

Supplementary Appendix to "Housing purchases and the dynamics of housing wealth": Additional results

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November 2010

1 Purchase hazards from retrospective histories

Investment vs. consumption use: alternative expected return measures

Table A1 explores alternative measures of expected returns that could be thought more appropriate for an investor type household than the one in Table 5. First, we consider the index of the Madrid stock exchange as an alternative to the aggregate interest rate. Second, expectations of housing returns two years ahead instead of five years ahead are introduced.

Table A1
Alternative measures of expected returns
Multinomial hazards for retrospective secondary housing purchases 1980-2001
Investment vs. consumption

	1		2	
	Consumption	Investment	Consumption	Investment
Secondary education	0.528 (2.17)	0.035 (0.10)	0.415 (1.74)	0.102 (0.31)
University education	1.301 (5.49)	0.434 (1.55)	1.275 (5.65)	0.436 (1.60)
Age	0.345 (5.14)	0.139 (1.81)	0.334 (5.20)	0.162 (2.13)
Age squared	-0.003 (4.79)	-0.001 (1.98)	-0.003 (4.92)	-0.002 (2.31)
$\Delta \ln \widehat{HP}_{t+5,t} - indStockEx^1$	0.579 (1.22)	0.658 (0.95)	—	—
$\Delta \ln \widehat{HP}_{t+2,t} - i$	—	—	4.436 (3.18)	3.087 (2.12)
Previous other housing	-0.529 (1.76)	0.262 (1.05)	-0.559 (1.92)	0.218 (0.90)
Constant	-13.429 (8.70)	-8.676 (4.72)	-13.065 (8.82)	-9.183 (5.00)

¹Aggregate HP and index of Madrid stock exchange
(change in the log annual average index)

Investment vs. consumption use: alternative volatility measure In Table A2 we use an alternative volatility measure based on a five year moving window of the variance of the change in (log) observed house prices. The results are to be compared with those in Table 5 (columns 3 and 4) where we use a volatility measure derived from an AR(2)ARCH(1) model.

Table A2
Alternative measure of volatility
Multinomial hazards for retrospective secondary housing purchases
1980-2001
Investment vs. consumption

	Consumption	Investment
Secondary education	0.405 (1.66)	-0.056 (0.16)
University education	1.225 (5.30)	0.380 (1.34)
Age	0.352 (5.26)	0.146 (1.89)
Age squared	-0.004 (5.01)	-0.002 (2.13)
$\Delta \ln \widehat{HP}_{t+5,t} - i$	7.469 (3.90)	6.100 (2.92)
$\widehat{Volatility}_{t+5}^1$	5.357 (1.15)	-1.956 (0.36)
Previous other housing	-0.562 (1.87)	0.247 (0.98)
Constant	-13.956 (8.69)	-8.858 (4.90)

¹Five year moving average window standard deviation of the annual change in log house prices.

2 Purchase probabilities over the sample period

Table A3 expands the set of controls taking the results in Table 6 (column 2) as the benchmark.

Table A3
Additional controls
Hazards for the timing of secondary housing purchases
2002-2006

	1	2	3
Secondary education	0.409 (1.62)	0.427 (1.67)	0.396 (1.53)
University education	0.793 (3.51)	0.835 (3.52)	0.712 (3.03)
Age	0.133 (2.02)	0.097 (1.63)	0.094 (1.57)
Age squared	-0.001 (2.40)	-0.001 (2.14)	-0.001 (2.09)
Married	0.720 (2.30)	0.713 (2.40)	0.688 (2.29)
$\Delta \ln \widehat{HP}_{t+5,t} - i_{incomegroup}$	13.749 (2.45)	12.987 (2.33)	13.161 (2.30)
Income (in million euro)	0.480 (1.60)	0.440 (1.48)	0.430 (1.35)
At least one child < 16 years old	0.166 (0.69)	—	—
At least one child \geq 16 years old	-0.324 (1.56)	—	—
\ln (n° inhabitants in municipality)	—	-0.015 (0.33)	—
Province dummies	—	—	included
Previous other housing	0.364 (1.89)	0.337 (1.75)	0.300 (1.48)
Constant	-9.297 (5.00)	-8.040 (4.72)	-8.316 (4.21)

Investment vs. consumption use Table A4 reports results for a competing risks model for the period 2002-2006. First, a model similar to the one for retrospective purchases (Table 5, columns 1 and 2) is presented. Second, the non-model based volatility measure is introduced, the model based volatility measure showing almost no variation for the period 2002-2006.

Table A4
Multinomial hazards for secondary housing purchases 2002-2006
Investment vs. consumption

	1		2	
	Consumption	Investment	Consumption	Investment
Secondary education	0.470 (1.22)	0.365 (1.11)	0.471 (1.23)	0.345 (1.05)
University education	1.025 (3.01)	0.643 (2.15)	1.027 (3.02)	0.623 (2.08)
Age	0.100 (1.12)	0.098 (1.26)	0.100 (1.12)	0.094 (1.20)
Age squared	-0.001 (1.35)	-0.001 (1.74)	-0.001 (1.35)	-0.001 (1.70)
Married	0.909 (1.92)	0.578 (1.52)	0.909 (1.92)	0.585 (1.54)
$\Delta \ln \widehat{HP}_{t+5,t} - i$	14.932 (1.72)	11.581 (1.58)	14.754 (1.70)	13.278 (1.67)
$\widehat{Volatility}_{t+5}$ ¹	-	-	2.138 (0.17)	-31.588 (2.40)
Income (in million euro)	0.210 (0.29)	0.530 (1.67)	0.200 (0.28)	0.540 (1.69)
Previous other housing	-0.105 (0.36)	0.688 (2.67)	-0.105 (0.36)	0.689 (2.67)
Constant	-9.675 (3.74)	-8.408 (3.86)	-9.710 (3.74)	-7.892 (3.58)

¹Five year moving average window standard deviation of the annual change in log house prices.

3 Heterogeneous responses to expected returns

Table A5 reports evidence on heterogeneity of the effect of expected returns. The first three columns expand on the specification in Table 4 (column 2) and the last column on the one in Table 6 (column 2).

Table A5
Heterogeneous responses of housing returns
Hazards for the timing of secondary housing purchases

	1980-2001			2002-2006
Secondary education	0.271 (1.39)	0.238 (1.22)	0.209 (1.07)	0.114 (0.44)
University education	0.694 (3.20)	0.942 (5.37)	0.926 (5.30)	0.194 (0.75)
Age	0.259 (5.19)	0.268 (5.35)	0.269 (5.37)	0.050 (0.87)
Age squared	-0.003 (5.19)	-0.003 (5.36)	-0.003 (5.42)	-0.001 (1.37)
Married	—	—		0.450 (1.49)
$\Delta \ln \widehat{HP}_{t+5,t} - i$	3.447 (2.26)	4.390 (4.01)		—
$\Delta \ln \widehat{HP}_{t+5,t} - i$ * university education	5.010 (1.80)	—		—
$\Delta \ln \widehat{HP}_{t+5,t} - i$ * overvaluation ¹	—	-9.431 (1.84)		—
positive($\Delta \ln \widehat{HP}_{t+5,t} - i$)	—	—	9.474 (5.72)	—
negative($\Delta \ln \widehat{HP}_{t+5,t} - i$)	—	—	-3.596 (2.09)	—
$\Delta \ln \widehat{HP}_{t+5,t} - i_{incomegroup}$	—	—		-81.382 (3.38)
$\Delta \ln \widehat{HP}_{t+5,t} - i_{incomegroup}$ * ln (income)	—	—		8.218 (3.99)
Income (in million euro)	—	—		-1.400 (0.98)
Previous other housing	-0.263 (1.42)	-0.248 (1.34)	-0.259 (1.40)	0.134 (0.68)
Constant	-10.715 (9.10)	-11.021 (9.34)	-11.312 (9.54)	-5.708 (3.41)

¹Overvaluation is measured as the difference between (log) observed house price and the long run equilibrium (from an update of the preferred model in Martínez Pagés and Maza, 2003)

To obtain the measure of overvaluation we use an updated version up to 2006 of the following estimated model of house prices in Martínez Pagés and Maza (2003):

$$\Delta \ln hp_t = 0.7 + 0.6 \Delta \ln hp_{t-1} + 1.9 \Delta \ln y_t$$

$$(4.5) \quad (4.6) \quad (3.9)$$

$$-1.3\Delta i_t - 0.1r_t * D95$$

$$(1.9) \quad (2.5)$$

$$-0.2(\ln hp_{t-1} - \ln y_{t-1}) - 0.9i_{t-1}$$

$$(4.0) \quad (4.3)$$

$$R^2 = 0.86 \quad \text{Annual data 1978-2002}$$

where hp_t denotes real house prices, y_t is real disposable per capita income, i_t is an interest rate, and r_t is real return on the Madrid stock exchange.

4 Duration dependence

Table A6 reports results on duration dependence in the hazards for retrospective purchases. The benchmark for column 1 is column 2 in Table 4 and for columns 2 and 3 it is columns 1 and 2 in Table 5.

Table A6
Duration dependence
Hazards for retrospective purchases
Secondary housing, 1980–2001

		Consumption	Investment
Secondary education	0.253 (1.30)	0.387 (1.63)	0.069 (0.21)
University education	0.971 (5.43)	1.289 (5.67)	0.404 (1.45)
Age	0.240 (4.88)	0.297 (4.68)	0.162 (2.15)
Age squared	−0.003 (4.98)	−0.003 (4.56)	−0.002 (2.34)
$\Delta \ln \widehat{HP}_{t+5,t} - i$	4.705 (3.72)	4.976 (3.03)	4.252 (2.16)
No previous 2ndary *	−0.353 (2.09)	−0.520 (2.37)	−0.014 (0.05)
up to 6 years since bought main			
With previous 2ndary *	0.493 (1.32)	0.536 (0.90)	0.484 (1.15)
up to 6 years since bought previous			
Previous other housing	−0.560 (2.45)	−0.947 (2.68)	0.038 (0.12)
Constant	−10.078 (8.62)	−11.947 (8.06)	−9.261 (5.09)

Table A7 reports results on duration dependence in the hazards over the sample period. The benchmark for column 1 is column2 in Table 6 and for columns 2 and 3 it is columns 1 and 2 in Table A4.

Table A7
Duration dependence
Hazards for secondary housing purchases
2002-2006

		Consumption	Investment
Secondary education	0.413 (1.64)	0.473 (1.23)	0.366 (1.11)
University education	0.821 (3.63)	1.039 (3.04)	0.650 (2.17)
Age	0.083 (1.41)	0.082 (0.92)	0.090 (1.15)
Age squared	-0.001 (1.95)	-0.001 (1.19)	-0.001 (1.65)
Married	0.713 (2.40)	0.906 (1.91)	0.574 (1.51)
$\Delta \ln \widehat{HP}_{t+5,t} - i_{incomegroup}$	13.385 (2.39)	15.473 (1.78)	11.816 (1.61)
Income (in million euro)	0.450 (1.48)	0.210 (0.29)	0.540 (1.68)
No previous 2ndary *	-0.548 (1.32)	-0.702 (1.12)	-0.393 (0.71)
up to 6 years since bought main			
With previous 2ndary *	0.077 (0.28)	0.042 (0.09)	0.086 (0.25)
up to 6 years since bought previous			
Previous other housing	0.238 (1.08)	-0.195 (0.58)	0.599 (2.02)
Constant	-7.763 (4.65)	-9.109 (3.52)	-8.140 (3.72)

5 Controlling for debt

Table A8 reports the results obtained adding the ratio of outstanding debt over gross wealth to the target and band specifications reported in Table 9.

Table A8
Adding outstanding debt over gross wealth
Estimates of (S, s) rule target and band

Target level equation		<i>t</i> – ratio
Self-employed	–0.185	(6.44)
Partner self-employed	–0.148	(3.58)
Head not working	–0.069	(3.34)
Other adult inactive	–0.048	(2.43)
$\Delta \ln \widehat{HP}_{2007,2002} - i_{incomegroup}$	1.131	(3.44)
Permanent income (in thousand euros)	–0.001	(4.00)
Wealth (in million euros)	–0.062	(7.61)
Debt/gross wealth	0.097	(1.42)
Constant	0.897	(24.89)
Standard deviation	0.179	(29.55)
Bandwidth equation		
$\Delta \ln \widehat{HP}_{2007,2002} - i_{incomegroup}$	–2.229	(0.71)
Permanent income (in thousand euros)	–0.008	(2.85)
Wealth (in million euros)	–0.293	(3.01)
Debt/gross wealth	–0.521	0.90
Constant	0.760	(2.56)
Standard deviation	2.225	(23.11)

In Table A9 we report the results for two specifications of the purchase probability equation over the period 2002-2006 that add to the specification in Table 6 column 2 the ratio of outstanding debt over gross wealth and a 0/1 dummy for the holding of debt, respectively.

Secondary education	0.409 (1.63)	0.411 (1.64)
University education	0.810 (3.59)	0.811 (3.59)
Age	0.095 (1.61)	0.095 (1.60)
Age squared	-0.001 (2.10)	-0.001 (2.11)
Married	0.707 (2.36)	0.716 (2.41)
$\Delta \ln \widehat{HP}_{t+5,t} - i_{incomegroup}$	13.019 (2.34)	13.015 (2.33)
Income (in million euro)	0.440 (1.47)	0.440 (1.47)
0/1 Dummy if any debt	0.042 (0.21)	-
Debt/gross wealth	-	-0.016 (0.02)
Previous other housing	0.340 (1.76)	0.336 (1.72)
Constant	-8.180 (4.91)	-8.160 (4.77)