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Systematic mistakes in the mortgage market and lack of financial sophistication☆

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ABSTRACT

Institutions often offer a menu of contracts to consumers in an attempt to create a separating equilibrium that reveals borrower types and provides better pricing. We test the effectiveness of a specific set of contracts in the mortgage market: mortgage points. Points allow borrowers to exchange an upfront amount for a decrease in the mortgage rate. We document that, on average, points takers lose about $700. Also, points takers are less financially savvy (less educated, older), and they make mistakes on other dimensions (e.g., inefficiently refinancing their mortgages). Overall, our results show that borrowers overestimate how long they will stay with the mortgage.

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1. Introduction

Firms often offer a menu of contracts to consumers in the expectation that consumers sort to the contract that maximizes both parties' utility. Previous studies have found that consumers in various contexts choose the wrong contract from a menu of options. For example, DellaVigna and Malmendier (2006) document that consumers overestimate their commitment to physical activity and therefore buy gym memberships that they rarely use. Agarwal, Chomsisengphet, Liu, and Souleles (2015) show that consumers pick credit cards with no annual fee and high interest, when they would benefit from cards with an annual fee but low interest. Finally, Miravete (2003) finds that consumers often choose the wrong calling plan for their phones. Other studies explore the theory behind product choice by households (Gabaix and Laibson, 2006; DellaVigna, 2009; Köszegi, 2014; Heidhues, Köszegi, and Murooka, 2016). These examples highlight a key failure of

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many households: the inability to correctly assess which contract best suits their current and future needs.

In this paper, we explore contract choice in the residential real estate market, where households make their largest financial decisions. Lenders in this market offer contracts that are menus of cash flows and prices (Dunn and Spatt, 1988). For example, lenders offer borrowers fixed rate mortgages and adjustable rate mortgages, each of which is characterized by a different stream of cash flows. In general, we cannot evaluate decisions made by households because they involve many unobservable factors (e.g., Campbell and Cocco, 2003).

A unique empirical setting that allows us to examine the quality of decision making is the *mortgage discount points* contract. Borrowers who buy a home or refinance an existing mortgage decide on whether to invest in "points." Borrowers who take points make an initial investment and receive a reduction in their interest rate along the life of the mortgage. This contract can be viewed as an investment project that provides greater benefits to borrowers who stay in the mortgage longer. Several studies propose that this contract is designed to create a separating equilibrium in which borrowers with a low propensity to prepay take points, allowing lenders to charge higher rates to borrowers with high prepayment risk (Dunn and McConnell, 1981; Dunn and Spatt, 1988; Borjas, Bronars, and Trejo, 1992; Brueckner, 1994).[1]

Exploring mortgage discount points offers several advantages for understanding the choices made by households. First, mortgage discount points are standardized products that allow easy data gathering and statistical analysis. Second, households make their points decisions in tandem with the mortgage decision and, therefore, reveal their cost of capital (the mortgage rate). Third, the points decision involves few unobserved factors. Specifically, discount points are an investment project and do not relieve financial constraints. The alternative investment for borrowers is to use the initial investment to decrease their mortgage balance (for which we know the interest rate). Finally, the profitability of the discount points investment depends only on a single variable: the time that borrowers stay with the mortgage.

The purpose of this study is to assess the soundness of the investment decision by households to take discount points. In contrast to the previous literature about mortgage points, which is mostly theoretical, our work is a large-scale empirical study. We look at more than 300,000 prime fixed rate mortgages that were originated between January 2001 and March 2011 and were insured by a large national mortgage securitizer. The data set includes information about the borrower, mortgage, discount points, and originating bank. In our sample, about 12% of borrowers take discount points with their mortgage. Among those who take discount points, the average borrower buys 1.31 discount points and as a result lowers their interest rate by 29 bps (basis points).

[1] Stanton and Wallace (1998) conclude, however, that a separating equilibrium is infeasible unless prepayment is very costly. Nevertheless, in the last two decades, prepayment transaction costs in the United States were minimal, and mortgage points are still offered in the market place.

Our study is presented in three parts. First, we conduct an ex post analysis of the profitability of discount points from the borrowers' perspective. A first and striking observation is that both points takers and non-points takers stay with their mortgages, on average, an almost identical length of time: 59.9 months for points takers versus 57.3 months for non-points takers. This fact alone suggests that borrowers are poor at sorting to contracts based on their expected duration.

We also conduct a more formal analysis of the net present value (NPV) of the decision to invest in points. For each borrower (points takers and non-points takers), we calculate the NPV of the discount points investment. This calculation contrasts the initial investment with the discounted benefits from lower interest rates. For those borrowers who did not terminate their mortgage by the end of our sample period in March 2015, we calculate two NPV measures. The first is a minimum NPV (assuming that they terminate the mortgage in April 2015). The second measure is a maximum NPV (assuming they hold the mortgage until maturity).

This analysis shows that, on average, borrowers who took discount points engaged in a negative-NPV project, meaning that the average return earned on discount points is lower than the cost of borrowing. Put differently, borrowers would have been better off decreasing their mortgage balance rather than investing in discount points. Our estimates do not vary substantially once we account for personal taxes. We estimate that the average after-tax loss due to taking discount points is about $676 per points taker. This result contradicts the literature suggesting that points should be a zero- or positive-NPV project for borrowers (e.g., Dunn and McConnell, 1981; Kau and Keenan, 1987; Dunn and Spatt, 1988; Borjas, Bronars, and Trejo, 1992; Brueckner, 1994).

In the second part of the study, we address the critique that our initial analysis relies on observing borrowers' exit behavior. In particular, our data period (1/2001–3/2011) reflects an unusual period in the residential real estate market (e.g., boom of 2004–2006 and bust of 2007–2009). It might be that borrowers behaved optimally when investing in points *and* when exiting the mortgage (e.g., refinancing in response to a rate decrease), yet, after the fact, they appear to have acted suboptimally.

To overcome this issue, we perform an analysis that uses ex ante information rather than ex post events. The analysis has two stages. In the first stage, we estimate a hazard model for the time it takes borrowers to exit their mortgage contracts. For this task, we use mortgage termination data for the period 1990–2015. For each borrower, we estimate an ex ante hazard model of exit using data from all the years that include different housing cycles. Borrowers exit their mortgage contracts for three primary reasons: selling the house and moving, refinancing, or defaulting. While each individual borrower faces much uncertainty, we can judge the quality of borrowers' sorting in the aggregate. Important drivers of the decision to exit are the change in interest rates since origination and the change in house prices since origination. To account for these factors, we simulate them and plug them back into the hazard model, resulting in a distribution of exit

horizons for each borrower. In the second stage of the analysis, we estimate points' NPV using an entire set of possible exit points (based on the hazard model). We document that the average after-tax NPV of the points investment is –$726, which is similar to the one found in the ex post analysis.[2]

In the third and final part of the study, we explore why borrowers take points. Given the evidence that taking mortgage discount points is a costly mistake, we hypothesize that borrowers who take points lack financial sophistication. For example, these borrowers may be fixated on reducing their monthly mortgage payments without considering the cost of doing so. To test this hypothesis, we explore the characteristics of borrowers who take points. The strongest predictors for taking points are high (prepoints) mortgage rates and engaging in cash-out refinancing. We speculate that borrowers who are stressed about high mortgage payments are so eager to reduce the rate that they are willing to pay the upfront costs. Also, it is likely that borrowers find it easier to invest in points when funds are readily available from a cash-out refinancing [see a discussion of investing windfall funds in Arkes, Joyner, Pezzo, Gradwohl Nash, Siegel-Jacobs, and Stone, (1994)].

To provide further evidence that lack of sophistication is behind the poor financial decision making we document, we examine another potential mistake related to points: when to refinance a mortgage. We investigate the relation between investing in discount points and the ex post likelihood of exiting the mortgage contract. We document that the average likelihood of refinancing a mortgage is statistically indistinguishable between points takers and non-points takers. Yet, points takers are less responsive to changes in interest rates than non-points takers are, suggesting that the former group is less attentive to their finances than the latter group. This finding expands on Keys, Pope, and Pope (2014), who find that borrowers (points takers and non-points takers), on average, fail to refinance their mortgages on time. Our evidence shows that points takers' refinancing behavior is even worse than that of the average borrower.

Our paper adds to several strands of the literature. A growing body of research shows that households make financial mistakes related to mortgages. For instance, Campbell and Cocco (2003) find that consumers suboptimally choose their mortgage contracts (i.e., adjustable rate mortgages (ARMs) versus fixed rate mortgages (FRMs)). Keys, Pope, and Pope (2014) and Agarwal, Rosen, and Yao (2016) document that a large fraction of borrowers suboptimally refinance their mortgages.

[2] We also study a special situation in which borrowers have a clear indication that points are an inferior product. We note that mortgage rates increase in a discontinuous fashion with respect to leverage. In other words, mortgage rates jump at thresholds like 80%, 85%, 90%, 95%, and 97% loan-to-value ratios (LTV). These discrete jumps are called leverage knots. When borrowers are just above these levels, they may be better off using their equity to reduce their leverage than purchasing points. We find that about 2.2% of points takers who are just above the leverage knots would be strictly better off not taking points and reducing their leverage. To save space, we do not include this analysis in the paper. The results are available upon request.

Our paper broadly contributes to the literature that documents mistakes in household financial decision making in general (Campbell, 2006; Agarwal, Driscoll, Gabaix, and Laibson, 2009; Campbell, Jackson, Madrian, and Tufano, 2011; Agarwal, Green, Rosenblatt, and Yao, 2015). Related to the phenomenon we document here, DellaVigna and Malmendier (2006) show that gym members underutilize their gym memberships. Akin to the current study, these gym members overstate the benefits from offered contracts and pick the wrong one. Examples of other mistakes made by households include individuals leaving money on the table in their 401 K decisions (Choi, Laibson, and Madrian, 2011), borrowers taking payday loans with astronomical annual percentage rates (APRs) when other cheaper forms of credit are available (Agarwal, Skiba, and Tobacman, 2009; Bertrand and Morse, 2011), and consumers with multiple credit card offers failing to optimally choose the right one (Agarwal, Chomsisengphet, Liu, and Souleles, 2015). More broadly, it is puzzling that less than 30% of U.S. households directly participate in equity markets (Cole and Shastry, 2009; Li, 2014), and among those who do hold stocks, many have highly concentrated portfolios and trade excessively (Korniotis and Kumar, 2011, 2013). Stango and Zinman (2009) find that U.S. borrowers regularly underestimate the APR of a loan if they are given only the loan principal and repayment stream. Bertrand and Morse (2011) find that payday loan borrowers who are shown information on the aggregate cost of their loan or the time to repayment frequently borrow significantly less per pay cycle.

Finally, this paper contributes to our knowledge about the (lack of) sophistication of households and financial education. Agarwal and Mazumder (2013) find that borrowers who make financial mistakes have lower cognitive ability. Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff (2010) document the effects of a successful financial education program on mortgage defaults, and Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff (2014) find that mandatory mortgage counseling does not achieve the expected change in behavior that regulators hoped for. Agarwal, Liu, Torus, and Yao (2014) find that sophisticated households are less likely to pay too high a mortgage rate and more likely to refinance when financially advantageous to do so.

2. The borrower's decision

2.1. Discount points as an investment decision

Mortgage discount points are an "add-on" feature of the mortgage contract. Once a mortgage application is approved, the borrower faces the choice of whether to take discount points. Taking discount points means that the borrower pays an upfront fee, calculated as a percentage of the loan amount, in exchange for a reduction in the mortgage's interest rate. An upfront payment of one percentage point of the loan balance is considered "one point." When investing in discount points, a borrower essentially trades an upfront investment for a reduction in the interest rate, i.e., future positive cash flows.

Unlike many other investment projects, discount points have an unknown horizon, because the future cash flows will persist only as long as the borrower maintains the mortgage. Borrowers, however, may exit the mortgage in several ways: selling the house and moving elsewhere, refinancing the loan, or defaulting on the mortgage. If no exit takes place, the borrower continues to hold the mortgage and receive the benefits of the reduced interest rate for the entire life of the mortgage.

How should borrowers decide whether to invest in points? Because borrowers consider points in the context of the mortgage they are about to take, they often think about the mortgage and points decisions as coupled, i.e., the investment in points reduces the interest rate from x to y. The decision to invest in points, however, should be considered independently of the other features of the mortgage. From the borrower's perspective, the investment in discount points depends only on the expected period of holding the mortgage and the opportunity cost of capital. The investment in discount points is more attractive when the borrower's horizon with the mortgage is longer and when alternative investment opportunities are weak. Borrowers should invest in mortgage discount points only when they have a positive NPV. This means that the expected discounted value of the monthly interest savings is greater than the upfront investment.

In exchange for investing one percentage point of the balance, a borrower receives a reduction of δ percentage points from the annual interest rate.[3] In the absence of personal taxes, one percentage point of the loan balance is

$$pre-tax\ NPV\ per\ 1\%\ of\ loan\ balance = -B_0 + \sum_{t=1}^{T} \frac{\frac{1}{12}\delta B_{t-1}}{(1+r)^t}. \tag{1}$$

In this calculation, the borrower invests one percentage point of the balance (B_0). In exchange, the borrower receives a series of T monthly interest payment reductions. T reflects the *actual* number of periods that the borrower stays with the mortgage. The monthly reduction in dollars can be calculated as the beginning-of-period balance (B_{t-1}) multiplied by the interest reduction, in percentage points. Over a year, a borrower who takes one point will save approximately δ (the annual reduction) times the beginning balance. More precisely, on a monthly frequency, the monthly savings is $\frac{1}{12}\delta B_{t-1}$. To find the NPV of points, the borrower should compare the initial investment to the present value of all the expected interest savings, discounted at r for T months.

[3] The tradeoff between the upfront payment and the interest reduction is often quoted using a "multiple," which measures the number of years it will take for one point to be paid back. For example, a multiple of 4 means that one point (an upfront fee of 1% of the borrowed amount) reduces the annual interest rate by 0.25%. For an interest-only mortgage, a borrower will recoup his or her entire investment amount in points after four years. For an amortizing mortgage, it will take slightly longer than four years for the borrower to recoup the initial investment because the monthly interest expense declines over time.

2.2. Tax effects

Personal taxes have several effects on the viability of mortgage points (Kau and Keenan, 1987). The timing of the tax deductibility of the points investment depends, however, on the type of transaction: purchase or refinancing. In purchase transactions, the initial investment reduces the borrower's taxable income for the current year; hence, the NPV calculation adjusted to personal taxes for purchase transactions is

$$after-tax\ NPV\ per\ 1\%\ of\ loan\ balance\ (purchase) = -B_0(1-\tau) + \sum_{t=1}^{T} \frac{\frac{1}{12}\delta B_{t-1}(1-\tau)}{(1+r)^t}, \tag{2}$$

where τ is the personal marginal tax rate. Note that because points lower the interest payments on the mortgage, the annual tax benefit from deducting the interest expense also declines.

For refinancing transactions, the initial investment amount is deductible from borrowers' income over the life of the mortgage. In the case of early termination, the remaining undeducted amount can be deducted as a lump sum:

$$after-tax\ NPV\ per\ point\ (refinancing) = -B_0 + \sum_{t=1}^{T}\left[\frac{\frac{1}{12}\delta B_{t-1}(1-\tau) + \frac{1}{N}B_0\tau}{(1+r)^t}\right] + I_{T<N}\left[\frac{B_0\frac{N-T}{N}\tau}{(1+r)^T}\right], \tag{3}$$

where N is the number of periods of the mortgage contract. For example, for a 30-year mortgage, $N=360$. $N - T$ reflects the number of periods left on the mortgage contract at the time of early termination. In Eq. (3), the term $\frac{1}{N}B_0\tau$ represents the fraction of the amount invested in points and is tax deductible each month over the life of the mortgage. The term $I_{T<N}[\frac{B_0\frac{N-T}{N}\tau}{(1+r)^T}]$ takes effect in the case of early termination of the mortgage and reflects the cash flow from the tax deduction of the remaining amount that has not yet been deducted.

In sum, personal taxes have conflicting effects on the desirability of points. On the one hand, the deductibility of the upfront investment in points increases their attractiveness. On the other hand, the loss of deductible mortgage interest makes mortgage points less attractive for borrowers. In our calculations, we present analyses with and without the effects of taxes.

3. Data

3.1. Data sources

Our main body of data consists of mortgages securitized by a national mortgage insurer from January 2001 to March 2011. These are conventional conforming loans that were made to borrowers with good credit standing (prime). Conforming mortgages meet the conforming loan

limit.[4] Prime borrowers have relatively high credit scores (620 or higher) compared to subprime borrowers with blemished credit. Relative to other data sets of securitized loans used in the literature, e.g., LoanPerformance or McDash, our data set contains loans of higher credit quality. This data set records the discount points paid by borrowers in dollars at the time of closing. Our data set also captures some basic demographic information about the borrower such as the level of education. Federal laws mandate that discount points and closing costs be recorded in the final mortgage settlement statement, i.e., the HUD-1. To reduce the possibility of latent information, we limit the sample to a single type of mortgages: fixed rate 30-year amortizing mortgages that have non-missing HUD-1 information about whether the borrower took points. Our sample is limited to the top 20 metropolitan statistical areas (MSAs) with Case-Shiller home price indices readily available. To minimize heterogeneity due to lender practices, we remove loans originated by banks that never offer discount points.[5] These filters leave 312,111 mortgages in our main sample.

For each borrower in the sample, we estimate the expected survival curve based on the information that was known at the time the mortgage was originated. To do so, we supplement the main sample with another data set of mortgages securitized by the same national entity that were originated between 1990 and 2000. This data set includes detailed borrower and mortgage information at origination as well as information on performance and termination (repayment or default). Unlike the main data set, these data do not include information about discount points.

In preparing the data, we compute a variable that captures the excess interest rate paid by the borrower beyond what would be expected by its characteristics (*excess premium*). The excess premium variable is computed as the residual from a regression of the mortgage's interest rate on several determinants: FICO score, loan-to-value ratio (LTV), back-end debt-to-income ratio, loan purpose, occupancy status, property location, and date of origination. The residual captures the part of the interest rate that is not explained by common factors across borrowers. Variable definitions are provided in Appendix A.

3.2. The interest reduction

Our data set includes information about the number of points that each borrower took; however, it does not contain information about the subsequent reduction in the interest rate for points takers. This is an issue for our analysis because the interest reduction that one point buys changes over time.

To overcome this obstacle, we use an institutional feature of the mortgage market that allows us to approximate the reduction in interest. Specifically, the interest reduction that market participants use is based on the price of interest-only (IO) securities. Banks that originate mortgages with points hedge their positions by buying IO strips (Fuster, Goodman, Lucca, Madar, Molloy, and Willen, 2013). The prices of these IO securities are denominated in "multiples" that measure the number of years it will take for one point to be paid back; the interest reduction is the inverse of the multiple. Thus, we approximate the specific interest reduction that borrowers face each month using the inverse of the market IO price for that month. This approximation should result in no bias, because banks use the same interest reduction for all borrowers.

In the analysis, we present our results with three levels of profit margin for the banks: 0%, 20%, and 50%. The effective interest reduction, therefore, is presented as δ/k, where k is the gross margin (called the *IO price factor* of 100%, 120%, or 150%), and δ is the interest reduction.

3.3. Borrowers' discount rate

When deciding whether to invest in points, borrowers should use a discount rate. In our setting, the mortgage rate is the borrower's cost of capital, because any dollar that is not invested in points could be used to reduce the borrower's mortgage balance, which is lent at the mortgage rate. This fact is an advantage of using points as our empirical setting; unlike many other settings, here we can directly observe the cost of capital of households with respect to an important financial decision.

We note that for many borrowers the mortgage rate is likely to be the lower bound of their opportunity cost of capital because mortgage rates generally increase with debt leverage. Hence, if a borrower decides not to invest in points and uses these funds to reduce the mortgage balance, the marginal rate can potentially be larger than the observed rate on the mortgage.

3.4. Summary statistics

Table 1 presents summary statistics. Panel A shows information about the main data set. The average note rate is 6.21%, the average FICO score is 708, and the average LTV ratio is 85%. The average monthly income is $6,819. The average borrower age is 40, and 67% of borrowers in the sample have a bachelor's degree or higher. Four percent of loans are taken for investment properties. Approximately 58% of mortgages are used for purchasing a new home (36% of these mortgages are for first-time home buying); 20% of mortgages are cash-out refinances; and 22% of mortgages are rate/term refinances.

Our sample includes some information about points. We use the HUD-1 closing statement form to flag borrowers who took points. In our sample, 12% of borrowers paid discount points. Furthermore, conditional on taking points, borrowers take, on average, 1.31 points. Our sample does not include, however, the reduction in interest rate due to

[4] The conforming loan limit increased each year until 2006; it has been $417,000 since 2006 for a single-family one-unit property.

[5] Not all banks offer points. Points require lenders to manage excess interest-only cash flows since borrowers sell these future payment liabilities to them with an upfront fee. A lender has to back them with long-term funding if it chooses to keep the loan on its balance sheet as a whole loan. If it chooses to securitize it on the secondary market instead, the bank can either trade with others or hold it until maturity. The value of these cash flows tends to be very volatile because of unexpected prepayment. Only large lenders have the knowledge and platforms to manage these types of assets or liabilities.

Table 1
Descriptive statistics
The table presents summary statistics for the data used in the study. Panel A shows summary statistics at the time of origination as well as for the panel data (used in the hazard regressions). Panel B compares the characteristics of borrowers who took discount points to those who did not. See Appendix A for variable definitions. Standard error *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Summary statistics of main sample

Variable	N	Mean	St dev	Min	p25	p50	p75	Max
Mortgage data								
Note rate (%)	312,111	6.21	0.81	3.00	5.75	6.25	6.75	12.63
Note rate w/o points (%)	312,111	6.24	0.82	3.00	5.75	6.25	6.88	12.63
Delta rate (%)	312,111	0.03	0.12	0.00	0.00	0.00	0.00	2.28
FICO	312,111	707.9	60.8	300	665	713	758	888
LTV (%)	312,111	84.74	7.51	76	80	80	90	104
Borrower age	312,111	40.22	11.39	18	32	38	47	99
Dummy: Age<=35	312,111	0.60	0.49	0	0	1	1	1
Dummy: 35<Age<=45	312,111	0.32	0.47	0	0	0	1	1
Dummy: 45<Age<=55	312,111	0.18	0.39	0	0	0	0	1
Dummy: 55<Age<=65	312,111	0.07	0.26	0	0	0	0	1
Dummy: Age>65	312,111	0.03	0.16	0	0	0	0	1
College/grad dummy	312,111	0.67	0.47	0	0	1	1	1
Monthly income ($)	312,111	6,819	4,128	647	4,310	6,009	8,260	100,000
Investor dummy	312,111	0.04	0.21	0	0	0	0	1
Cash-out refi dummy	312,111	0.20	0.40	0	0	0	0	1
Rate term refi dummy	312,111	0.22	0.41	0	0	0	0	1
Broker loan dummy	312,111	0.60	0.49	0	0	1	1	1
First-time homebuyer dummy	312,111	0.21	0.41	0	0	0	0	1
Back-end DTI ratio	312,111	0.39	0.13	0.0003	0.2997	0.3846	0.4704	0.9999
Loan balance ($)	312,111	201,336	82,536	13,500	138,000	188,300	256,000	417,000
Points dummy	312,111	0.12	0.32	0	0	0	0	1
Points (% of balance)	312,111	0.16	0.52	0	0	0	0	9.66
IO price	312,111	4.61	0.73	3.33	4.10	4.43	4.97	7.90
Move exit dummy	312,111	0.12	0.32	0	0	0	0	1
Refi exit dummy	312,111	0.46	0.50	0	0	0	1	1
Default exit dummy	312,111	0.14	0.34	0	0	0	0	1
Duration (months)	312,111	57.59	40.11	9	22	48	86	167
Loan-quarter panel data								
Cumulative home price growth	5,712,984	−0.02	0.23	−0.95	−0.12	0.00	0.09	0.92
Mark-to-market LTV (%)	5,712,984	90.51	24.54	30.44	75.79	85.72	100.19	259.84
Rate savings (%)	5,712,984	−0.62	0.95	−3.81	−1.30	−0.47	0.09	2.89

Panel B: *Summary statistics of the out-of-sample used to estimate the ex ante NPV*

Variable	N	Mean	St dev	Min	p25	p50	p75	Max
Mortgage data								
Note rate (%)	3,569,954	7.60	0.66	0.08	7.10	7.60	8.13	14.90
FICO	3,569,954	703.8	54.3	300	666	710	747	899
LTV (%)	3,569,954	86.35	6.96	76	80	85	95	204
Investor dummy	3,569,954	0.02	0.12	0	0	0	0	1
Cash-out refi dummy	3,569,954	0.05	0.22	0	0	0	0	1
Rate term refi dummy	3,569,954	0.22	0.42	0	0	0	0	1
Broker dummy	3,569,954	0.51	0.50	0	0	1	1	1
First-time homebuyer dummy	3,569,954	0.23	0.42	0	0	0	0	1
Back-end ratio	3,569,954	0.34	0.11	0.00	0.27	0.33	0.40	1.00
Refi exit dummy	3,569,954	0.96	0.19	0	1	1	1	1
Default exit dummy	3,569,954	0.02	0.13	0	0	0	0	1
All exits	3,569,954	0.98	0.14	0	1	1	1	1
Duration (months)	3,569,954	48.93	34.22	1	25	43	61	252
Loan-year panel data								
Cumulative home price growth	16,498,901	0.07	0.21	−0.88	−0.07	0.07	0.17	0.88
Rate savings (%)	16,498,901	−0.61	1.05	−6.21	−1.27	−0.64	0.04	2.11

(*continued on next page*)

Table 1 (*continued*)

Panel C: *Summary statistics by points takers and non-points takers*

	Points takers		Non-points takers			
Variable	Mean	St dev	Mean	St dev	Diff	*t*-stat
No of obs	37,172		272,267			
Duration (months, conditional on termination)	59.92	39.18	57.27	40.22	2.65	0.07
Note rate (%)	6.22	0.89	6.21	0.80	0.01	0.01
Note rate w/o points (%)	6.51	0.93	6.21	0.80	0.30	0.37
Delta rate (%)	0.29	0.19	0.00	0.00	0.29	4.40
FICO	697.80	64.99	709.31	60.04	−11.50	−0.19
LTV (%)	84.77	7.47	84.73	7.52	0.04	0.01
Borrower age	41.93	11.70	39.99	11.33	1.94	0.17
Dummy: Age<=35	0.33	0.47	0.41	0.49	−0.07	−0.15
Dummy: 35<Age<=45	0.32	0.47	0.32	0.47	0.01	0.01
Dummy: 45<Age<=55	0.22	0.41	0.18	0.38	0.04	0.09
Dummy: 55<Age<=65	0.09	0.29	0.07	0.26	0.02	0.08
Dummy: Age>65	0.03	0.18	0.03	0.16	0.01	0.06
College/grad dummy	0.63	0.48	0.68	0.47	−0.05	−0.11
Monthly income ($)	6,659	4,284	6,841	4,106	−183	−0.04
Investor dummy	0.09	0.29	0.04	0.19	0.05	0.27
Cash-out refi dummy	0.31	0.46	0.19	0.39	0.12	0.31
Rate term refi dummy	0.16	0.37	0.22	0.42	−0.06	−0.15
Broker loan dummy	0.51	0.50	0.61	0.49	−0.10	−0.20
First-time homebuyer dummy	0.19	0.39	0.21	0.41	−0.02	−0.05
Back-end DTI ratio	0.40	0.13	0.39	0.13	0.01	0.05
Loan balance ($)	191,477	85,981	202,679	81,964	−11,202	−0.14
Points dummy	1.00	0.00	0.00	0.00	1.00	
Points (% of balance)	1.31	0.83	0.00	0.00	1.31	4.55
IO price	4.62	0.76	4.61	0.73	0.02	0.02
Move exit dummy	0.10	0.30	0.12	0.33	−0.02	−0.06
Refi exit dummy	0.39	0.49	0.47	0.50	−0.08	−0.15
Default exit dummy	0.17	0.37	0.13	0.34	0.04	0.10
Loan-quarter panel data						
Cumulative home price growth	−0.03	0.24	−0.02	0.23	−0.02	−0.08
Mark-to-market LTV (%)	91.60	25.67	90.36	24.37	1.25	0.05
Rate savings (%)	−0.46	0.96	−0.64	0.95	0.17	0.18

points. We overcome this issue by using a proxy for the interest reduction: the IO price (measured in years of payback) at the origination month. In our sample, the average market price for IO securities at the time of origination is 4.6 years, which is equivalent to an average annual rate reduction of 0.21% per percentage point of the balance that is invested.

When loan panel data are matched to economic environments experienced by borrowers, the average cumulative home price growth from origination of the loan is −2% because home price run-ups are cancelled out by post-crisis declines. Average mark-to-market LTV is 91%, and average cumulative rate savings from origination is 62 bps.

Panel B presents information about the 1990–2000 sample used for estimating the tenure with the mortgage. Mortgage rates were much higher in the 1990s, with an average note rate of 7.6%. FICO and LTV are similar to those in the main sample, with averages of 704% and 86%, respectively. Cash-out refinancing and rate-term refinancing account for 5% and 22% of this sample. Also, only 2% of transactions were done by investors. By the end of our observation window in 2015, 98% of loans in the out-of-sample have exited, providing an almost complete picture of loan life cycles.

Before we turn to the main tests of the paper, we provide some summary statistics comparing points takers to non-points takers. Table 1, Panel C reports the summary statistics of the borrowers who pay discount points compared to those who do not. With an average of 1.31 discount points, we estimate that the average rate reduction from discount points is about 29 bps. The average gross interest rate (excluding the effect of points) of points takers is, therefore, 6.51% versus 6.21% for non-points takers. After paying the points, points takers have an almost identical note rate as non-takers. The average FICO score of borrowers who pay discount points is 11.5 points lower and their monthly income is $182 lower than those who do not take points. The LTV is practically the same. Borrowers are more likely to invest in points following cash-out refi transactions. Points takers are also more likely to be investors, as opposed to owner occupiers. The average loan balance is $11,202 lower for points takers. Borrowers who pay discount points default more often, by 4 percentage points, and they refinance less often, by 8 percentage points.

The summary statistics in Table 1, Panel C also give insight into the main results we report in this study. Specifically, the panel summarizes how long borrowers stay with the mortgage, conditional on exit during the sample period. The panel shows that borrowers who took points

stayed with their mortgage for 59.9 months, on average. Borrowers who did not take points stayed with their mortgage a slightly shorter period, 57.3 months on average. This result provides evidence that indeed borrowers sort poorly to the points contract offered by lenders.

4. Empirical analysis: are points worth taking?

4.1. Ex post analysis

Our ex post analysis is based on calculating the actual NPV on borrowers' investments in mortgage discount points. For each borrower in the data set (whether he/she took discount points or not), we have the origination date and the termination date, if it occurred prior to April 2015. As discussed in the previous section, conditional on termination, borrowers who took points have almost the same duration with the mortgage as those who did not take points. Nevertheless, these statistics do not account for the censoring of the sample. Here, we attempt to address this issue.

Because our sample contains borrowers with 30-year mortgages, some of them had not terminated by the time the sample ends. For borrowers who did not terminate their mortgages by March 2015, we consider two extreme scenarios: (1) that they all terminate in April 2015 and (2) that they all terminate at the end of the mortgage term (30 years). These two scenarios determine the minimal and maximal NPV values, NPV_{min} and NPV_{max}, respectively.

To minimize the effect of systematic and cohort effects related to the origination month, we conduct this analysis in two steps. First, we compute the NPV for each mortgage. Second, we average the individual NPVs per month-of-origination cohort, resulting in a time series of NPVs. Then, we average the monthly NPV across all months. To account for potential autocorrelation in the data, we adjust the standard errors using the Newey and West (1987) procedure with 12 monthly lags.

Fig. 1a presents the time series of the minimal and maximal NPV values for borrowers who took discount points. From early 2009 to March 2011, fewer and fewer borrowers terminate their mortgages; hence, the gap between the minimal and maximal NPV estimation widens. For the purpose of the figure, we assume that banks charge a margin of 20%. The figure shows that in most months, both NPV_{min} and NPV_{max} are below zero for both segments of the population.

We provide more statistics about the performance of discount points in Table 2. Panel A presents the average pre-tax NPV of a point taken in each month, averaged over the sample period (1/2001–3/2011), and the fraction of months in which the average NPV is negative.[6] We first focus on the borrowers who take discount points (Columns 1–2 and 5–6). The panel shows that for an IO price factor of 100%, the average NPV ranges from -0.28 to -0.10 (both statistically different from zero). The fraction of negative-NPV months ranges from 0.76 to 0.98. Hence, even when the IO price factor is 100%, the discount points investment is a net loss for borrowers, on average. As the IO price factor increases, the discount points investment becomes worse and worse. With an IO price factor of 120%, the average NPV ranges between −0.40 and −0.25 and at least 89% of the months have a negative NPV. At an IO price factor of 150%, the average NPV ranges between −0.52 and −0.40 and at least 98% of the months have an average NPV that is negative. The panel shows that borrowers who do not take discount points (Columns 3–4 and 7–8) would have experienced even worse NPV had they taken points. For this population, the ex post analysis shows that discount points are even a worse investment decision than for points takers. An important caveat to this analysis is that mortgage termination is endogenous (e.g., non-points takers refinance earlier than points takers; see Section 5.2), which is likely to sharpen the difference in ex post NPV between points takers and non-points takers.

Next, we analyze the value of the points investment in the presence of taxes. As discussed in Section 2.4, the U.S. tax code considers points as prepaid interest that may be deductible as home mortgage interest. However, purchase and refinance transactions have different requirements. On a purchase transaction, points paid in cash are fully deductible in the year the loan is closed; thus, no discounting is necessary on the tax benefits. If points are taken as part of a refinance transaction, points paid in cash are deductible evenly over the amortization term. If the loan is prepaid early, all unused deductions can be taken in the year of payoff. Our after-tax NPV calculations take into account the composition of home-purchase mortgages and refinancing mortgages. The fact that the interest itself is tax deductible detracts from the desirability of investing in points, since the future benefit is smaller after tax than pre-tax.

Borrowers in our sample are subject to different marginal tax rates, which vary according to their total income and deductions. Because we observe only borrowers' income, we must use a rough estimate of the marginal tax rate. Given that the average borrower makes nearly $82,000, we use $\tau = 25\%$ for all borrowers.

Table 2, Panel B presents the average after-tax NPV of a point taken in each month, averaged over the sample period, and the fraction of months in which the average NPV is negative. Fig. 1b shows the time series of the points' NPV. The average after-tax NPVs are less negative than before-tax numbers, yet the fraction of negative NPVs is in general higher for both points takers and non-points takers. For example, with an IO price factor of 120%, after-tax NPV for points takers is between −0.32 and −0.21. Comparing these results to the findings in Panel A shows that taxes improve the NPV of points; however, points still have negative NPVs in all the scenarios that we study. This evidence that taxes have little effect on the viability of points is at odds with Kau and Keenan (1987), who argue that taxes are one of the reasons that the points contract exists.

Overall, these results show that discount points are a negative-NPV project, on average. Because we do not know the actual IO price factor associated with individual loans, we can only give a rough estimate of the economic

[6] All months are weighted equally. The results barely change when we value by the number of mortgages.

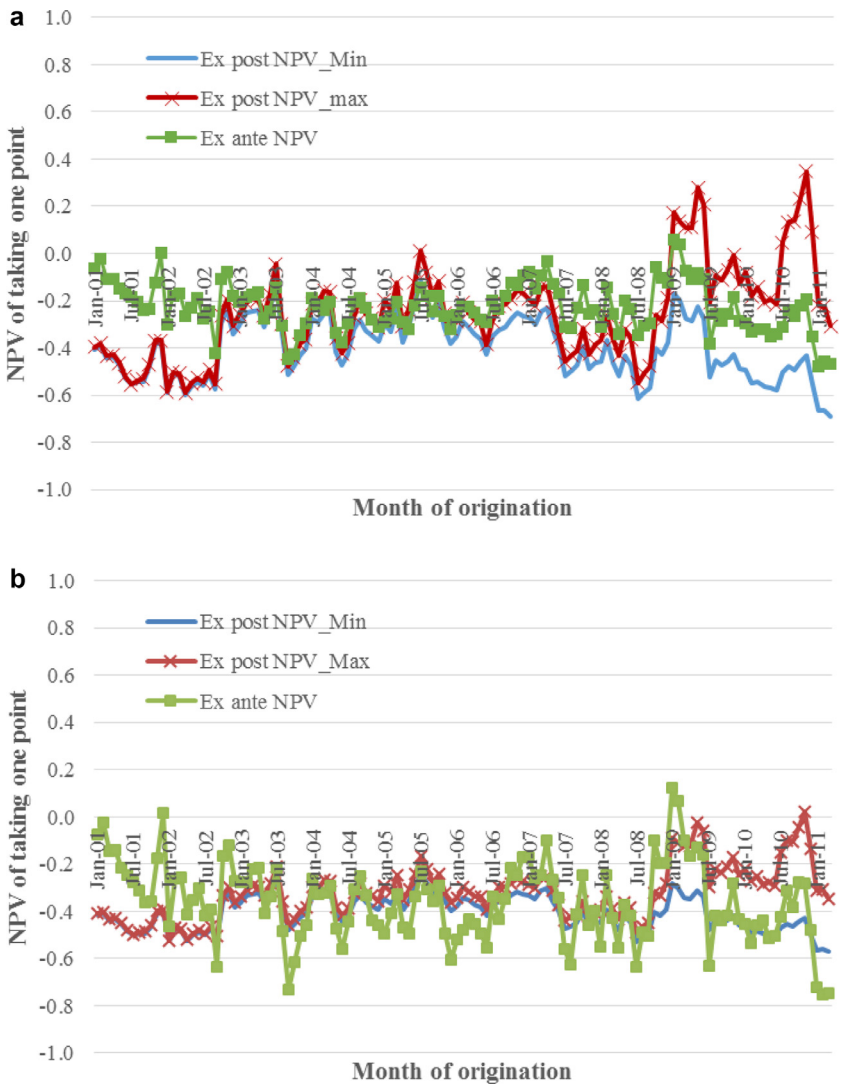

Fig. 1. Ex post and ex ante analyses of discount points profitability. (a). Points takers: Pre-tax NPV of taking points (investment is δ/120%). (b). Points takers: After-tax NPV of taking points (investment is δ/120%).

magnitude. If we assume that banks charge a 20% margin on their cost, i.e., that the IO price factor is 120%, the after-tax NPV from an investment in each mortgage point is somewhere between −0.32 and −0.21 mortgage discount points, with a midpoint between the NPV_{min} and NPV_{max} of −0.27. The average mortgage balance in our sample for points takers is about $191,000, and the average points-taking borrower takes 1.31 points. Therefore, the average loss to borrowers who take discount points is –$676 (= 191,000 × (1.31/100) × -0.27).

4.2. Ex ante analysis

While the ex post analysis shows that discount points are a negative-NPV project, on average, there is a concern that the results are driven by unexpected systematic events that make discount points appear a bad investment after the fact. In particular, it is possible that at the time of mortgage origination, borrowers may have made the right decision to invest in discount points given the information that they had at the time. To examine this possibility, we conduct an ex ante analysis. We begin by estimating a hazard model for mortgage termination using 1/1990–3/2011 origination and 1/1990–12/2013 termination. Then, we use the model to predict ex ante tenure for each borrower. Finally, we estimate the NPV for each borrower, based on the estimated survival curves.

4.2.1. Borrowers' exit hazard

The decision of whether to take discount points boils down to an estimation of how long borrowers expect to hold the mortgage. If a borrower expects to stay a long period with the mortgage (i.e., low probability of moving, refinancing, or defaulting), taking discount points can be a good decision. If, however, the expected period with the mortgage is short, the borrower is better off not taking discount points; the period of the rate reduction (positive cash flows) is just too short.

Table 2
Ex post analysis of investment in discount points

The table presents statistics about ex post performance of discount points in the sample period of 1/2001–3/2011. Panel A presents an analysis of the average net present value (NPV) pre-tax. Panel B presents an analysis of the average NPV after-tax. See Appendix A for variable definitions. For the columns under "Average NPV," the coefficients measure the average across months of the average NPV in the month. For these columns, the *t*-statistics (in parentheses) measure the statistical significance of the NPV difference from zero. For the columns under "% Months with negative NPV," the coefficients measure the percentage of months in which the average NPV is negative. For these columns, the *t*-statistics (in parentheses) measure the statistical significance of the coefficient from 0.5. Standard errors are adjusted for autocorrelation using the Newey and West (1987) procedure with 12 lags. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. .

Panel A: Average NPV of investing in one point, pre-tax

	Average NPV				% Months with negative NPV			
	Points takers		Non-points takers		Points takers		Non-points takers	
IO price	NPV_{min} (1)	NPV_{max} (2)	NPV_{min} (3)	NPV_{max} (4)	NPV_{min} (5)	NPV_{max} (6)	NPV_{min} (7)	NPV_{max} (8)
100%	−0.281***	−0.104*	−0.328***	−0.194***	0.984***	0.756***	0.976***	0.854***
	(−8.72)	(−1.95)	(−8.56)	(−4.21)	(95.35)	(9.65)	(60.31)	(15.41)
120%	−0.400***	−0.254***	−0.440***	−0.328***	1.000***	0.894***	1.000***	0.967***
	(−14.94)	(−5.69)	(−13.78)	(−8.56)	(-)	(16.09)	(-)	(47.14)
150%	−0.520***	−0.403***	−0.552***	−0.463***	1.000***	0.984***	1.000***	1.000***
	(−24.27)	(−11.30)	(−21.61)	(−15.08)	(-)	(93.17)	(-)	(-)

Panel B: Average NPV of investing in one point, after tax

	Average NPV				% Months with negative NPV			
	Points takers		Non-points takers		Points takers		Non-points takers	
IO price	NPV_{min} (1)	NPV_{max} (2)	NPV_{min} (3)	NPV_{max} (4)	NPV_{min} (5)	NPV_{max} (6)	NPV_{min} (7)	NPV_{max} (8)
100%	−0.230***	−0.101***	−0.267***	−0.170***	0.984***	0.797***	0.984***	0.878***
	(−9.80)	(−2.59)	(−9.65)	(−5.09)	(95.35)	(10.15)	(95.35)	(16.45)
120%	−0.319***	−0.213***	−0.351***	−0.270***	1.000***	0.902***	1.000***	0.976***
	(−16.47)	(−6.59)	(−15.34)	(−9.80)	(-)	(16.00)	(-)	(58.84)
150%	−0.409***	−0.325***	−0.435***	−0.371***	1.000***	0.992***	1.000***	1.000***
	(−26.63)	(−12.67)	(−24.04)	(−16.98)	(-)	(125.51)	(-)	(-)

Hence, a critical step in the analysis is to estimate the hazard rate at which borrowers exit the mortgage contract. For each year of originated mortgages (2001–2011), we run an out-of-sample regression that uses all of the information that was known at this point (origination and termination). We then apply these estimates to predict the survival rate of each loan in our in-sample from 2001 to 2011. The probability of survival of the loan in each period is used to calculate the NPV.

We use a Cox hazard model to estimate the ex ante likelihoods of competing risks. Each observation (at the mortgage-year level) includes indicators for whether the borrower exited (e.g., due to refinancing, selling the house, defaulting) or stayed with the contract. The exit indicator is the dependent variable in the regression. The explanatory variables include information known at origination: FICO score, an investor (as opposed to owner-occupier) indicator, refinance indicators (cash-out refi and rate refi indicators), a broker and correspondent intermediary indicator, a first-time homebuyer indicator, back-end debt-to-income (DTI) ratio, and excess premium. In addition, we include variables that change over time: the marked-to-market LTV (MLTV) and the difference between the current 30-year interest rate and the interest rate at the time of origination.[7] MLTV incorporates the effect of changes in home prices (by updating the "value" component in the loan-to-value ratio using the Case-Shiller MSA-level index). We use three different splines of MLTV ($\leq$ 80%, 80% to 100%, and $>$ 100%) to capture the nonlinear effects of different equity levels. To account for the asymmetric effects of positive and negative rate changes, we separate interest rate shocks into positive and negative in the hazard regression. Positive rate changes preclude borrowers from refinancing to lower payments and thus increase their likelihood of default. Negative rate changes help borrowers lower their interest burden, thus increasing their propensity to refinance.

The estimated coefficients of the last year (2011) are reported in Table 3. The table shows the sensitivities of the different types of exits to the explanatory variables. The likelihood of exit increases with marked-to-market LTV by different rates at different equity levels. When borrowers have either a low or very high leverage, they are more likely to exit the mortgage. Furthermore, a decrease in interest rates pushes borrowers to refinance. Broker loans are more likely to prepay earlier or to default, presumably because brokers profit from frequent refinancing or their loan quality is in general worse than those originated by retail banks. First-time homebuyers are less experienced in taking advantage of refinancing incentives and thus stay with their current mortgage terms longer than more experienced homeowners.

For each borrower in the main sample, we use the regression to predict the distribution of exit in the years

[7] We use the Freddie Mac Primary Mortgage Market Survey (PMMS) rate.

Table 3
Hazard regression
The table presents a hazard regression for the exit of borrowers from their mortgage contracts. The results are based on mortgages originated between 1/1990 and 3/2011 and terminated between 1/1990 and 12/2013. See Appendix A for variable definitions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. .

Dependent variable:	Mortgage exit (0/1) (1)
FICO	0.026***
	(49.68)
Investor dummy	−0.027***
	(−49.17)
Cash-out refi	−0.045***
	(−78.92)
Rate refi	−0.027***
	(−46.84)
Broker/Corresponding bank	0.039***
	(72.87)
First-time homebuyer	−0.018***
	(−31.32)
Back-end DTI ratio	0.036***
	(67.52)
Excess premium	0.113***
	(228.35)
MtM LTV Spline: MLTV<= 80	−0.012***
	(−163.09)
MtM LTV Spline: MLTV<= 100 & MLTV > 80	−0.015***
	(−242.34)
MtM LTV Spline: MLTV> 100	−0.038***
	(−458.39)
Negative cumulative rate change	−0.609***
	(−216.15)
Positive cumulative rate change	−0.456***
	(−562.04)
Observations	17,204,751
Pseudo-R^2	0.015
Log likelihood	−5.080e+07
Chi-sq	1,545,153

following origination until the expiration of the mortgage (30 years). The predicted survival curve is the product of baseline survival and individual $x\beta$, both estimated from a Cox model:

$$\lambda_1 = \lambda_0 \times \exp(x\beta). \quad (4)$$

4.2.3. Do borrowers make ex ante mistakes in the discount points decision?

We next use our hazard model to estimate the expected NPV (ex ante) at the time of origination. A borrower may not know the exact future date of exit, but given her characteristics and the distribution of changes in property prices and changes in interest rates, she can calculate the distribution of potential exit points.

Based on the estimated survival curve λ_1, we simulate the ex ante NPV of the points decision. This basically repeats Eqs. (2) and (3) using the survival probabilities from years 1 through 30. Because future changes in home prices and interest rates are unknown at the time of origination, we conduct Monte Carlo simulations using 50 paths of home price growth and interest rate changes randomly drawn from their historical distributions. We assume that home price growth and interest rate change follow a bivariate normal distribution, and we estimate the parameters from the historical Case-Shiller National Home Price Index and Freddie Mac's Primary Mortgage Market Survey (PMMS) rates in 1990–2015 (Fig. 2). Annual home price growth and interest rate changes follow means and variances of (3.4%, 0.36%) and (−0.25%, 0.57%), respectively. They also have had a weak covariance of 0.012 between them since 1990. The 25-year history ensures that we cover the range of scenarios of housing market conditions that one can experience. Different shocks to home prices and interest rates affect the estimated survival curve through the $x\beta$s of the various mark-to-market LTV splines and positive and negative interest rate changes reported in Table 3.

Table 4 summarizes statistics for the simulated NPVs. As in Table 2, the unit of analysis is a month, and for each month we calculate the average NPV across new mortgage originations. Then, we average across months. Panel A presents the average across months as well as the fraction of months in which the average NPV is negative, both before taxes. Panel B reports these two sets of numbers with after-tax implications incorporated. On average, when banks charge a 20% margin on their cost, i.e., the IO price factor is 120%, the NPV of an investment in one mortgage point is about -0.30 of the mortgage point before tax and −0.29 after tax. The average mortgage balance in our sample is about $191,000 and an average borrower takes 1.31 points. Thus, the average loss to borrowers who took discount points is $726 after taxes. This figure is close to what was found in the ex post analysis ($676). The loss is smaller if banks do not charge any margin (about a $450 loss) or larger if banks charge a margin of 50% (a $976 loss).

Table 4 also shows that in most months, borrowers make on average negative NPV decisions when investing in points. When banks charge no margin and in the presence of taxes (Panel B), in 98% of the months, points takers make a negative NPV decision, on average. In the case of the 20% margin, in 100% of the months points takers are expected to make a negative NPV decision. We also present the time series of the NPV for borrowers who took discount points (pre-tax in Fig. 1a and after-tax in Fig. 1b). Interestingly, the ex ante NPV series has a correlation of 0.59 with the ex post NPV_{min} and 0.16 with the ex post NPV_{max} series.

Overall, these results show that points are likely to be a negative NPV investment. On average, in almost all months in our analysis, investing in points is a bad decision.

5. Who takes points?

5.1. Borrower characteristics

Our previous analysis shows that borrowers lose money, on average, when investing in mortgage discount points. Given that points do not seem to serve any real purpose, it is important to explore why borrowers are investing in this product.

One possibility is that borrowers lack financial sophistication. For example, borrowers might have the mindset of lowering interest rates; however, they do not properly weight the benefits against the costs involved. After all, while the benefit of reducing the interest rate is clear on

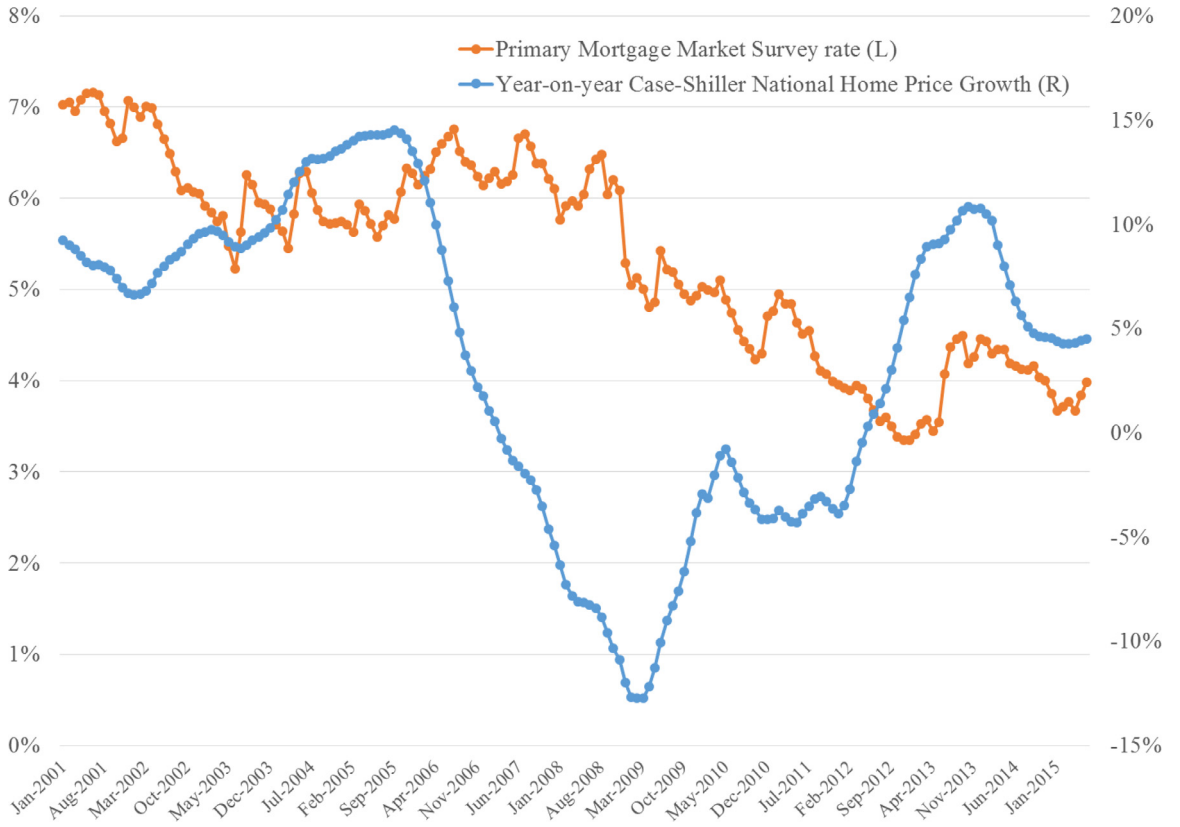

Fig. 2. Home price growth and interest rate since 2001.

a monthly basis, it is harder to assess the overall benefit over an uncertain duration. Therefore, we hypothesize that borrowers who take points have several distinguishing features. First, points takers are concerned about high mortgage rates, and hence they focus on the monthly payment and may strive to find ways to reduce it. Second, points takers are liquid; they have the resources to make the upfront payment. Finally, they are not financially sophisticated.

To test these predictions, we explore the characteristics of borrowers who take points. The dependent variable in our analysis is an indicator for whether a borrower took points at origination. The explanatory variables are mortgage and borrower characteristics at the time of origination.

The results are presented in Table 5. The regressions show that a main explanatory variable for which borrowers take points is the pre-points mortgage rate; the higher the mortgage rate is, the more likely borrowers are to take points. Given that we control for the origination year and month of the mortgage, this result shows that borrowers' primary motivation for buying points is to lower their quoted interest rate, especially when it is above the market rate. If the mortgage rate increases by one percentage point, the likelihood of taking points is 14.8 percentage points higher [Column 6; compare with the sample mean of 12.0 percentage points (Table 1, Panel A)].

We also find evidence supporting the idea that borrowers who take points are relatively liquid. The regressions show that points takers have low leverage and low back-end ratios (debt-to-income ratio). Furthermore, borrowers who engage in cash-out refinancing transactions are very likely to take points. This result is likely due to borrowers using some of the equity they extracted from the property to pay for the points; essentially, the cash-out amount may be considered a "windfall" that is psychologically easier for borrowers to spend (Arkes, Joyner, Pezzo, Gradwohl Nash, Siegel-Jacobs, and Stone, 1994). A cash-out refi borrower is 2.6 percentage points more likely to take points.

The regression also presents evidence that points takers are more likely to be less sophisticated than other borrowers. The regressions show that borrowers who have a bachelor's degree or higher are less likely to buy points and older borrowers (above age 65) are more likely to take points. These results are consistent with Campbell (2006) and Calvet, Campbell, and Sodini (2009), who show that older and less educated borrowers are more likely to make financial mistakes. Younger borrowers (age 35 or younger) are less likely to take points, potentially due to their financial constraints. Note that we include bank fixed effects to control for bank-related incentives to take points, e.g., financial advice to borrowers.

The regressions also show that investors (as opposed to owner-occupiers) are more likely to take points. Investors tend to stay longer (four months longer, which is 7% longer on average) with their mortgages than homeowners, implying that their NPV is less negative and points are a more rational decision relative to homeowners. In addition,

Table 4
Ex ante analysis of investment in discount points

The table presents statistics about ex ante performance of discount points in the sample period 1/2001–3/2011. It is based on the estimated hazard coefficients reported in Table 3. Because home price growth (HP) and interest rate changes (IR) are unknown at the time of origination, we conduct a Monte Carlo simulation based on 50 paths of home price growth and interest rate changes. The paths are drawn from bivariate normal distributions based on historical Case-Shiller home price index and PMMS rate data from 1990 to 2015. Mean (HP, IR)=(0.0340, −0.0025) and variance-covariance of (HP, IR)=(0.0036, 0.0121 \ 0.0121, 0.0057). Panel A presents the average net present value (NPV) of a point taken in each month, averaged over the sample period. Panel B shows the percentage of months in which the average NPV is positive. See Appendix A for variable definitions. *t*-statistics are reported in parentheses; standard errors are adjusted for autocorrelation using the Newey and West (1987) procedure with 12 lags. For the columns under "Average NPV," the coefficients measure the average across months of the average NPV in the month. For these columns, the *t*-statistics (in parentheses) measure the statistical significance of the NPV difference from zero. For the columns under "% Months with negative NPV," the coefficients measure the percentage of months in which the average NPV is negative. For these columns, the *t*-statistics (in parentheses) measure the statistical significance of the coefficient from 0.5. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Average NPV of investing in one point, pre-tax

	Average NPV		% Months with negative NPV	
IO price	Points takers (1)	Non-points takers (2)	Points takers (3)	Non-points takers (4)
100%	−0.160***	−0.159***	0.902***	0.943***
	(−3.15)	(−3.17)	(14.10)	(22.21)
120%	−0.300***	−0.299***	1.000***	1.000***
	(−7.07)	(−7.18)	(-)	(-)
150%	−0.440***	−0.439***	1.000***	1.000***
	(−13.03)	(−13.17)	(-)	(-)

Panel B: Average NPV of investing in one point, after tax

	Average NPV		% Months with negative NPV	
IO price	Points takers (1)	Non-points takers (2)	Points takers (3)	Non-points takers (4)
100%	−0.181***	−0.170***	0.984***	0.976***
	(−5.07)	(−4.60)	(74.78)	(51.30)
120%	−0.287***	−0.275***	1.000***	1.000***
	(−9.71)	(−8.94)	(-)	(-)
150%	−0.391***	−0.380***	1.000***	1.000***
	(−16.85)	(−15.31)	(-)	(-)

borrowers who are investors will receive rent in the future; thus, they may be able to better use the tax benefits of points.

We also find evidence of the marketing channel of points. Points are less likely to be sold by brokers because points are embedded in banks' rate sheets, and brokers do not benefit from steering borrowers toward mortgages with points.

To summarize, it appears that borrowers who invest in points are concerned about their mortgage rates, have the financial resources to make the necessary investment, and are not likely to be financially savvy.

5.2. Inattentiveness of points takers

We use the points empirical setting to explore whether points takers are inattentive to their finances. Specifically, we test whether points takers fail to refinance their mortgages when interest rates decrease. Finding such evidence would support the hypothesis that a lack of financial sophistication among some borrowers is the reason that the option to buy points does not disappear from this market.

Our test explores whether points takers refinance better than, similar to, or worse than the rest of the borrower population. Borrowers refinance their mortgages to lower their interest rate or monthly payments.[8] An extensive literature estimates the optimal time for a borrower to refinance. The initial work in this area uses continuous time option valuation models (Dunn and McConnell, 1981). Later studies relax some of the assumptions of the early models, for example, by allowing borrowers to endogenously choose to default (Hendershott and Van Order, 1987). Finally, Agarwal, Driscoll, and Laibson (2013) derive a closed-form solution showing that it is optimal to refinance when the refinancing rate is between 100 and 200 basis discount points below the original mortgage rate. The actual behavior of mortgage holders sometimes differs from the predictions of the optimal refinancing model. In the 1980s, when mortgage interest rates fell, some borrowers failed to refinance despite holding options that were deeply "in the money" (Giliberto and Thibodeau, 1989). Keys, Pope, and Pope (2014) find that borrowers, in general, refinance their mortgages too late and

[8] Historically, annual refinancing volume in the United States accounted for half of all mortgage originations, according to the Mortgage Bankers Association. Due to historically low mortgage rates, total refinancing originations doubled from $1.1 trillion in 2001 to $2.4 trillion during the 2003 refinancing boom. It had shrunk to $959 billion by 2011, accounting for about 68% of all originations (Source: Home Mortgage Disclosure Act (HMDA) 2001–2011).

Table 5
Who takes points?
The table presents ordinary least squares regressions investigating the characteristics of borrowers who take points. Standard errors are clustered by calendar month. See Appendix A for variable definitions. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Points-taker indicator (0/1)					
	(1)	(2)	(3)	(4)	(5)	(6)
Mortgage rate (%)	0.059***	0.160***	0.170***	0.168***	0.160***	0.153***
	(17.26)	(33.55)	(36.53)	(37.09)	(37.31)	(35.89)
Loan-to-value (%)			−0.018***	−0.018***	−0.015***	−0.007***
			(−13.22)	(−13.12)	(−11.17)	(−5.07)
Back-end ratio				−0.001	−0.002*	−0.002*
				(−1.68)	(−2.42)	(−2.56)
log(Loan balance)				−0.005***	−0.002	−0.002*
				(−4.30)	(−1.76)	(−2.46)
FICO score				0.000	-−0.001	0.001
				(0.25)	(−1.07)	(1.35)
Investor dummy					0.009***	0.011***
					(7.39)	(8.55)
College/grad dummy					−0.005***	−0.004***
					(−6.41)	(−4.81)
Younger household: Age<=35					−0.009***	−0.006***
					(−12.95)	(−8.46)
Older household: Age>65					0.002*	0.001
					(2.25)	(1.98)
Cash-out refi dummy						0.026***
						(19.58)
Rate refi dummy						−0.000
						(−0.03)
Broker dummy	−0.033***	−0.034***	−0.034***	−0.034***	−0.034***	−0.035***
	(−10.68)	(−12.65)	(−12.49)	(−12.33)	(−12.35)	(−13.19)
Bank size	0.020***	0.019***	0.017***	0.017***	0.017***	0.017***
	(9.19)	(8.65)	(8.13)	(8.11)	(8.01)	(8.13)
House price growth (*t*−1) (%)	−0.038***	0.079*	0.072*	0.071*	0.072*	0.068*
	(−7.65)	(2.41)	(2.35)	(2.35)	(2.42)	(2.40)
Change in mortgage rate (*t*−1) (%)	−0.003	−0.004	−0.001	−0.001	−0.001	0.002
	(−0.97)	(−0.17)	(−0.05)	(−0.03)	(−0.06)	(0.10)
Calendar month FE	No	Yes	Yes	Yes	Yes	Yes
Observations	312,111	312,111	312,111	312,111	312,111	312,111
Adjusted R^2	0.032	0.070	0.073	0.073	0.075	0.080

consequently incur substantial losses. On the other hand, Agarwal, Rosen, and Yao (2016) note that some borrowers err by refinancing too early without getting enough rate savings.

The analysis is presented in Table 6. First, we explore different types of exits by points takers. The sample we use is a panel data set of all mortgage-months. We use Cox hazard model regressions in which the dependent variables are indicators for whether the borrower exits. In Column 1, the dependent variable is all types of exits combined. We control, in addition to the usual controls, for the negative and positive changes in interest rates since the origination of the loan. Note that these changes are after points were taken. To account for the rate savings motive behind refinancing, we control in Column 2 for the rate savings, which we compute as the PMMS rate at month *t* minus the PMMS rate at month 0 (the origination month), plus $\Delta rate$ (the rate reduction from paying discount points):[9]

$$Rate\ Saving_{0,t} = Mortgage\ Rate_t - (Mortgage\ Rate_0 \pm \Delta\ Rate). \quad (6)$$

Column 1 shows that when all exits are considered together, there is no special effect for points takers. Next, we examine the likelihood to repay following a sale in Column 2. The results show, as expected, that points takers are less likely to move from their houses. Column 3 explores the likelihood of default. It shows that there is no significant difference between points takers and non-points takers.

Columns 4 and 5 address the hazard rate of refinancing. Controlling for the potential savings from refinancing, the regression in Column 4 shows that points takers are not statistically different in their likelihood to refinance than non-points takers. However, when we interact the potential savings with the points taker indicator, there is a strong interaction effect. Points takers react more slowly to interest rate savings. A lower interest rate change means

[9] The following example illustrates the rate savings in refinancing. The rate of a 30-year FRM at origination in January 2006 was 6.15%. The borrower took two discount points, and the interest reduction per point at the time was 0.16%. The delta rate in this case is 0.33%. The rate for a 30-year FRM in January 2010 was 5.03%. Therefore, the rate savings from refinancing is 5.03% − (6.15% − 0.33%) = −0.79% instead of the much smaller 5.03% − 6.15% = −1.12%. Hence, the rate savings variable accounts for the fact that the interest rate on the mortgage is lower due to discount points. The results show that rate savings is indeed a primary variable that explains default. As the rate savings motive becomes stronger (i.e., this variable becomes more negative), the hazard of refinancing is higher. The same idea is expressed in Agarwal, Driscoll, and Laibson (2013).

Table 6
Borrower inattentiveness

The table explores whether points takers have the same hazard rate of exiting the mortgage as do non-points takers. The sample is a panel in which observations are at the mortgage-month level. The dependent variables are indicators for whether borrowers exited (moved, defaulted, or refinanced) in a particular month. See Appendix A for variable definitions. All regressions are Cox hazard model regressions. Standard errors are clustered by calendar month. *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	All exits	Move	Default	Refinance	
	(1)	(2)	(3)	(4)	(5)
Points indicator	−1.545	−13.319***	−6.392	2.574	8.481
	(−0.48)	(−5.44)	(−1.81)	(0.75)	(1.71)
Rate saving (%)	−0.523***	−0.044	0.044	−0.724***	−0.730***
	(−7.54)	(−0.59)	(1.30)	(−11.22)	(−11.21)
× Points indicator					14.370***
					(6.10)
Rate increase (%)	−0.602***	−0.102	−0.357***	−0.927***	−1.026***
	(−5.97)	(−1.50)	(−3.42)	(−8.34)	(−8.41)
× Points indicator					41.889***
					(4.49)
Mortgage characteristics	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes	Yes
MSA FE	Yes	Yes	Yes	Yes	Yes
Observations	5,712,984	5,712,984	5,712,984	5,712,984	5,712,984
R^2	0.012	0.023	0.056	0.021	0.021
Log likelihood	−2,336,356	−441,956	−246,362	−1,703,627	−1,703,424
Chi^2	7,165	10,378	10,671	11,910	17,982

more savings. The coefficient on the interaction in Column 5 is positive, meaning that it reduces the sensitivity of the hazard of refinancing to the interest rate savings.

To see the effects of rate savings and discount points on the hazard of refinancing, consider the following example. Compare two borrowers who can save 1% relative to their original mortgage rate by refinancing. The borrower who does not have discount points increases the hazard of refinancing by 108% (= exp(−0.730 * −1) − 1). In contrast, the borrower who invested in discount points in the past has a lower hazard of refinancing: 96% (= exp(8.481/100+(−0.730 * −1)+(14.370 * −1 * 1/100)) − 1). The difference is 12% lower.

The findings presented in this section are consistent with points takers lacking financial sophistication. Given that most empirical evidence suggests that borrowers, on average, are refinancing too late (e.g., Agarwal, Driscoll, and Laibson, 2013; Keys, Pope, and Pope, 2014), the fact that points takers are even less likely to refinance indicates that they operate less optimally than the overall borrower population. These results are consistent with borrowers being inattentive, suggesting that points takers are not actively managing their finances and do not make optimal financial decisions.

6. Conclusion

We study a setting in which lenders offer borrowers multiple contracts and borrowers voluntarily select which contract works best for them. In this setting, borrowers invest in mortgage discount points in exchange for future reductions in the monthly interest rate. Because there are no benefits in these transactions to borrowers except for earning a return on their investment, borrowers are expected to sort to the contract that offers them the best return.

Our study presents evidence that households make systematic mistakes in the points decision. We find that borrowers who invest in points (about 12% of borrowers) lose about $700 on average. We show that this result holds when using both ex post data and ex ante information.

The mistake that borrowers make seems to be poorly predicting when they will exit the mortgage. In other words, borrowers, on average, overestimate how long they will stay with their mortgage or they underestimate the costs associated with obtaining a rate reduction. A similar mistake takes place in the credit card industry: Agarwal, Chomsisengphet, Liu, and Souleles (2015) report that credit card users prefer contracts with low annual fees and high interest rates; however, this contract results in overall higher costs for users, because they underestimate the likelihood of carrying a balance.

Our results suggest that points takers lack financial sophistication. Similarly, demographic characteristics of the points takers in our sample suggest low sophistication (lower education levels and mature age). Furthermore, points takers are less likely to refinance relative to peer borrowers given a potential savings due to declining interest rates. This result is likely driven by the financial inattentiveness of these points takers.

An important question is why not all banks offer the points contact. Although we do not have a firm answer to this question, we speculate that banks have the long-term perspective and data to evaluate the profitability of this feature. To assess the profitability of this product, banks need to collect data about duration and product choice decisions that were made at origination, many years before.

They need to account for sample censoring and develop predictive models (like we do here). Small banks are likely to lack the capacity to conduct such analyses.

Our study has a potential policy implication. While in principle offering multiple options to borrowers is desirable, we show that borrowers do not benefit from the points option. On the contrary, borrowers who choose to invest in points lose, on average, because they are poor at estimating how long they will stay with their mortgage contract. Hence, most borrowers would be better off if points were not offered in the market.

Appendix A. Variable definitions

Variable	Definition
Back-end DTI ratio	Back-end debt-to-income ratio, computed as the total monthly debt expense divided by the gross monthly income.
Borrower age	Age of the borrower, measured in years, at the time of origination.
Broker loan dummy	An indicator for whether the mortgage was originated by a mortgage broker.
Cash-out refi dummy	An indicator for whether the mortgage is a cash-out refinance mortgage.
College/grad dummy	An indicator for whether the borrower had acquired a bachelor's degree or higher at the time of origination.
Cumulative rate change	The mortgage rate at time t minus the mortgage rate at origination, plus the delta rate.
Default dummy	An indicator for whether a borrower defaulted on the mortgage in a particular month or quarter.
Delta rate	The rate reduction due to discount points. Calculated as the number of discount points divided by the IO price.
Discount points (% of balance)	The number of discount points taken by the borrower, as a percentage of the loan balance.
Discount points dummy	An indicator for whether the borrower took discount points at the time of origination.
Duration (months)	The period of time (in months) that the borrower stayed with the mortgage.
Excess premium	The residual of a regression of the mortgage rate on mortgage characteristics.
FICO	The FICO (Fair Isaac Company) credit score of the borrower.
First-time homebuyer	An indicator for whether the borrower is a first-time homebuyer.
Home price growth	The quarter-on-quarter average price growth of the metropolitan statistical area (MSA) in which the property is located.
Investor	An indicator for whether the borrower is an investor.
IO price	The price at which interest-only securities trade in the secondary market. This is a proxy for the inverse of the interest reduction of discount points, i.e., the time in years it will take to recoup the investment in discount points via rate reduction.
Loan balance	The amount originally borrowed.
LTV	Loan-to-value ratio, calculated as the amount borrowed divided by the value of the home at the time of origination.
Mark-to-market LTV	An ongoing loan-to-value ratio that takes into account the repayment of the principal and the change in home prices in the MSA in which the property is located.
Monthly income	The borrower's monthly income at the time of origination.
Move dummy	An indicator for whether a borrower sold the house in a particular month or quarter.
Note rate	The nominal rate of the mortgage contract. All mortgages in the sample are 30-year fixed rate mortgages.
Note rate w/o discount points	The rate of the mortgage contract after adding back the rate reduction due to discount points (computed as the number of discount points divided by the IO price).
Rate/term refi dummy	An indicator for whether the mortgage is a rate or term refinance mortgage.
Refi dummy	An indicator for whether a borrower refinanced the mortgage in a particular month or quarter.

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