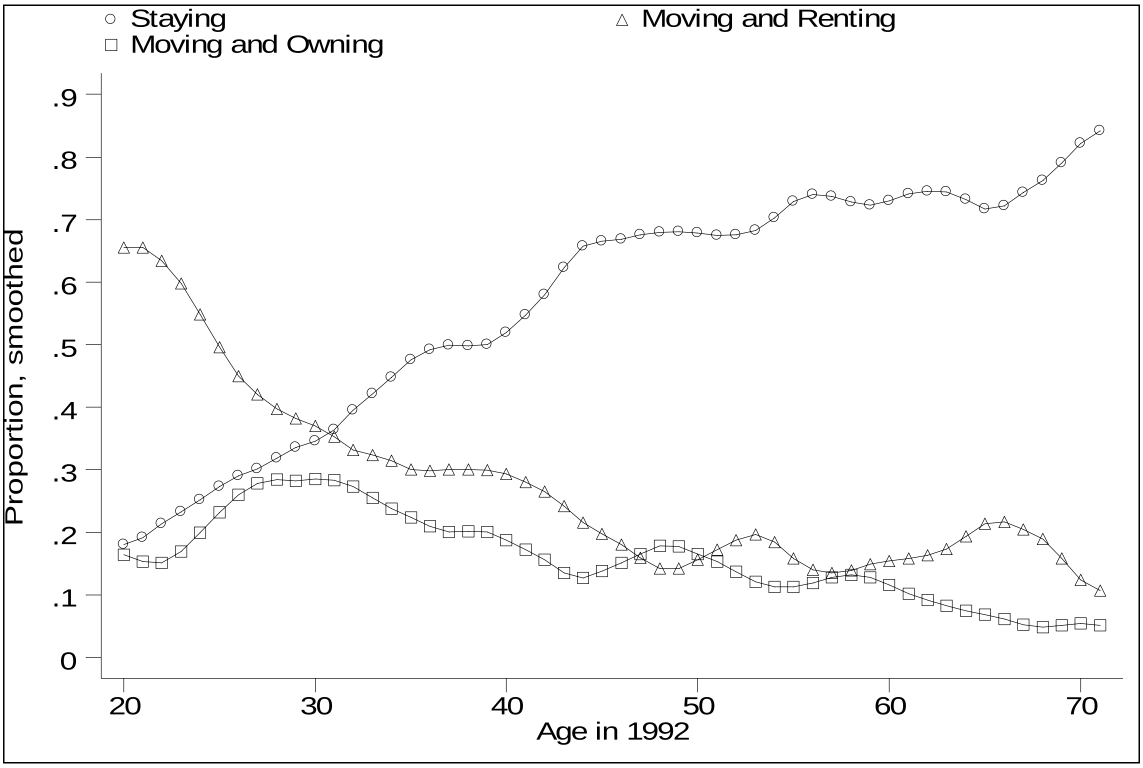

FIGURE 3:
Dwelling Value, Maximum Value and Wealth (median)

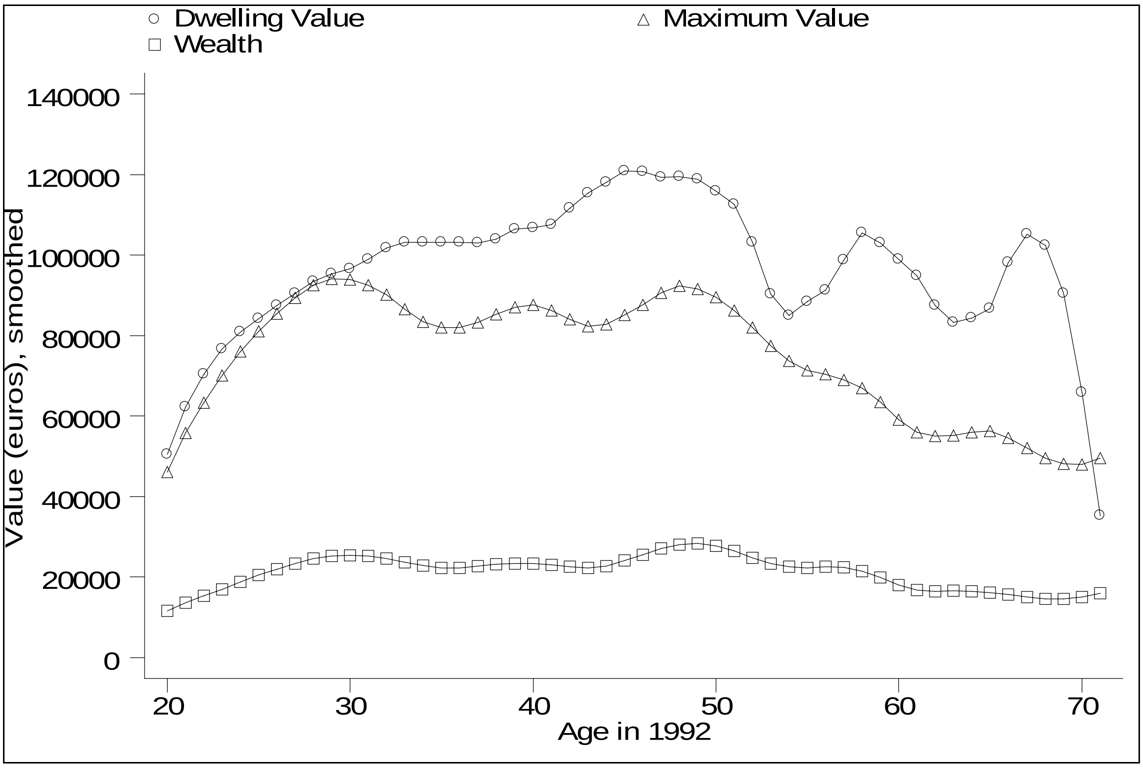

FIGURE 4:
Percentage Income Constraint in V_{max}