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EVALUATING REFINANCING STRATEGIES PRECISELY

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Abstract

When a borrower refinances a mortgage, choices have to be made between fixed-rate and adjustable-rate loans based on expectations of future interest rates and the expected holding period of the loan. This paper presents a new, comprehensive and precise calculation procedure which will assist a borrower in selecting the best refinancing option by taking into account all of the interacting factors that contribute to the decision. The calculation procedure can be computerized and used to investigate various refinancing conventional wisdoms, for example it leads us to refute the conventional 2% rule, and to avoid erroneous and costly decisions.

INTRODUCTION

When interest rates fall, a common financial planning question is whether or not borrowers are able to save money by refinancing their mortgages. The conventional rule-of-thumb is to refinance only if the market interest rate has fallen at least 2% below the existing mortgage rate. Another conventional wisdom is referred to as the 2-2-2 rule, i.e., when interest rates have dropped 2%, the borrower has already paid two years on the mortgage and will keep the property for two more years, it usually pays to refinance. However, the refinancing decision is in reality a complicated one and such commonly accepted rules of thumb are at best crude simplifications of decision rules and can lead to erroneous and costly decisions. An article entitled "More Homeowners Are Saying Farewell to ARMs" which appeared in *Wall Street Journal* on June 9, 1995 was misleading because the actual savings in the refinancing example were overstated. The article contained an example of a hypothetical couple where the monthly payment on the new loan was subtracted from the monthly payment on an existing loan to calculate the monthly savings and then the monthly savings were divided into the refinancing costs to determine the time to break even. *Consumer Report* [4] provided a worksheet advising its readers to follow this same erroneous procedure. *Business Week* [2] presented an oversimplification of the refinancing problem by not considering all the relevant factors. Whether it is financially viable to refinance an existing mortgage depends on many factors, including the magnitude of the decline in interest rates, the closing costs and points, the length of time the original loan has been held, the length of time the borrower expects to keep the new loan, the difference in the amounts owed on the original and new loans over the planning horizon, the effect of tax deductibility of interest payments, the borrower's marginal tax rate, and all of these factors should be considered in the decision-making process.

There are basically two types of mortgage loans available to borrowers: fixed and adjustable. However, there are numerous variations among each type of loan. For fixed-rate loans, interest rates are usually locked in for a period of 15 or 30 years. For adjustable-rate loans, the index used to determine the interest rate includes LIBOR (London Interbank Offer Rate), prime rate, T-bill (Treasury bill), CD (certificate of deposit) and COFI (cost of fund index). Interest payments on these loans can change monthly, semiannually or annually and amortization of the loans is usually 30 years.

The simplest form of refinancing from the point of view of calculating the financial consequences (or costs) is the replacement of a fixed-rate mortgage by another fixed-rate mortgage with a lower interest rate. However, other options could be a fixed-rate mortgage replaced by an adjustable-rate mortgage, an adjustable-rate mortgage replaced by a fixed-rate mortgage, and an adjustable-rate mortgage replaced by another adjustable-rate mortgage with a different index or a different margin. Even though interest rates may have dropped by two percentage points, refinancing decisions should by no means be automatic or routine. Each borrower should examine a potential

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refinancing decision carefully to determine if refinancing is cost effective and then select the best choice of several possible alternatives. Furthermore, in certain situations it may pay to refinance even if interest rates have dropped by less than two percentage points.

BACKGROUND AND MOTIVATION

There are many factors to consider in a mortgage refinancing decision. They are (1) the refinancing costs, (2) the reduction in mortgage payments, (3) the expected holding period of the new loan, (4) the opportunity cost of refinancing, (5) the borrower's marginal tax rate, and (6) the difference in the outstanding balances of the original and new loans over the planning horizon. The costs of refinancing include points, escrow fee, title insurance, application fee, appraisal fee, credit report fee and document recording fee as well as other "junk fees" often added by the broker or lender. The costs of refinancing a mortgage are payable up front at the time of refinancing although some borrowers prefer to increase the loan amount to cover these up front out-of-pocket expenses. Of the various types of fees, only the points are tax deductible but must be amortized over the life of the new loan according to the Tax Reform Act of 1986.

A study of the finance literature revealed many articles have been written on mortgage refinancing. However, we have two main criticisms of the limited amount of earlier work that exists in the area: (1) some of the analyses are overly simplified (by ignoring certain important variables in the refinancing decision) or even misleading in the assumptions or calculations made and (2) the focus is exclusively on fixed-rate loans completely ignoring adjustable-rate loans.

For example, Arsan and Poindexter [1] and Rose [10] investigated the economics of mortgage refinancing. Rose failed to recognize that the reduction in mortgage payments is not the actual savings accrued to borrowers. The amount of the per period savings should be determined by the decrease in monthly mortgage payments minus the reduced tax benefits as a result of lower interest expense on the new loan. Also, Rose failed to recognize that most costs incurred in refinancing a mortgage are not tax deductible. Only the points which are considered as prepaid interest are tax deductible, but they must be amortized over the term of the new loan.

Furthermore, since refinancing decisions are made today and the benefits of the tax write-offs of the points and interest expense will occur over a period of time, it is necessary to conduct a present value analysis of the cash flows associated with refinancing. Rose however, did not consider these present value calculations. In order to determine the net present value (NPV) of refinancing, that is, the present value of the cash inflows less cash outflows, a discount rate must be used. Refinancing a mortgage is similar to a firm's bond refunding decision, and the accepted discount rate used in evaluating a bond refunding situation is the after-tax interest rate on the new bonds. Therefore, the after-tax interest rate on the new loan should be the discount rate used in evaluating a refinancing decision. Arsan and Poindexter however, used the before-tax interest rate on the new loan as the discount rate in evaluating a refinancing decision. Since savings are calculated after tax, using a before-tax discount rate would understate the present value of the savings. Randle and Johnson's [9] model uses a break-even approach that includes the present value calculations but omits any mention of the tax implications of refinancing and does not distinguish between points (which can be amortized over the life of the loan) and fees (which are not tax deductible).

Four earlier studies (G-Yohannes [6], Kirby, Nash, and Stanford [7], Marquardt and Woerheide [8] and Waller [12] correctly analyzed the refinancing decision using the NPV technique. However, like the Arsan and Poindexter and Rose studies they considered only fixed-rate mortgages and only one study (G-Yohannes) included the effects of the differences in the outstanding balances of the two loans over the planning horizon. Waller calculated the tax savings using an average payment over the entire holding period. Since mortgage interest is tax deductible each year, the average savings underestimate the actual savings in the early years and overestimate the actual savings in the later years thereby introducing a bias. This bias would be nontrivial over long holding periods. Furthermore, both G-Yohannes and Waller used a required rate of return which was not the same as the interest rate on the new loan. The interest rate on the new loan represents the borrower's opportunity cost of alternative investments and therefore should be used as the discount rate. Other approaches to refinancing introduce a stochastic interest rate environment (Dickinson and Heuson [5] and Yang and Maris [13]) and this should be included in any comprehensive and precise calculations.

Adjustable-rate mortgages, although omitted in the literature, can however, be attractive if interest rates are expected to fall, or to borrowers who do not qualify for fixed-rate mortgages or who would like to obtain a larger mortgage, or who plan to keep their properties for a short period of time. Despite the relative complexity of analyzing adjustable-rate mortgages due to fluctuating interest rates, an effort must be made to include them in any mortgage refinancing analysis.

This paper introduces and describes a calculation procedure which allows a comprehensive and precise analysis of mortgage refinancing by including both fixed-rate and adjustable-rate mortgages and by taking into account all relevant costs and benefits associated with refinancing in a present value context. Deterministic or stochastic interest rate assumptions can also be readily accommodated. The authors believe that his is the first attempt to include adjustable-rate mortgages in refinancing analysis and to provide such a complete calculation procedure or model for determining the best decision. This model should enhance real estate teaching and research activities related to mortgage refinancing as well as benefit potential and existing borrowers.

DESCRIPTION OF THE CALCULATIONS

There are numerous interacting variables that affect the decision to refinance, such as the interest rate, the points and fees, the amount and type of loan, i.e., fixed, 6-month or 12-month adjustable, and margins and caps (for adjustable-rate loans) as well as the anticipated time the borrower plans to keep the new loan and the borrower's marginal tax rate. In the absence of any theoretical model, each decision to refinance would have to be evaluated on a case-by-case basis to calculate the exact costs or savings produced by these interacting variables. Consequently, we identified a need for a calculation procedure that could calculate precisely the cash flows resulting from any given refinancing scenario. Specifically, the intention was to develop a general procedure that would calculate the NPV of the cash flows obtained over any planning horizon, given data on an existing loan and data regarding the opportunity to refinance to a new loan. Various alternative refinancing options could be compared by examining the associated NPV of the resulting cash flows, calculating the time to break even and thereby aiding with the decision to refinance or not.

In the following calculations, we assume (1) that borrowers will realize the tax benefit of mortgage interest deduction monthly because they will have less taxes withheld from their monthly payroll as owners of the property and (2) that borrowers' total itemized deductions in the annual income tax return will exceed the standard deduction so that they will always be able to enjoy the tax benefit of mortgage interest deduction.

Input Variables in the Decision to Refinance

1. The planning horizon: the length of time the borrower intends to keep the property (i.e., up to the life of the new loan or the remaining life of the existing loan, whichever is longer).
2. When refinancing will take place (i.e., the number of months that the existing loan has been held.)
3. The marginal tax rate of the borrower.
4. The opportunity cost of alternative investments.
5. The behavior of the market interest rate (for adjustable-rate loans only). Some assumptions or forecasts have to be made about the future behavior of the market interest rate. Examples are: (1) a worst case scenario (where the market interest rate increases such that the new loan's annual cap is exceeded each year), or (2) the historical market rate over the last 30 years, or (3) randomly generated market rate. Other, customized, deterministic or stochastic, market interest rate assumptions can be made as appropriate.
6. Information about the existing loan (LOAN1) and the refinanced loan (LOAN2). Specifically, for both LOAN1 and LOAN2:
   - the loan amount
   - the amortization period
   - if the loan is fixed: the interest rate
   - if the loan is adjustable: the initial interest rate, the index (e.g., T-bill, LIBOR, COFI), the margin, the annual cap, the lifetime cap and the frequency of payment adjustment (e.g., annual, semiannual, or monthly)
   - for LOAN2 only, the costs of initiating the loan namely the points and the (sum of all) fees
   - the points on LOAN1. If LOAN1 has not been previously refinanced the points and fees have already been paid and are considered sunk costs which are irrelevant in the refinancing decision. On the other hand however, if LOAN1 is a refinanced loan the tax savings from the amortization of the points must be considered (the fees paid on originating LOAN1 are sunk costs).
7. Prepayment penalty on LOAN1, if any.
8. Prepayment amounts: any additional payments applied to reduction of the principal, for LOAN1 or LOAN2.

Calculations

Given specific values for each of the variables identified in 1-8 above as input data we now determine the NPV of the cash flows obtained as a result of refinancing. The NPV of the resulting cash flows over the desired planning horizon is obtained from the amortization schedules for LOAN1 and LOAN2. (Note that the amortization schedule for LOAN2 begins in the period that the refinancing will take place, which can be at any period up to the life of LOAN1). Finally, the break-even period is calculated. This is defined as the time taken to recover the refinancing costs and the difference in the outstanding balances of the two loans.

Calculation of Amortization Schedule for LOAN1 and LOAN2:

For a fixed-rate loan the amortization schedule is created by the standard procedure of calculating the per period payment, based on the loan amount, amortization period and interest rate. The calculations for the interest and principal payments each period then follow. For an adjustable-rate loan the new interest rate has to be recomputed based on the loan's payment adjustment frequency, i.e., either, annually, semiannually, or monthly, so that the new periodic payment can be calculated (based on the outstanding loan balance and remaining unamortized period). The new interest rate is computed as follows:

(a) When the indexed interest rate rises above the initial indexed interest rate,
  let A = borrower's current interest rate + annual cap,
  if index + margin > A,
  then if A > initial interest rate + lifetime cap,
    then borrower's new interest rate = initial interest rate + lifetime cap,
    else borrower's new interest rate = A,
  else borrower's new interest rate = index + margin.

(b) When the indexed interest rate falls below the initial indexed interest rate,
  let B = borrower's current interest rate - annual cap,
  if index + margin < B,
  then if B < initial interest rate - lifetime cap,
    then borrower's new interest rate = initial interest rate - lifetime cap,
    else borrower's new interest rate = B,
  else borrower's new interest rate = index + margin.

The calculations for the interest and principal payments each period can then be made as for a fixed-rate loan until the next time the interest rate has to be adjusted.

Calculation of NPV of Cash Flows:

Once the amortization schedules for LOAN1 and LOAN2 have been constructed the savings obtained each period, S_i, are then calculated and the NPV of cash flows up to period i, NPV_i, of the planning horizon is obtained as follows:

Per period savings, S_i:

= the reduction in principal payments
– the decrease in interest tax deduction
– the lost tax deduction from the amortization of points on LOAN1 (if LOAN1 has been obtained by refinancing, otherwise this is zero)
+ the tax benefit from the amortization of points on LOAN2.

NPV of cash flows up to period i, NPV_i:

= the present value of the per period savings, S_i,
– the sum of all fees paid in refinancing, the points paid, the after-tax prepayment penalty (if any) and the unpaid principal
+ the LOAN2 amount
+ the present value of the difference in outstanding loan balances.

Appendix 1 provides detailed formulas and Appendix 2 illustrates the calculations with a specific example.

TABLE 1
Calculations For Adjustable-Rate To Adjustable-Rate Refinancing For Borrower A (Example 1)

		LOAN 1													
Period No.	New Interest Rate	Monthly Payment	Interest Paid	Principal Paid	Balance								NPV of Cash Flows		
0	5.0%				$200,000.00										
1	5.0%	$1,073.64	$833.33	$240.31	$199,759.69										
2	5.0%	1,073.64	832.33	241.31	199,518.38										
3	5.0%	1,073.64	831.33	242.32	199,276.06										
4	5.0%	1,073.64	830.32	243.33	199,032.74										
5	5.0%	1,073.64	829.30	244.34	198,788.40										
6	5.0%	1,073.64	828.28	245.36	198,543.04										
7	5.0%	1,073.64	827.26	246.38	198,296.66										
8	5.0%	1,073.64	826.24	247.41	198,049.25										
9	5.0%	1,073.64	825.21	248.44	197,800.81			LOAN 2							
10	5.0%	1,073.64	824.17	249.47	197,551.34	Period No.	New Interest Rate	Monthly Payment	Interest Paid	Principal Paid	Balance	Per Period Savings	Over the Life of LOAN2	Over 48 Periods	Break Even Period
11	5.0%	1,073.64	823.13	250.51	197,300.83	0	4.5%				$197,300.83				
12	5.0%	1,073.64	822.09	251.56	197,049.27	1	4.5%	$999.69	$739.88	$259.82	$197,041.01	$51.86	$8,082.67	$2,599.81	28
13	7.0%	1,324.43	1,149.45	174.97	196,874.30	2	4.5%	999.69	738.90	260.79	196,780.22	$200.86			
14	7.0%	1,324.43	1,148.43	175.99	196,698.30	3	4.5%	999.69	737.93	261.77	196,518.45	$200.87			
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20	7.0%	1,324.43	1,142.18	182.24	195,620.57	9	4.5%	999.69	731.98	267.71	194,927.10	$200.97			
21	7.0%	1,324.43	1,141.12	183.31	195,437.26	10	4.5%	999.69	730.98	268.72	194,658.38	$200.99			
22	7.0%	1,324.43	1,140.05	184.38	195,252.88	11	4.5%	999.69	729.97	269.73	194,388.66	$201.01			
23	7.0%	1,324.43	1,138.98	185.45	195,067.43	12	4.5%	999.69	728.96	270.74	194,117.92	$201.03			
24	7.0%	1,324.43	1,137.89	186.53	194,880.90	13	6.5%	1,240.83	1,051.47	189.35	193,928.57	$60.21			
25	9.0%	1,590.81	1,461.61	129.21	194,751.69	14	6.5%	1,240.83	1,050.45	190.38	193,738.19	$225.92			
26	9.0%	1,590.81	1,460.64	130.17	194,621.52	15	6.5%	1,240.83	1,049.42	191.41	193,546.77	$225.90			
27	9.0%	1,590.81	1,459.66	131.15	194,490.37	16	6.5%	1,240.83	1,048.38	192.45	193,354.33	$225.89			
28	9.0%	1,590.81	1,458.68	132.13	194,358.23	17	6.5%	1,240.83	1,047.34	193.49	193,160.84	$225.87			
29	9.0%	1,590.81	1,457.69	133.13	194,225.11	18	6.5%	1,240.83	1,046.29	194.54	192,966.30	$225.85			
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358	11.0%	1,868.77	50.46	1,818.31	3,686.78	347	10.5%	1,767.87	202.99	1,564.88	21,634.18	$151.58			
359	11.0%	1,868.77	33.80	1,834.98	1,851.80	348	10.5%	1,767.87	189.30	1,578.57	20,055.60	$152.51			
360	11.0%	1,868.77	16.97	1,851.80	0.00	349	10.5%	1,767.87	175.49	1,592.39	18,463.21	$153.44			
						350	10.5%	1,767.87	161.55	1,606.32	16,856.89	($1,714.39)			
						351	10.5%	1,767.87	147.50	1,620.38	15,236.52	($1,718.75)			
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						359	10.5%	1,767.87	30.54	1,737.34	1,752.54	($1,755.01)			
						360	10.5%	1,767.87	15.33	1,752.54	0.00	($1,759.72)			

TABLE 2
Calculations For Adjustable-Rate To Fixed-Rate Refinancing For Borrower A (Example 2)

		LOAN 1						LOAN 2					NPV of Cash Flows		
Period Number	New Interest Rate	Monthly Payment	Interest Paid	Principal Paid	Balance	Period Number	Monthly Payment	Interest Paid	Principal Paid	Balance	Per Period Savings	Over the Life of LOAN2	Over 48 Periods	Break Even Period
0	5.0%				$200,000.00									
1	5.0%	$1,073.64	$833.33	$240.31	$199,759.69									
2	5.0%	1,073.64	832.33	241.31	199,518.38									
3	5.0%	1,073.64	831.33	242.32	199,276.06									
4	5.0%	1,073.64	830.32	243.33	199,032.74									
5	5.0%	1,073.64	829.30	244.34	198,788.40									
6	5.0%	1,073.64	828.28	245.36	198,543.04									
7	5.0%	1,073.64	827.26	246.38	198,296.66									
8	5.0%	1,073.64	826.24	247.41	198,049.25									
9	5.0%	1,073.64	825.21	248.44	197,800.81									
10	5.0%	1,073.64	824.17	249.47	197,551.34									
11	5.0%	1,073.64	823.13	250.51	197,300.83	0	$1,379.56			$197,300.83				
12	5.0%	1,073.64	822.09	251.56	197,049.27	1	1,379.56	1,233.13	146.43	197,154.40	($175.09)	$43,951.86	$1,699.45	43
13	7.0%	1,324.43	1,149.45	174.97	196,874.30	2	1,379.56	1,232.22	147.34	197,007.06	($26.07)			
14	7.0%	1,324.43	1,148.43	175.99	196,698.30	3	1,379.56	1,231.29	148.26	196,858.80	($26.04)			
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20	7.0%	1,324.43	1,142.18	182.24	195,620.57	9	1,379.56	1,225.65	153.91	195,949.57	($25.86)			
21	7.0%	1,324.43	1,141.12	183.31	195,437.26	10	1,379.56	1,224.68	154.87	195,794.70	($25.83)			
22	7.0%	1,324.43	1,140.05	184.38	195,252.88	11	1,379.56	1,223.72	155.84	195,638.86	($25.79)			
23	7.0%	1,324.43	1,138.98	185.45	195,067.43	12	1,379.56	1,222.74	156.81	195,482.04	($25.76)			
24	7.0%	1,324.43	1,137.89	186.53	194,880.90	13	1,379.56	1,221.76	157.79	195,324.25	($25.73)			
25	9.0%	1,590.81	1,461.61	129.21	194,751.69	14	1,379.56	1,220.78	158.78	195,165.47	$140.00			
26	9.0%	1,590.81	1,460.64	130.17	194,621.52	15	1,379.56	1,219.78	159.77	195,005.70	$139.99			
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358	11.0%	1,868.77	50.46	1,818.31	3,686.78	347	1,379.56	115.24	1,264.32	17,173.53	$512.70			
359	11.0%	1,868.77	33.80	1,834.98	1,851.80	348	1,379.56	107.33	1,272.22	15,901.30	$515.41			
360	11.0%	1,868.77	16.97	1,851.80	0.00	349	1,379.56	99.38	1,280.17	14,621.13	$518.16			
						350	1,379.56	91.38	1,288.17	13,332.96	($1,347.83)			
						351	1,379.56	83.33	1,296.23	12,036.73	($1,350.33)			
						352	1,379.56	75.23	1,304.33	10,732.41	($1,352.84)			
						353	1,379.56	67.08	1,312.48	9,419.93	($1,355.36)			
						354	1,379.56	58.87	1,320.68	8,099.25	($1,357.91)			
						355	1,379.56	50.62	1,328.94	6,770.31	($1,360.47)			
						356	1,379.56	42.31	1,337.24	5,433.07	($1,363.04)			
						357	1,379.56	33.96	1,345.60	4,087.47	($1,365.63)			
						358	1,379.56	25.55	1,354.01	2,733.46	($1,368.24)			
						359	1,379.56	17.08	1,362.47	1,370.99	($1,370.86)			
						360	1,379.56	8.57	1,370.99	(0.00)	($1,373.50)			

Calculation of Time to Breakeven

Initially, after refinancing NPV_i will be negative, so the time to breakeven, i.e., period i, occurs when NPV_i becomes positive.

Examples of Calculation Procedure

Example 1: Assume Borrower A took out a 30-year adjustable-rate loan (which was not obtained by refinancing) for $200,000 with an initial interest rate of 5%, adjusted annually based on one-year T-bill rate with a 3% margin and annual and lifetime caps of 2% and 6% respectively. Borrower A's marginal tax rate is 31%. After 11 monthly payments of $1,073.64 A's outstanding balance on the loan is $197,300.83 and there is an opportunity (with no prepayment penalty) to refinance to another 30-year adjustable-rate loan with an initial interest rate of 4.5%, adjusted annually based on the same index and with the same margin, annual and lifetime caps. The costs of originating the new loan are 2 points plus various fees which total $3,000.00. Borrower A will pay up front all the out-of-pocket expenses for obtaining the new loan so will have $197,300.83 as the (new) loan amount. Assuming a worst case scenario where the market interest rate is expected to rise such that the annual cap is reached each year, and if A expects to hold the property for another four years only, is it worthwhile for A to refinance? Table 1 displays the (abbreviated) amortization schedules for A's situation, where LOAN1 is A's original loan and LOAN2 is the refinanced loan, together with the calculation of the per period savings and discounted cash flows. Even though the initial interest rate on the new loan was only 0.5% lower than on the original loan and the original loan was held for just 11 months the NPV of cash flows amount to $8,082.67. (Since the new loan, in this example, is of the same duration as the original loan, the cash flows are calculated over the life of the new loan. In general, the cash flows are calculated over the maximum of the number of periods left to pay off the original loan and the number of periods of the new loan). Over A's planning horizon of four years the NPV of cash flows amount to $2,599.81 so it would be advantageous for A to refinance to the new adjustable-rate loan. Obviously, if A retained the new loan longer than the planned four years the benefits of refinancing would be even greater. The break-even period is 28 months. This example then, is a counter example to the conventional 2% rule-of-thumb.

Example 2: Suppose Borrower A, holding the original loan as described above, may be tempted (also after 11 months) to refinance to a 30-year fixed-rate loan at 7.5%, obtained at 2 points and fees of $3,000.00. In this case we find that the NPV of cash flows (over the life of the new loan) is $43,951.86 which is significantly higher than for the adjustable loan refinancing option. The break-even period is longer at 43 months however, and over A's planning horizon of four years the NPV of cash flows is less than that of the adjustable rate option with cash flows of $1,699.45. Table 2 shows the (abbreviated) amortization schedules for A's new situation.

Typically a lender will do the following. The monthly payment on the new loan is subtracted from the monthly payment on an existing loan to calculate the monthly savings and then the monthly savings are divided into the refinancing costs to determine the time to break even. This procedure is erroreous because it ignores the time value of money, the decrease in interest tax deduction as a result of lower interest payments on the new loan, the lost tax deduction from the amortization of points on the existing loan, and the tax benefit from the amortization of points on the new loan.

Further Use of the Calculation Procedure

If a borrower's original loan is a fixed-rate one refinancing to other fixed-rate or adjustable-rate loans can similarly be investigated by suitably amending the various input variables. Several what-if scenarios can be investigated (or simulated) to determine a series of break-even values for a particular borrower's situation.

Furthermore, in addition to providing decision support for refinancing decisions in the sense of calculating the per period savings and resulting cash flows associated with refinancing an existing loan, as in the preceding examples, the following related issues can be addressed: (1) refinancing with a cash-out option, where the borrower takes out a loan higher than the outstanding balance in order to receive the difference as cash in hand (many borrowers often increase the new loan amount to cover all the upfront costs which is just a special case of the cash out situation), (2) refinancing with a cash-in option, where the borrower takes out a loan lower than the outstanding balance by paying in the difference to bring down the loan and hence the monthly payments and (3) choosing among various loan alternatives for a first time borrower who is confronted with a myriad of choices (e.g., fixed-rate or adjustable-rate, higher points and fees traded off for a lower interest rate, so-called "no costs" or "free closer" loans etc.). The calculation procedure is sufficiently robust and adaptable to provide decision support in all these cases simply by amending relevant input values. In the first two cases the LOAN2 amount is increased (or lowered) by the

amount of the cash out (or cash in) and the resulting costs and break-even period are calculated. In the third case the LOAN1 amount is taken to be $0.00, the period when refinancing will occur is considered as 1 and LOAN2 is considered as the "new" loan. In this case the costs of the new loan will be calculated (as negative savings) and a comparison or break-even analysis can be made between the various alternatives under consideration.

IMPLEMENTATION

The calculation procedure described above was implemented in a spreadsheet. Entering data values for all input variables concerning LOAN1 and LOAN2 yields the NPV of savings or costs resulting from the refinancing and the associated break-even period. The spreadsheet medium not only provides a familiar interface for data input but also facilitates evaluation of alternatives and "what-if" analysis. Questions such as "should I refinance now?", "when is the best time to refinance?", "how far should the interest rate drop before it is worthwhile to refinance?", "is a 6-month or 12-month adjustable-rate loan or a 15-year or 30-year fixed-rate loan most advantageous?", "should I make extra (principal) payments regularly?", "how long do I have to hold the new loan to break even?" can readily be answered with a few keystrokes. The authors believe the model is comprehensive in that all variables impacting the refinancing decision are considered.

DISCUSSION

The *Wall Street Journal* article "More Homeowners Are Saying Farewell to ARMs" which contains the example of a hypothetical couple where the monthly payment on the new loan was subtracted from the monthly payment on an existing loan to calculate the monthly savings and then the monthly savings were divided into the refinancing costs to determine the time to break even. The *Wall Street Journal* calculated this to be 3.75 years. Such an approach is erroneous because the reduction in monthly payments is not the actual saving accrued to the refinancers as stated earlier in this paper. Using the same numbers in the example but applying our precise calculation and including all factors, the time to break even is in fact 10.33 years, nearly seven years longer than that presented in the article.

For many borrowers facing the option of refinancing, depending on their specific case, this discrepancy would be even more dramatic and could even reverse the decision to refinance or not, depending upon how long the borrower plans on keeping the new loan. For obvious reasons however, lenders often overstate the real savings obtained through refinancing. The following hypothetical example will be used to illustrate this.

Assume Borrower B took out an original 30-year fixed-rate loan for $130,000 with an interest rate of 9%. Borrower B's marginal tax rate is 31%. After 11 monthly payments of $1,046.01 B's outstanding balance on the loan is $129,188.94 and B is presented with an opportunity to refinance to another 30-year fixed-rate loan with an interest rate of 7.5% with no prepayment penalty. The costs of originating the new loan are 2 points plus various fees which total $3,000.00. B will pay up front all the out-of-pocket expenses for obtaining the new loan so will have $129,188.94 as the (new) loan amount. If B expects to hold the new loan for another four years is it worthwhile for B to refinance?

If Borrower B asks a loan broker, loan agent or lender, their advice would typically be to refinance, because they would calculate the savings over four years to be $1,265.82. They would obtain this by subtracting the monthly payment on the new loan ($903.31) from the monthly payment on the existing loan ($1,046.01) multiplied by 48 months; the points ($2,583.78) and the fees ($3,000.00) would then be subtracted from that amount. Using the model presented in this paper, however, the NPV of cash flows over four years is dramatically different at -$738.96 and the break-even period is 57 months. So B should in fact be advised *not* to refinance. Table 3 displays the (abbreviated) amortization schedules for B's situation.

CONCLUSION

This paper introduces and describes a comprehensive and precise calculation procedure that assists in decision making when a borrower is confronted with the choice of fixed- or adjustable-rate mortgages. The authors believe this is the first attempt to include adjustable-rate mortgages in refinancing analysis and include all factors in determining the best decision. The model enhances real estate teaching and research activities related to refinancing as well as benefit potential and existing borrowers.

TABLE 3
Calculations For Fixed-Rate To Fixed-Rate Refinancing For Borrower B

	LOAN 1												
Period Number	Monthly Payment	Interest Paid	Principal Paid	Balance									
0	$1,046.01			$130,000.00									
1	1,046.01	975.00	71.01	129,928.99									
2	1,046.01	974.47	71.54	129,857.45									
3	1,046.01	973.93	72.08	129,785.37									
4	1,046.01	973.39	72.62	129,712.75									
5	1,046.01	972.85	73.16	129,639.59									
6	1,046.01	972.30	73.71	129,565.87									
7	1,046.01	971.74	74.27	129,491.61									
8	1,046.01	971.19	74.82	129,416.79									
9	1,046.01	970.63	75.38	129,341.40		LOAN 2					NPV of cash flows		
10	1,046.01	970.06	75.95	129,265.45	Period Number	Monthly Payment	Interest Paid	Principal Paid	Balance	Per Period Savings	Over the Life of LOAN2	Over 48 Periods	Break Even Period
11	1,046.01	969.49	76.52	129,188.94	0	$903.31			$129,188.94				
12	1,046.01	968.92	77.09	129,111.84	1	903.31	807.43	95.88	129,093.06	$94.87	$10,879.76	($738.96)	57
13	1,046.01	968.34	77.67	129,034.17	2	903.31	806.83	96.48	128,996.59	$94.86			
14	1,046.01	967.76	78.25	128,955.92	3	903.31	806.23	97.08	128,899.51	$94.85			
.	.	.	.	.	.	.	.	.	.	.			
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20	1,046.01	964.17	81.84	128,473.92	9	903.31	802.53	100.78	128,304.16	$94.82			
21	1,046.01	963.55	82.45	128,391.47	10	903.31	801.90	101.41	128,202.75	$94.81			
22	1,046.01	962.94	83.07	128,308.39	11	903.31	801.27	102.04	128,100.71	$94.81			
23	1,046.01	962.31	83.70	128,224.70	12	903.31	800.63	102.68	127,998.03	$94.80			
24	1,046.01	961.69	84.32	128,140.37	13	903.31	799.99	103.32	127,894.71	$94.80			
25	1,046.01	961.05	84.96	128,055.42	14	903.31	799.34	103.97	127,790.75	$94.80			
26	1,046.01	960.42	85.59	127,969.82	15	903.31	798.69	104.62	127,686.13	$94.79			
.	.	.	.	.	.	.	.	.	.	.			
.	.	.	.	.	.	.	.	.	.	.			
.	.	.	.	.	.	.	.	.	.	.			
358	1,046.01	23.19	1,022.82	2,068.72	347	903.31	75.45	827.85	11,244.91	$161.13			
359	1,046.01	15.52	1,030.49	1,038.22	348	903.31	70.28	833.03	10,411.88	$161.90			
360	1,046.01	7.79	1,038.22	0.00	349	903.31	65.07	838.23	9,573.65	$162.69			
					350	903.31	59.84	843.47	8,730.17	($882.53)			
					351	903.31	54.56	848.74	7,881.43	($884.17)			
					352	903.31	49.26	854.05	7,027.38	($885.81)			
					353	903.31	43.92	859.39	6,167.99	($887.47)			
					354	903.31	38.55	864.76	5,303.24	($889.13)			
					355	903.31	33.15	870.16	4,433.07	($890.81)			
					356	903.31	27.71	875.60	3,557.47	($892.49)			
					357	903.31	22.23	881.07	2,676.40	($894.19)			
					358	903.31	16.73	886.58	1,789.82	($895.90)			
					359	903.31	11.19	892.12	897.70	($897.62)			
					360	903.31	5.61	897.70	(0.00)	($899.34)			

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APPENDIX 1
Formulas For Per Period Savings And NPV Of Cash Flows

Per period savings, S_i:

$$S_i = (P_{1i} - P_{2i}) - (I_{1i} - I_{2i})t + \frac{C_2 L_2 t}{D_2} - \frac{\delta C_1 L_1 t}{D_1}$$

NPV of cash flows up to period i, NPV_i:

(1) If LOAN2 is fixed:

$$NPV_i = \sum_{m=1}^{i} \frac{S_m}{[1+(1-t)r \div 12]^m} - F - C_2 L_2 - Q(1-t) + L_2 - B_{10} + \frac{(-B_{2i} + B_{1i})}{[1+(1-t)r \div 12]^i}$$

(2) If LOAN2 is adjustable:

$$NPV_i = \sum_{m=1}^{i} S_m \prod_{k=1}^{m} \frac{1}{[1+(1-t)r_k \div 12]} - F - C_2 L_2 - Q(1-t) + L_2 - B_{10} + (-B_{2i} + B_{1i}) \prod_{m=1}^{i} \frac{1}{[1+(1-t)r_m \div 12]}$$

where:

- S_i = per period savings in period i
- P_{ij} = loan i payment (i = 1, 2) in period j
- I_{ij} = loan i interest rate (i = 1, 2) in period j
- t = borrower's marginal tax rate
- C_i = points paid on loan i (i = 1, 2)
- D_i = amortization period for loan i (i = 1, 2)
- r_i = LOAN2 interest rate in period i (for adjustable-rate loans)
- r = LOAN2 interest rate (for fixed-rate loans)
- F = sum of fees paid in refinancing to LOAN2
- L_i = loan i amount (i = 1, 2)
- B_{ij} = outstanding balance on loan i (i = 1, 2) in period j
- n = number of periods left to payoff LOAN1
- d = max (D_2, n)
- k = frequency of interest adjustment (for adjustable-rate LOAN2)
- Q = prepayment penalty on early repayment of LOAN1
- δ = 1 if LOAN1 has been obtained by refinancing, = 0 otherwise

APPENDIX 2
Example of Calculations

Specific steps in the calculation procedure will be illustrated by reference to the following example. A hypothetical couple Mr. and Mrs. X took out an original 30-year fixed-rate loan for $150,000 with an interest rate of 8.75%. This was their first loan on the property so it was not obtained by refinancing. The couple's marginal tax rate is 28%. After 30 months of monthly payments of $1,180.05 their outstanding balance on the loan is $147,117.67 and the couple has an opportunity to refinance to another 30-year fixed-rate loan with an interest rate of 7.5% and with no prepayment penalty. The costs of originating the new loan are 1.5 points plus various fees, which amount to $2,200.00. The couple will pay all up-front out-of-pocket expenses for obtaining the new loan, so will have $147,117.67 as the new loan amount. The couple expects to hold the property for four more years.

The calculations are performed by considering the amortization tables for the two loans. These are displayed below. From these we can see that if Mr. and Mrs. X held on to their original loan their situation in Months 30 and 31 would be as follows:

Month	Monthly Payment	Interest	Principal	Loan Balance
30	$1,180.05	$1,073.51	$106.54	$147,117.67
31	1,180.05	1,072.73	107.32	147,010.35

However, if they refinance to their new loan then we would have:

Month	Monthly Payment	Interest	Principal	Loan Balance
0				$147,117.67
1	$1,028.67	$919.49	$109.18	147,008.49

We now calculate the per period savings between the original and new loans. These are obtained by subtracting the decrease in interest tax deduction and the lost tax deduction from the amortization of points on the existing loan (if any) from the reduction in monthly payments, and then adding the tax benefit from the amortization of points on the new loan.

Therefore, for the first month of the new loan (i.e., Month 31 of the original loan) we have:

the reduction in monthly payments = $1,180.05 - $1,028.67 = $151.38

- the decrease in interest tax deduction = ($1,072.73 - $919.49) × 28% = $42.91
- the lost tax deduction from the amortization of points on the existing loan = $0 (since the existing loan was not obtained by refinancing. Points paid to purchase a home are tax deductible in the year the home is purchased, but points paid to refinance an existing mortgage must be amortized over the life of the new loan).

\+ the tax benefit from the amortization of points on the new loan = (1.5% × $147,117.67 × 28%)/360

= $1.72.

So, the savings for Month 1 (of the new loan) = $151.38 - $42.91 - $0 + $1.72 = $110.19.

The per period savings are calculated similarly for each of the 360 months of the new loan and their present value is then calculated. Here we get $4,781.32. The discount rate used is the after-tax interest rate on the new loan so in this case we will have 7.5% × (1 - 28%)/12 = 0.45%.

To calculate the net present value of cash flows we subtract the outstanding balance on the original loan ($147,117.67), the sum of all fees paid in refinancing ($2,200.00), the points paid (1.5% × $147,117.67 = $2,206.77), the after-tax prepayment penalty, if any, (here none), and the unpaid principal ($147,117.67) from the present value of the per period savings ($4,781.32), and then add the new loan amount ($147,117.67) to the present value of the difference in the outstanding loan balances over the planning horizon of 48 months (here $113,644.71 - $113,686.24 = -$41.53). The discount rate used is as above, i.e., the after-tax interest rate on the new loan, here 0.45%. So the net present value of cash flows in this case is $4,781.32 + $147,117.67 + (-$41.53) - $2,200.00 - $2,206.77 - $147,117.67 - $0 = $333.02.

AMORTIZATION TABLES FOR ORIGINAL AND NEW LOANS

ORIGINAL LOAN

Month	Monthly Payment	Interest Paid	Principal Paid	Balance
0				$150,000.00
1	1,180.05	1,093.75	86.30	149,913.70
2	1,180.05	1,093.12	86.93	149,826.77
3	1,180.05	1,092.49	87.56	149,739.21
4	1,180.05	1,091.85	88.20	149,651.00
5	1,180.05	1,091.21	88.85	149,562.16
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
28	1,180.05	1,075.05	105.00	147,329.98
29	1,180.05	1,074.28	105.77	147,224.21
30	1,180.05	1,073.51	106.54	147,117.67
31	1,180.05	1,072.73	107.32	147,010.35
32	1,180.05	1,071.95	108.10	146,902.25
33	1,180.05	1,071.16	108.89	146,793.36
34	1,180.05	1,070.37	109.68	146,683.68
35	1,180.05	1,069.57	110.48	146,573.19
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
355	1,180.05	50.33	1,129.72	5,773.35
356	1,180.05	42.10	1,137.95	4,635.40
357	1,180.05	33.80	1,146.25	3,489.15
358	1,180.05	25.44	1,154.61	2,334.54
359	1,180.05	17.02	1,163.03	1,171.51
360	1,180.05	8.54	1,171.51	0.00

NEW LOAN

Month	Monthly Payment	Interest Paid	Principal Paid	Balance
0				$147,117.67
1	1,028.67	919.49	109.18	147,008.49
2	1,028.67	918.80	109.87	146,898.62
3	1,028.67	918.12	110.55	146,788.07
4	1,028.67	917.43	111.24	146,676.83
5	1,028.67	916.73	111.94	146,564.89
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
325	1,028.67	206.68	821.98	32,247.55
326	1,028.67	201.55	827.12	31,420.43
327	1,028.67	196.38	832.29	30,588.14
328	1,028.67	191.18	837.49	29,750.65
329	1,028.67	185.94	842.73	28,907.92
330	1,028.67	180.67	847.99	28,059.93
331	1,028.67	175.37	853.29	27,206.63
332	1,028.67	170.04	858.63	26,348.01
333	1,028.67	164.68	863.99	25,484.01
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
356	1,028.67	31.55	997.12	4,051.18
357	1,028.67	25.32	1,003.35	3,047.83
358	1,028.67	19.05	1,009.62	2,038.21
359	1,028.67	12.74	1,015.93	1,022.28
360	1,028.67	6.39	1,022.28	0.00