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Modeling of Fixed-Rate HEL Prepayments

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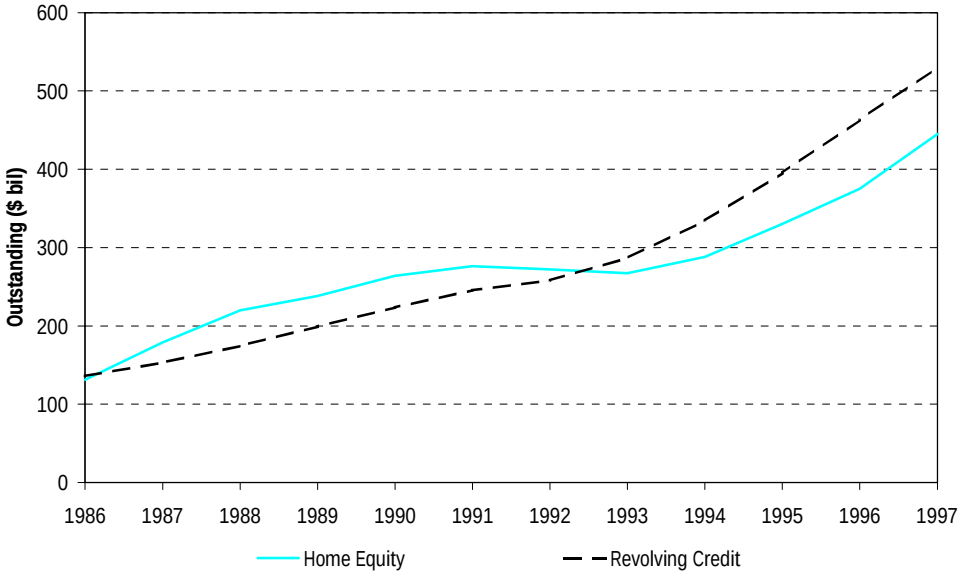
Introduction

Home equity debt has grown dramatically during the last decade. According to estimates by SMR Research Corporation, aggregate outstandings of open- and closed-end home equity loans more than tripled between the end of 1986 and the end of 1997.[1] Since the end of 1993, closed-end receivables alone have increased by more than 100%. To many observers, the sheer size of the industry may not be apparent. However, as Figure 1 shows, the total size of home equity debt outstanding has come close to keeping pace with total consumer revolving credit, as reported by the Federal Reserve.

Figure 1. Home Equity Loan and Consumer Revolving Credit Outstanding, 1986–1997 (Dollars in Billions)



Source: SMR Research Corporation and Federal Reserve Board.

Of the $445 billion total in estimated home equity outstandings at the end of 1997, amounts on the balance sheets of finance companies accounted for approximately $96 billion, securitized amounts accounted for approximately $88 billion, and amounts on the balance sheets of a variety of other financial institutions, including commercial banks, accounted for the remainder.[2] Closed- and open-end loans constituted approximately 65% and 35% of total outstandings, respectively.

In the securitization market, finance companies by far have been the most active players. Although most traditional finance companies have either been slow to securitize or have consistently securitized only a moderate percentage of their receivables, specialty finance companies have used securitization as one of the primary engines of growth and capital formation. Specialty finance companies typically obtain short-term lines of credit to fund the origination or purchase of

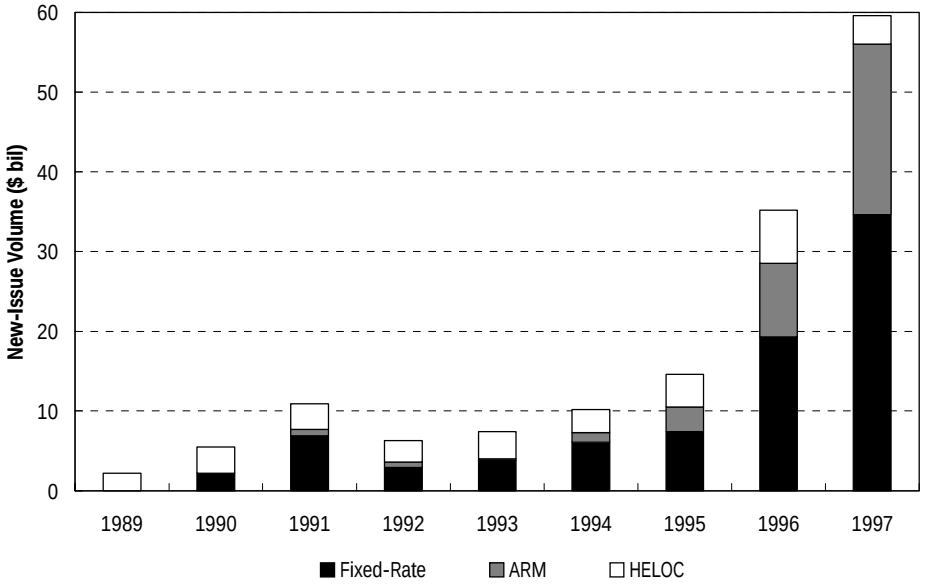
[1] *Home Equity Loans, 1998,* SMR Research Corporation.

[2] To derive the estimate of finance company holdings, we first calculate the percentage of total outstandings held by finance companies at the end of June 1997, as reported by SMR and, second, apply the same percentage to the total outstandings estimated by SMR for the end of 1997. The source for securitized amounts outstanding is Bloomberg.

loans, sell the loans on a quarterly basis into a securitization, compute a gain on the sale of the loans based on the present value of projected residual cash flows, and book the gain as one component of earnings for the quarter. Lenders who do not want to expose themselves to the potential earnings volatility of gain-on-sale accounting, alternatively sell the loans wholesale to another market participant, who more than likely *will* securitize them. In either case, long-term funding of the loans occurs through securitization.

The home equity loan ABS market has developed rapidly, reflecting the robust growth of the specialty finance sector. Figure 2 shows public US-dollar home equity loan ABS new-issue volume since the first transaction in 1989.

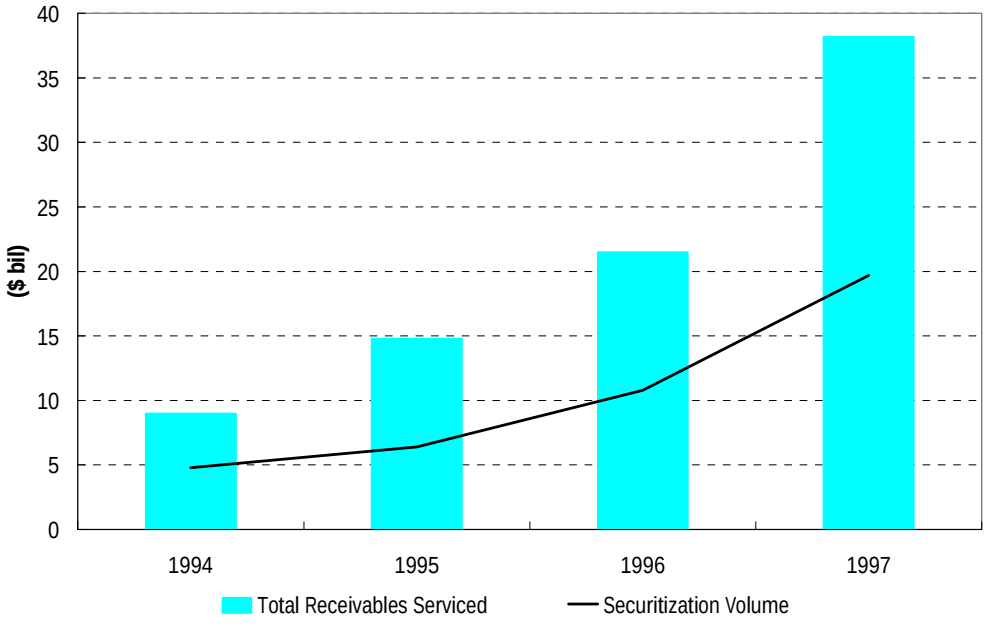
Figure 2. Public US-Dollar Home Equity Loan ABS New-Issue Volume, 1989–1997 (Dollars in Billions)



Source: MCM Corporate Watch, Salomon Smith Barney.

Although the market almost doubled in size between 1990 and 1991, the majority of the growth has occurred since 1994. Since then, annual new-issue volumes have increased six-fold. Most of this explosion in supply has been fueled by closed-end loans, including both fixed- and adjustable-rate products and, more recently, hybrid loans. In this paper, we focus specifically on the fixed-rate originations of five specialty lenders: ContiFinancial, EquiCredit Corporation, IMC Mortgage Co., The Money Store, and United Companies Financial Corporation. As Figure 3 suggests, the sharp increases in home equity loan ABS supply are well correlated with the dramatic growth rate in specialty lending, as represented by these five companies.

Figure 3. Home Equity Loan Receivables Outstanding and Home Equity Loan ABS Volume of Five Specialty Lenders, 1994–1997 (Dollars in Billions)



Source: Prospectuses, company reports, MCM Corporate Watch, Salomon Smith Barney.

Tracking supply is not as simple as it might seem. There is no single definition of a home equity loan and, in fact, pool characteristics differ from lender to lender and vintage to vintage. As a result, exact classification of the loans can be difficult. For the most part, home equity loans are used for purposes other than the purchase of property, although most pools do contain at least a small percentage of loans applied to new purchases. In fact, lien position, loan size, credit quality of the borrower, origination source, and loan purpose can vary widely. In the next section, we review some of these characteristics in more detail.

Home equity loans are essentially a segment of an increasingly well-rounded residential mortgage spectrum offering products to an increasingly diverse borrower base. From this perspective, home equity loans may be differentiated — but only somewhat ambiguously — from nonconforming B and C, 125% LTV, and alt-A products. As a result, in the context of prepayment modeling, the same theoretical foundation should apply to each of these types of mortgage loans. After providing an overview of home equity loan speeds in the next section, we then discuss various aspects of this theoretical foundation and present the Salomon Smith Barney Home Equity Loan Prepayment Model. Finally, we discuss the inherent limitations and assumptions in the modeling process.

Characteristics of Home Equity Loans

In the context of the ABS market, home equity lending generally refers to the extension of mortgage loans to credit-impaired borrowers. Originators are frequently referred to as "subprime" or B and C lenders, reflecting an industry convention grading borrowers from A (lowest risk) to D (highest risk) by credit quality. Interestingly, a recent study suggests that the demographic and economic attributes of home equity borrowers are not dramatically different from those of the population of all homeowners.[3] Home equity borrowers tend to be somewhat younger with tighter income distribution concentrated around the median, but that median itself is close to the median income for all homeowners ($34,000 for home equity borrowers versus $37,000 for all homeowners), and about the same as the median income for all US households.

The characteristics of home equity loan pools can vary significantly by vintage and originator. In this paper, we focus on the fixed-rate home equity originations of the five lenders for whom we have developed prepayment models. Although there are clear similarities among the pools of these originators, there is enough variation to defy generalization. The following is a brief review of some of the major loan characteristics.

Loan Purpose

Borrowers take out home equity loans for many reasons. The three most common reasons include (1) refinancing an existing mortgage, (2) equity take-out, and, to a lesser degree, (3) home purchase. Refinancing has generally been motivated by the opportunity to lower monthly payments, either by taking advantage of falling interest rates or by trading into a higher credit–category mortgage after performing on an existing subprime loan for at least several months. Competition in the industry appears to have created more opportunities during the last couple of years for borrowers to trade up in credit quality.

"Equity take-out" (or cash-out) is a somewhat ambiguous term. In most cases, borrowers appear to be using the available equity in their homes to refinance higher-cost, non-tax-deductible consumer debt at more affordable rates by consolidating all of their debt (including existing mortgages) into a single, larger first-lien mortgage. In other cases, borrowers may take equity out of their homes to finance home improvements, the purchase of an automobile, vacations, medical expenses, and childrens' educations. As a result, borrowers may find incentives to prepay existing mortgages in the absence of any obvious interest rate–related refinancing opportunities, as long as they believe that the overall monthly payment on a new, single consolidated loan is lower than that of alternatives.

The precise breakdown of loan purposes is often difficult to determine and depends on how consistently issuers report them. The percentage of new-home purchases, for example, is generally below 20%, but varies widely. For EquiCredit, the percentage has been at or below 4% on all home equity ABS transactions since

[3] John C. Weicher, *The Home Equity Lending Industry*, Hudson Institute, 1997, p. 52.

1993. For The Money Store, the percentage has been 0%. EquiCredit reports 50%–60% equity take-out, The Money Store reports 100%, Conti reports generally above 75%, UCFC reports generally 0%, and IMC reports below 13%. We conclude little from these figures, except that most home equity loans appear to be for purposes other than the purchase of a new home.

Loan Coupon

On average, home equity loan coupons tend to be 300bp–400bp higher than the FHLMC primary mortgage market survey (PMMS) rate, a benchmark measure of the interest rate on conforming mortgages. Our earlier loan-level study of EquiCredit's home equity portfolio suggested that the coupon differentials between A and C credits and A and D credits were 200bp–300bp and 400bp–500bp, respectively[4] — roughly consistent with averages reported by Weicher in his study of the home equity lending industry.[5]

Credit Grades

The distribution of credit grades within a portfolio varies by issuer and vintage. Lenders frequently focus on a specific niche within the industry and therefore may be weighted more heavily among lower- or higher-risk borrowers. Mortgage Information Corporation recently reported that, as of March 1998, A-, B, C, and D risk grades accounted for first-lien market shares of 45.6%, 23.0%, 16.9%, and 4.5%, respectively.[6] However, these figures must be viewed somewhat fluidly, since there is no standard classification system. Although it is usually reasonable to assume that a specific originator's A loans are on average less likely to default than the same originator's B, C, and D loans, it is not always reasonable to assume that the A loans of one originator carry a similar likelihood of default as those of another originator.

Loan Balance

Average loan balances for the issuers in this study range from $40,000 to $70,000. EquiCredit and United Companies originations have consistently remained at the low end of the range, The Money Store in the low-to-middle segment, and Conti and IMC at the high end. Other originators who were not included in the study may offer a greater percentage of higher-balance loans, with average balances that may be as high as $100,000.

Lien Position

Home equity loans are predominantly a first-lien product. Generally, 75%–100% of the loans in a pool will be first-lien mortgages. This distribution is entirely consistent with the large percentage of originations that are equity take-out refinancings, including consumer-debt consolidations.

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[4] Arvind Rajan, et. al, *Home Equity Loan Prepayments: A Study of EquiCredit Corporation*, Salomon Brothers Inc, April 1996.

[5] John C. Weicher, *The Home Equity Lending Industry*,Hudson Institute, 1997, p. 65.

[6] *The Market Pulse*, Mortgage Information Corporation, Summer 1998, p. 6.

Loan Term

Average loan terms range from approximately 15 to 20 years. Since the early 1990s, loan maturities have gradually extended from the lower end of this range to the higher end, at least in part due to competitive pressure. Of the five issuers in this study, EquiCredit is the only one whose weighted average maturity is still consistently at or below 180 months.

By offering longer amortization schedules, originators can lower borrowers' monthly payments. For example, the monthly payment on a $50,000 loan with an 11% coupon and a 180-month maturity declines by $52 when the maturity is extended to 240 months. This improvement is equivalent to the change in monthly payment that would result from reducing the loan coupon by 170bp (while keeping the maturity constant at 180 months). Thus, maturity extension can provide some borrowers with an incentive to refinance that is virtually as strong as that of a significant interest rate rally or the opportunity to trade up a notch in credit quality.

While average loan terms range up through 20 years, individual loans can have maturities as long as 30 years. Most originators also offer balloon products, which can account for as much as half the balance of a given pool. Balloon loans generally carry a 30-year amortization schedule with an actual maturity date of five, seven, ten, or 15 years after origination.

Combined Loan-to-Value Ratio

Average combined loan-to-value ratios (CLTVs) for the issuers in this study range from 70% to 80%. Originators usually require lower credit-quality borrowers to have lower CLTVs to help protect against the higher risk of default. For example, our loan-level study of EquiCredit suggested that typical CLTV limits for A, B, and C borrowers were 90%, 80%, and 75%, respectively.[7] Citing unpublished data from Mortgage Information Corporation, Weicher reports that 23% of subprime loans have LTVs below 60%, 67% have LTVs of 60%–80%, and 10% have LTVs over 80%.[8]

[7] Arvind Rajan, et. al, *Home Equity Loan Prepayments: A Study of EquiCredit Corporation*, Salomon Brothers Inc, April 1996, p.14.

[8] John C. Weicher, *The Home Equity Lending Industry*, Hudson Institute, 1997, p. 61.

Overview of HEL Prepayment Behavior

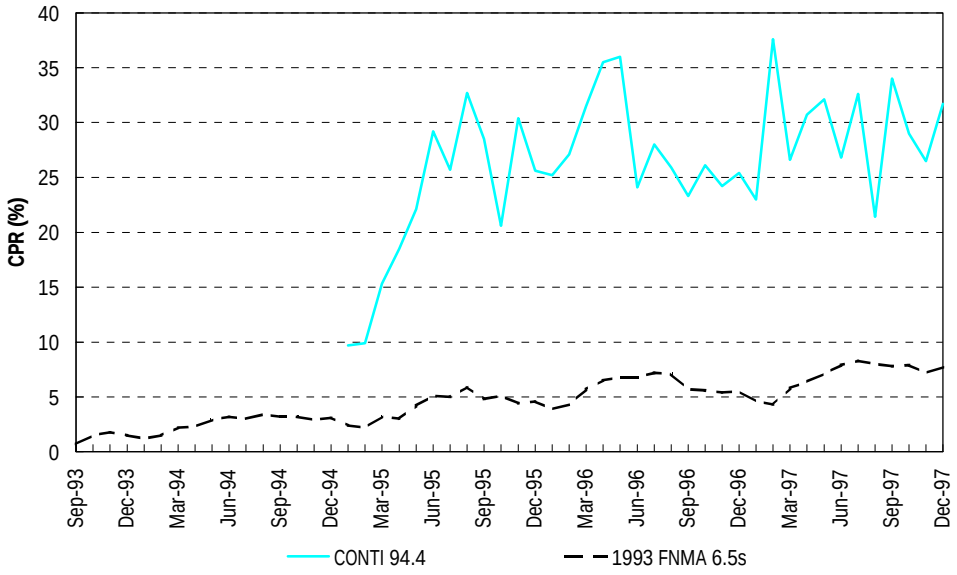
In this section, we review the basic characteristics of HEL speeds and discuss some of the differences relative to agency MBS prepayments. In the next section, we describe how HEL speeds are modeled within the general framework of the Salomon Smith Barney Prepayment Model.

Comparison of HEL and Agency Speeds

Prepayments on HELs differ sharply from those on conforming loans. Their most distinguishing features include the following:

- **Higher baseline speeds**. Speeds on seasoned HELs typically tend to be in the 25%–35% CPR range, or about three times the typical average speeds on 30-year current-coupon agency MBSs. Figure 4 illustrates the difference.

Figure 4. HEL and Agency Baseline Prepayment Speeds



Source: Salomon Smith Barney.

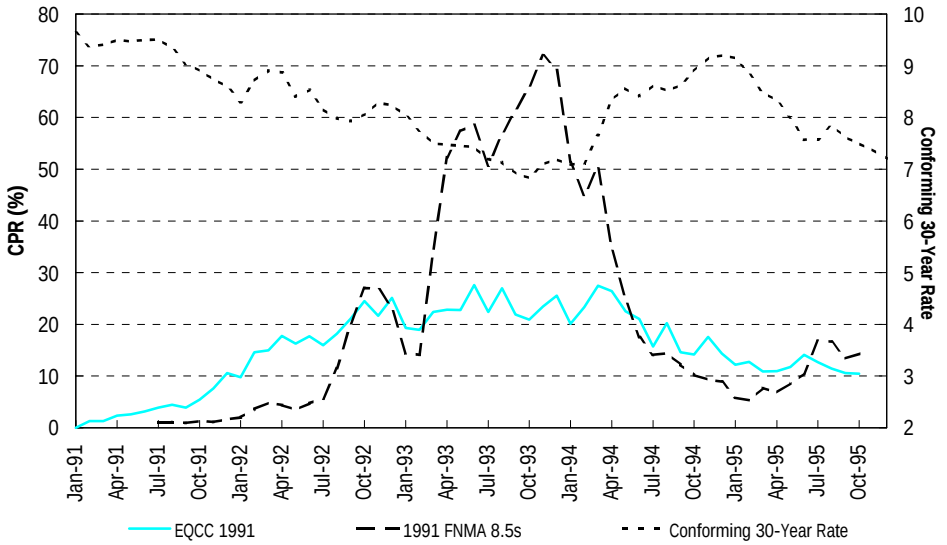
- **Lower Sensitivity to Interest Rates**. Whether the refinancing incentive is measured by the difference between the prevailing mortgage rate and the coupon on the loan by relative coupon[9] or by some other measure,[10] prepayments on HELs are less affected by rate movements than prepayments on conforming loans. Figures 5 and 6 offer two examples. Figure 5 is taken from the refinancing wave of 1993,[11] and Figure 6 shows 1998 data.

[9] Relative coupon is defined as the ratio of the weighted-average coupon of the pool (or original coupon if referring to a single loan) and the current prevailing mortgage rate for that type of loan, minus one. Therefore, a positive value of the relative coupon implies the existence of an incentive to refinance.

[10] For example, percent savings.

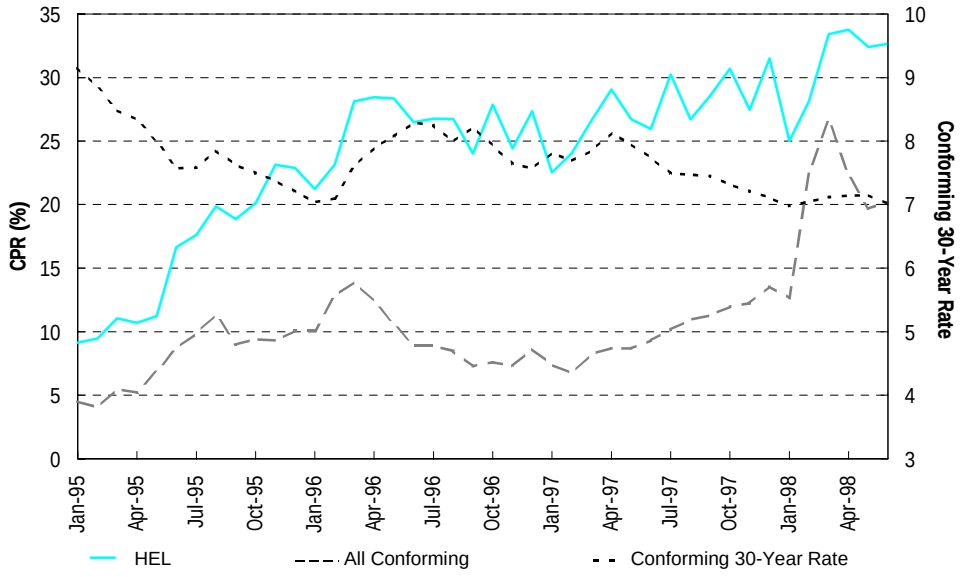
[11] The baseline prepayment levels on EquiCredit 1992 originations are lower than those on later originations by EquiCredit or by other issuers we model.

Figure 5. Refinancing Response in 1993 and 1994 of HEL and Conforming Loans Originated in 1991



Source: Freddie Mac and Salomon Smith Barney.

Figure 6. Aggregate HEL and Conforming Loan Prepayments During the 1997–1998 Refinancing Period[12]



Source: Freddie Mac and Salomon Smith Barney.

➤ **Faster Seasoning**. HELs typically season in 12–15 months, compared with about 30 months for conforming loans (see Figure 4).

[12] To remove the effect of the seasoning ramp on HEL prepayments, only transactions backed by collateral with loan ages 13 months and higher were included in the calculation.

Key Determinants of HEL Speeds

The differences between HEL and conforming loan prepayments can be accounted for by the characteristics of HEL borrowers and loans discussed in the previous section. Based on our loan-level studies,[13] we have found that, in addition to **loan age** and the level of interest rates, some of the most important variables for determining prepayments are **borrowers' credit, average loan size, CLTVs, loan terms**, including the presence of balloons, **geographical distribution, loan purpose,** and borrowers' **debt-to-income ratio**. To these we can add the costs of refinancing, which depend on the credit status of the borrower as well as the competitive conditions in the industry, and the **amount paid in points at origination** (rarely available on a pool level).

Our HEL prepayment models include some of these variables explicitly, such as interest rates, loan size, the evolution of initial LTV and costs of refinancing. **Borrowers' credit**, on the other hand, **is proxied by the difference between the WAC of a deal and prevailing** conforming mortgage rates at the time of origination (WAC-original current coupon, or WAC-OCC spread in the rest of this paper). Its effect is allowed to depend on the issuer. Still other variables are taken into account implicitly, through parameters that depend on specific issuers and on calendar time.

The identification of WAC-OCC spread with borrowers' credit is a matter of convenience, not necessity. By direct fitting, we have found this variable to be a reliable numerical measure of prepayment behavior. Although it is most directly related to credit, as discussed below, it also reflects other collateral characteristics that affect the spread, such as lien position or the changing competitive environment in the industry.[14]

By allowing for dependence of parameters on issuers we avoid dealing with incomplete information, arrest the proliferation of explanatory variables, and account for differences that cannot be captured by a profile of loans or borrowers (such as loan servicing). We have found that only a small variation in models can successfully account for the observed prepayments for all five issuers we study — across origination times from 1992 to the present.

[13] Arvind Rajan, et. al, *Home Equity Loan Prepayments: A Study of Equicredit Corporation*, Salomon Brothers Inc., April 1996 and unpublished studies.

[14] Competition also has an impact on other factors, such as costs.

Salomon Smith Barney Fixed-Rate HEL Prepayment Model

Our fixed-rate HEL prepayment model is a member of a family of Salomon Smith Barney prepayment models for mortgage-type instruments. These models have the same general structure, with prepayments assumed to result from four sources: **housing turnover, refinancings, curtailments** (including **full payoffs**), and **defaults.** For HELs, we further divide the refinancing component into those that occur as a result of drops in **interest rates** and those driven by changes in the borrower's **credit**. Hence, the basic structure of the HEL prepayment model is

Total Speed = Housing Turnover + Credit-Driven Refis

+ Rate-Driven Refis + Defaults + Curtailments & Payoffs

In practice, we observe only the total prepayment, and hence cannot directly estimate each component. Nevertheless, having separate components provides a conceptual framework for modeling prepayments and, as we illustrate in the rest of this section, allows loan or borrower characteristics (whether known or assumed) to be incorporated in a logical manner. We next discuss each of these components.

Housing Turnover

We assume that the turnover component is the product of four factors: an overall **turnover rate**, a **relative mobility factor**, a **seasoning curve**, and a **lock-in effect**.

The *overall turnover rate* is the percentage of existing homes sold each year, and is estimated by dividing total existing home sales by the total stock of single-family homes. Historically, it has averaged between 5% to 7%, and is currently at the upper end of this range. Data on existing home sales (and monthly seasonal factors) are reported each month by the National Association of Realtors. We also assume a weak dependence of turnover on interest rates. [15]

The *relative mobility factor* captures demographic or socioeconomic differences between borrowers in different types of loans. HEL borrowers generally have lower credits compared to their conforming loan counterparts and many have taken equity out of their home in order to consolidate debt or finance home improvements. This suggests that their ability or desire to move is suppressed. We therefore assume that the relative mobility factor is lower than for conforming loans, with the fitting process suggesting that it is approximately 20% less than that for conforming 15-year loans. Also consistent with these assumptions, the seasoning ramp extends to ten years, much longer than for conforming loans, though the increase after the second year is much smaller than in years 1 and 2.

The *lock-in effect* refers to the disincentive to move because of rising interest rates. It is modeled in the same way as for agencies, by comparing the cost of higher rates with the likely amount of a new loan. (Hence, because of inflation, the lock-in effect diminishes over time).

[15] For a description of the agency turnover model see Lakhbir Hayre and Arvind Rajan, *Anatomy of Prepayments: The Salomon Brothers Prepayment Model*, Salomon Brothers, June 1995.

The turnover component of prepayments is assumed to be the same for all issuers. For current coupon HEL loans seasoned about 30 months, prepayments from turnover average about 6% CPR.

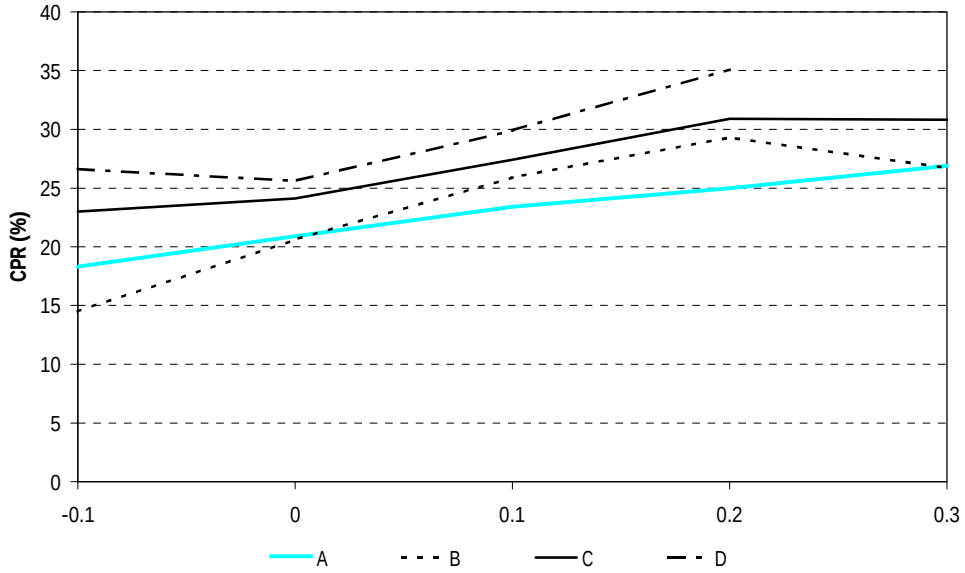
Credit-Driven Refinancings

Our loan-level studies of HEL prepayments show that many refinancings occur because borrowers take advantage of lower rates made possible by an improvement in their credit standing. The incentive to refinance can be considerable. The interest charged to A borrowers for a 30-year first lien HEL is typically 150bp–250bp above the prevailing conforming rate, and increases by 100bp to 150bp for a second lien. It is only weakly dependent on the term of the loan. Moving to lower credits, the B to A credit spread is about 100bp; C to A about 250bp; and D to A between 350bp and 450bp. In addition, a borrower whose credit improves can often obtain a loan with a larger LTV ratio. The typical LTV limits are 90% for A-credit borrowers, 80% for B-credit borrowers, and 75% for C-credit borrowers. (The *actual* LTVs are about 75% for A, 73% for B, 68% for C, and 60% for D-credit borrowers.)[16]

Although a borrower may be able to find a lender who will refinance the loan into a higher credit category with as little as six months of adequate financial performance, more typically, credit improvement requires about one year of satisfactory performance. Thereafter, the rate of credit-driven refinacings depends primarily on the rate at which borrowers improve their credit and act on the available refinancing options. Figure 7 shows prepayment rates by credit and relative coupon.

[16] John C. Weicher, *The Home Equity Lending Industry*, Hudson Institute, 1997.

Figure 7. Average CPR Versus Rate Change–Related Incentive by Credit Class



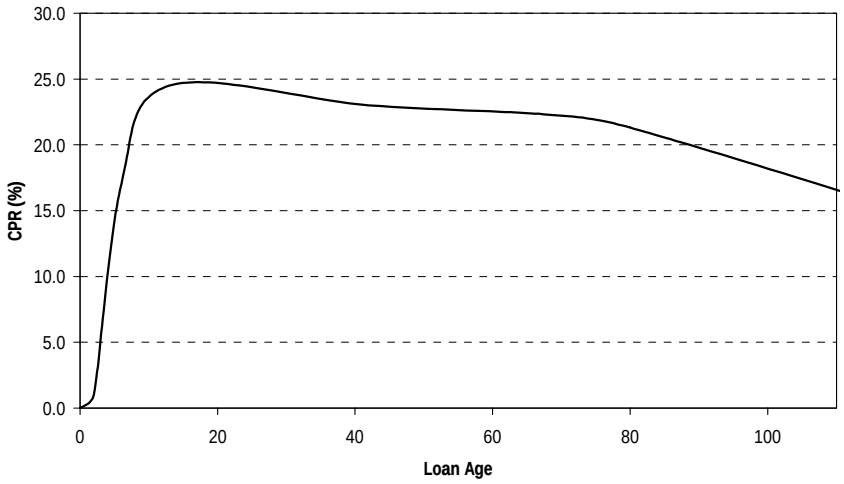
Note: Incentive = original note rate/current note rate - 1.
Source: Salomon Smith Barney.

Figure 7 shows that prepayments on lower-credit loans tend to be faster than those on higher-credit loans. This illustrates the dominant role typically played by credit-driven refinancings, compared to refinancings that result from drops in interest rates. In addition, it is generally easier to upgrade credit status from one subprime category to a higher one than from the subprime A category to the standards for conforming loans. Because of their lower overall financial strength, lower credit borrowers are also more likely to be able to use additional financing to consolidate installment debt that was acquired since the origination of the first mortgage, or to extend the term of the mortgage (even without overall savings), in order to decrease the monthly payments. Particularly susceptible to these term-extension refinancings are pools that contain a high concentration of lower-credit borrowers carrying loans of relatively short WAM (of about 15 years).

Direct fits of the seasoning ramp for credit-driven refinancings on the deal level suggest that for all five issuers the ramp peaks at between 12 and 14 months, stays nearly constant (or declines very gradually) until loan age of 5–6 years, after which it declines more steeply at about 2% CPR per year. While we fit the seasoning ramp independently for each issuer, the differences are small, arising primarily in the steepness of the ramp in the first 12 months of loan life. These differences account for, among other things, variations in underwriting policies between issuers (for example, the number of points charged).[17] Figure 8 shows a typical baseline curve.

[17] But not for the credit composition of the pool.

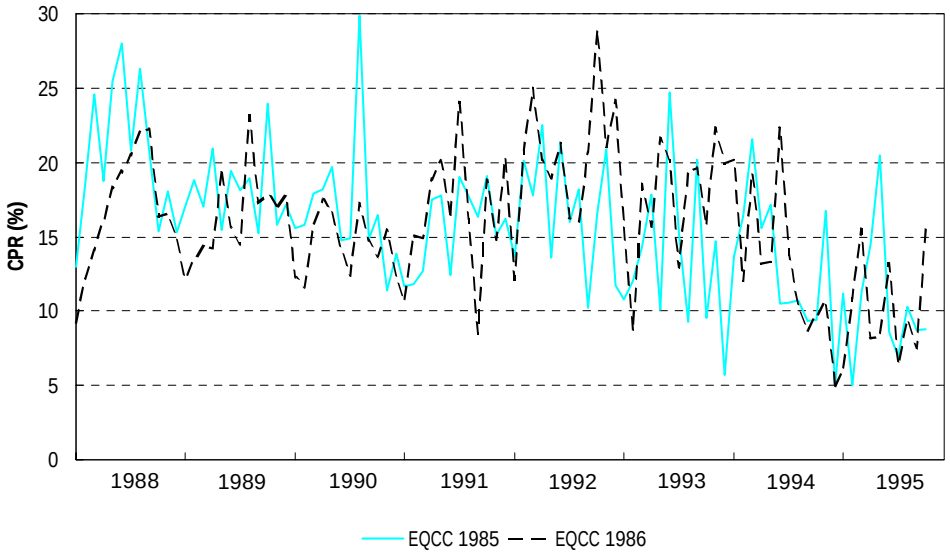
Figure 8. Model Seasoning Ramp for Credit-Driven Refinancings



Source: Salomon Smith Barney.

The decrease in credit-driven refinancings for loans aged more than 5 or 6 years is the result of the decreasing likelihood of a borrower curing his credit in a given year after an appreciable time has elapsed. It is supported by data on pools originated in the 1980s. Figure 9 provides an example.

Figure 9. Prepayment Speeds on EquiCredit Loans Originated in 1985 and 1986

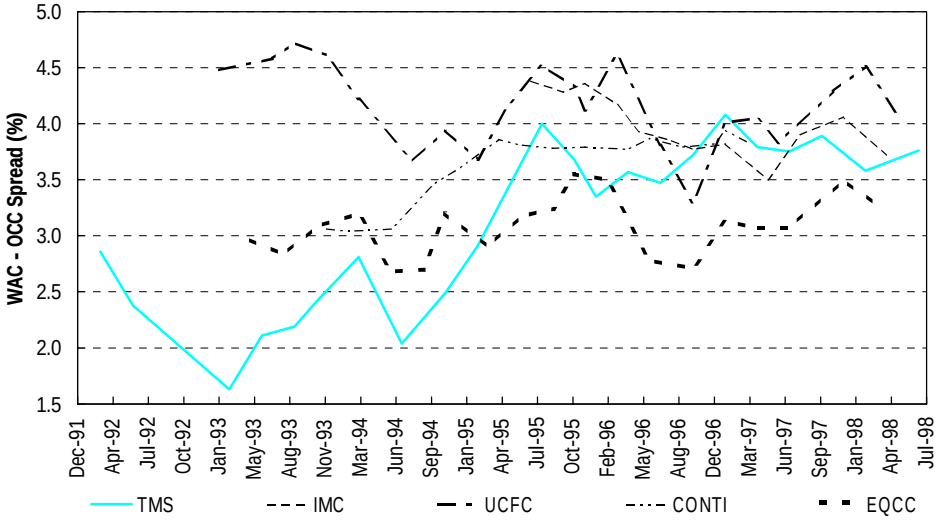


Source: Salomon Smith Barney.

To allow for the variation of the borrowers' credit composition from deal to deal for a given issuer, we make credit-driven refinancings depend on the WAC-OCC spread in the prepayment model. For Equicredit this spread has remained approximately constant since 1993 at about 300bp, but for other issuers, such as The Money Store and Conti, there has been a clear trend toward increasing spread over some periods in the past.

Figure 10 shows the values of the WAC-OCC spread for the five issuers we model, at the origination time of each deal.

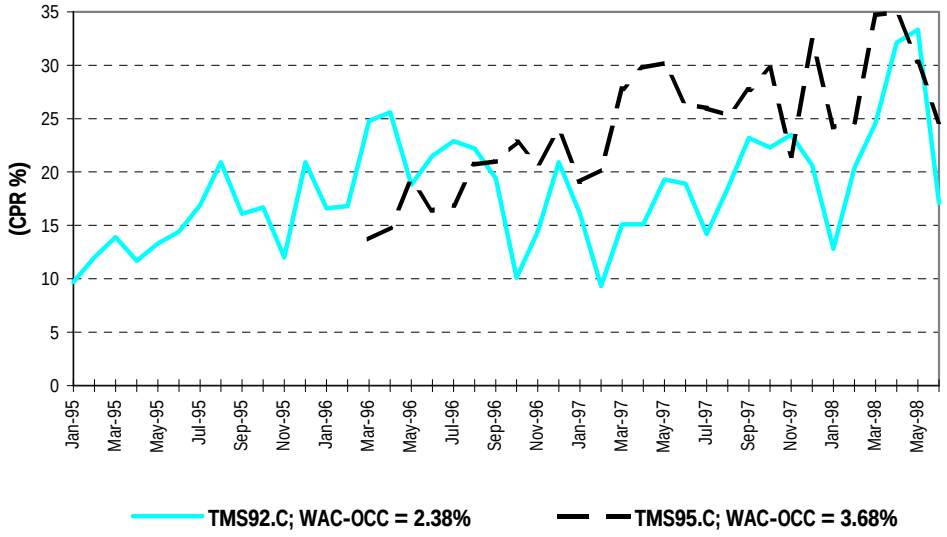
Figure 10. The WAC-OCC Spread for Five HEL Issuers



Source: Salomon Smith Barney Inc.

Based on our interpretation of the WAC-OCC spread, and the dependence of prepayments on credit as illustrated in Figure 7, we would expect that this quantity impacts prepayment speeds directly. This is indeed what we find. Figure 11 provides an illustration.

Figure 11. The Effect of WAC-OCC Spread on Prepayment Speeds (The Money Store 92.C and 95.C)



Source: Salomon Smith Barne;y.

Even though TMS92.C and TMS95.C have comparable original WACs (11.13% versus 11.27%), their baseline prepayment speeds are quite different. The WAC-

OCC spread is one of the contributing factors. The two deals differ also in the original WAMs (160 months versus 280 months), mean loan amounts ($30,000 versus $45,000), and original LTVs (61% versus 71%). Some of these factors, such as the original WAM and the original LTV, impact the spread.

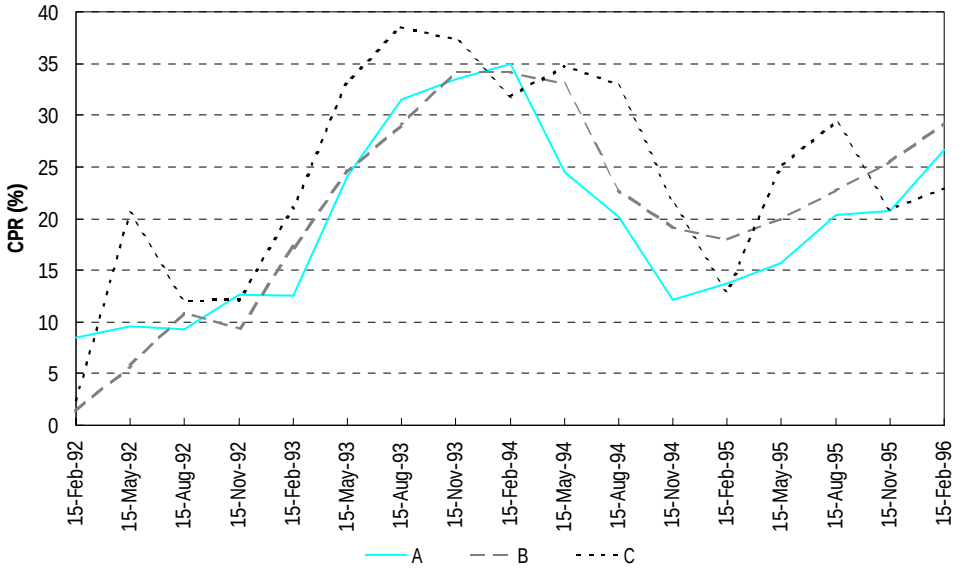
We assume that credit-driven refinancings also depend on interest rates (although, of course, in an interest rate rally the increase in credit-driven refinancings is empirically hard to distinguish from rate-driven refinancings). In the model, we allow for an increase in credit-driven refinancings over approximately the first 50bp of the rally. In this regime, the economic incentive is insufficient to trigger pure interest rate–driven refinancings, but it is assumed to increase credit-driven refinancings by a modest amount. Increases in interest rates, on the other hand, suppress credit-driven refinancings. In particular, in extreme scenarios where the rate increase is comparable to the differences in coupons between credit classes, it is logical to expect credit-driven refinancings to slow to a trickle.

Interest Rate–Driven Refinancings

As discussed earlier, HELs are less sensitive to refinancing opportunities presented by declining interest rates than conforming loans. Their prepayment patterns over three recent refinancing waves illustrates this point.

Figure 12 shows the typical prepayments of HEL loans during the 1993 refinancing wave, separated by credit type.

Figure 12. Prepayments on Loans Originated in 1992, by Borrower's Credit



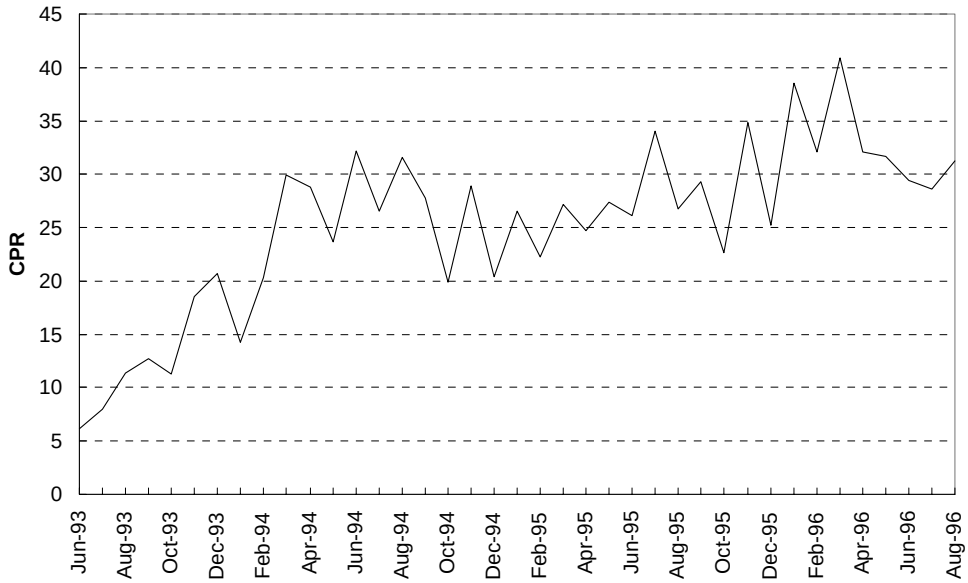
Source: Salomon Smith Barney

Even though the loans carried an average coupon of 11.60%, the prepayment speeds generally remained below 40% CPR throughout the refinancing wave. (In contrast, agency speeds in some cases reached 70% CPR during the same period.) The figure also demonstrates the different sensitivities of credit classes to refinancings. While the baseline levels are lowest for the highest credit grade, the increase in

prepayment speeds is inversely related to the credit grade. This is expected, since higher credit borrowers experience a proportionally larger increase in the refinancing incentive — compared to the incentive available from credit improvements alone — than the lower credit ones. In addition, the relatively greater financial resources and sophistication of higher credit borrowers make them more likely to take advantage of declines in interest rates.

Refinancings of HELs picked up speed again during the 1995 interest rate rally, when mortgage rates declined by about 220bp between early 1995 and early 1996. Figure 13 shows the behavior of a typical HEL deal during this period. Again the increase in speed was moderate, registering about 15% CPR.

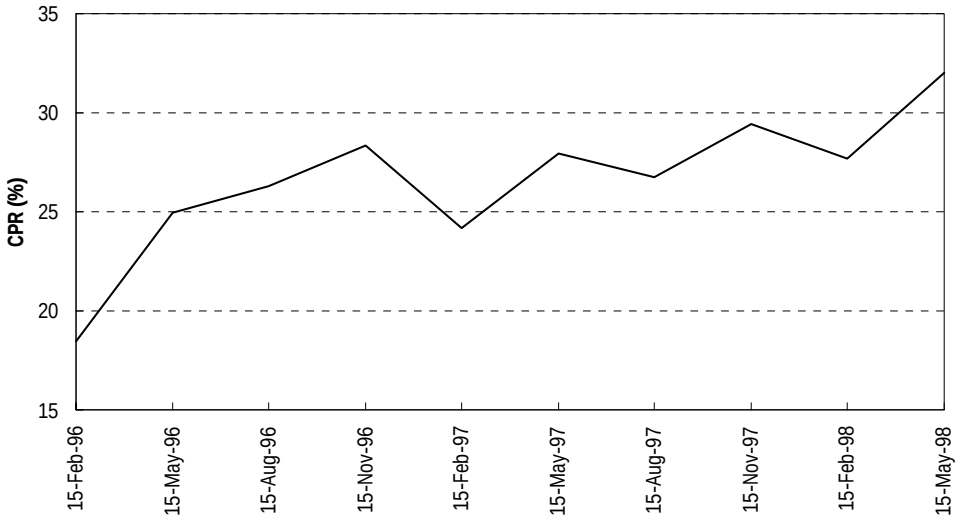
Figure 13. Typical Increase in HEL Prepayment Speeds During the 1995–1996 Rate Rally (UCFC 93.B1)



Source: Salomon Smith Barney.

The most recent refinancing wave occurred in late-1997 and into the first half of 1998. Mortgage rates for 30-year conforming loans dropped to well below 7%, equaling the lows in 1993. From April of 1997, this represented a decrease of about 120bp. Figure 14 shows the prepayment on a typical seasoned HEL deal that was originated at rates comparable to the ones prevailing in the first half of 1997 (prepayments are aggregated by quarter). Increases in HEL speeds typically seem to be less than about 6% CPR for a 100bp decline in mortgage rates.

Figure 14. Prepayments on The Money Store 95.B During the 1997–1998 Refinancing Wave



Source: Salomon Smith Barney.

Although historical data indicates that the pickup in speeds due to a coupon becoming about 100bp in-the-money seems to be less than about 6% CPR, further drops in rates can lead to larger pickups in speeds. Prepayment speeds also seem to level off after the refinancing incentive exceeds about 300bp. Thus, the interest rate refinancing pattern of HELs exhibits the well-known S-curve.

Our interest rate refinancing model follows the approach of other prepayment models in the Salomon Smith Barney family. To allow for burnout and differences in the composition of deals, the total refinancing prepayment is a sum of prepayments for different populations, each of which has its own refinancing curve and refinancing costs.[18] The refinancing incentive is represented by the relative coupon, where the current coupon is computed from the FHLMC rate and the WAC-OCC spread. The relative coupon is then adjusted for refinancing costs, which are divided into **fixed** and **variable** costs. Fixed costs do not depend on the size of the loan and represent items such as application fee, title search, legal fees, and so on. For HELs, which typically have loan balances in the $40,000–$60,000 range, fixed costs can represent a significant obstacle to refinancing. Variable costs depend on the loan amount and cover items such as origination fees and points. These costs can also significantly dampen prepayments, since the number of points can be as high as 7 for some lenders. Overall, for a typical HEL loan the costs of refinancing are in the range of 4% to 8%[19] of the loan balance, considerably higher than for conforming loans.

[18] Lakhbir Hayre & Arvind Rajan, *Anatomy of Prepayments: The Salomon Brothers Prepayment Model*, Salomon Brothers Inc, June 1995.

[19] John C. Weicher, *The Home Equity Lending Industry*, Hudson Institute, 1997.

Initial Population Mix

The initial population distribution (which represents the initial proportions of borrowers in each class, ranging from very slow to very fast refinancers) is assumed to differ from issuer to issuer. The estimated credit distribution of borrowers, as determined by the WAC-OCC spread, is used to estimate the initial mix. The initial mix can also vary by the origination date of a deal, to account for possible changes in credit characteristics of the borrowers for a particular issuer over time.

The Media Effect

The SSB prepayment models assume that the refinancing response to a drop in interest rates is also influenced by the perception of the level of rates compared to their "historical levels."[20] We refer to this phenomenon as the media effect. While the data for HELs is more limited, a comparison of the magnitudes of refinancing waves in 1993 and 1996 suggests that the 30bp difference in the level of mortgage rates does not fully explain the appreciably greater degree of refinancings in 1993. Similarly, the refinancings in early 1998 displayed substantially higher speeds on many seasoned deals than in 1996, even though the difference in the lowest rates was again only about 30bp. Our model therefore incorporates the media effect for interest rate–driven refinancings. Its implementation is the same as in the prepayment model for conforming mortgages.[21]

Cash-Out Refinancings

Even when a borrower cannot realize savings from refinancing his loan, he may still choose to refinance in order to take advantage of the equity available in his home. We refer to this type of prepayment as cash-out refinancing. Its effect is most pronounced when interest rates are at historically low levels, the coupon on the loan is not far out-of-the-money, and following a period of sustained rally in home prices. Therefore, we assume that cash-out refinancings are a function of the media effect, the ratio of the WAC to the current coupon, and of the *current* LTV. The last one is a function of amortization and home-price appreciation. Our model of cash-out refinancings is issuer-specific. One reason for this refinement is the need to account for the different geographical distributions of the five issuers, which leads to home appreciations that deviate from the national average, and therefore to different levels of cash-out refinancings.

Compared to agency mortgages, HELs are susceptible to cash-out refinancings at lower levels of the media effect and smaller declines in LTV. Not surprisingly, lower-credit borrowers, many of whom have already taken equity out of their home to repay installment debt or to finance other purchases, are more likely to face financial circumstances that would prompt them to seek additional liquid assets through HEL borrowing.

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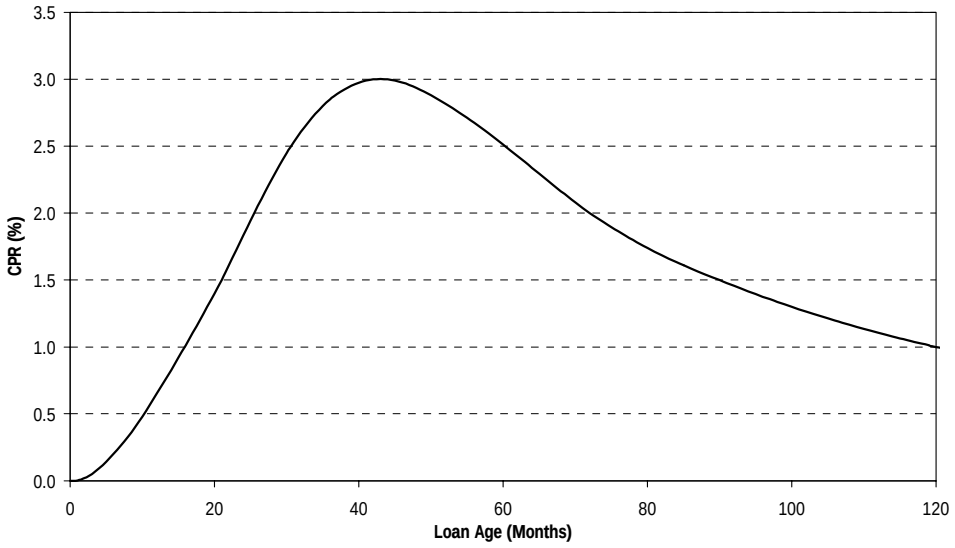
[20] As can be measured by the ratio of current rates to their historical average and the number of months since the rates have been at the current level.

[21] Lakhbir Hayre & Arvind Rajan, *Anatomy of Prepayments: The Salomon Brothers Prepayment Model*, Salomon Brothers Inc, June 1995.

Defaults

Defaults on HELs depend on loan age, current LTV, borrower credit, and other macroeconomic variables. Figure 15 displays a typical default curve.

Figure 15. Typical Seasoning Curve for HEL Defaults



Source: Salomon Smith Barney.

The probability of default is highest about three years after origination, when the cumulative probability of adverse price movement is large, yet the amortization of the loan has not decreased the LTV ratio enough to avoid the possibility of negative equity. Our model assumes that defaults peak at the age of 42 months at about 3% CPR and decline afterward.

Curtailments and Full Payoffs

For conventional loans, partial prepayments (curtailments) form a minor component of prepayments, contributing about 0.5% CPR to the prepayment speed. They tend to increase slowly as loans become more seasoned. Since HEL borrowers are generally in a weaker financial position than agency borrowers, we estimate that curtailments do not exceed those of conventional loans. This is also supported by loan-level studies on a variety of mortgage products. Full prepayments, on the other hand, are negligible early in the life of the loan, but can become a significant source of prepayments in the last few years of the term, adding upward of 10% CPR to the total speed. For HELs, however, such considerations are of limited importance. Given the high level of credit-driven refinancings, the balances remaining in a deal close to the expiration of the term are likely to be extremely small.

Fits and Projections

The HEL prepayment models described above track historical speeds well for all five issuers for deals originated since 1992.[22] Figure 16 shows a sample of fits. Since there is significant month-to-month random variation in speeds for nearly all deals, the display shows quarterly prepayments.[23]

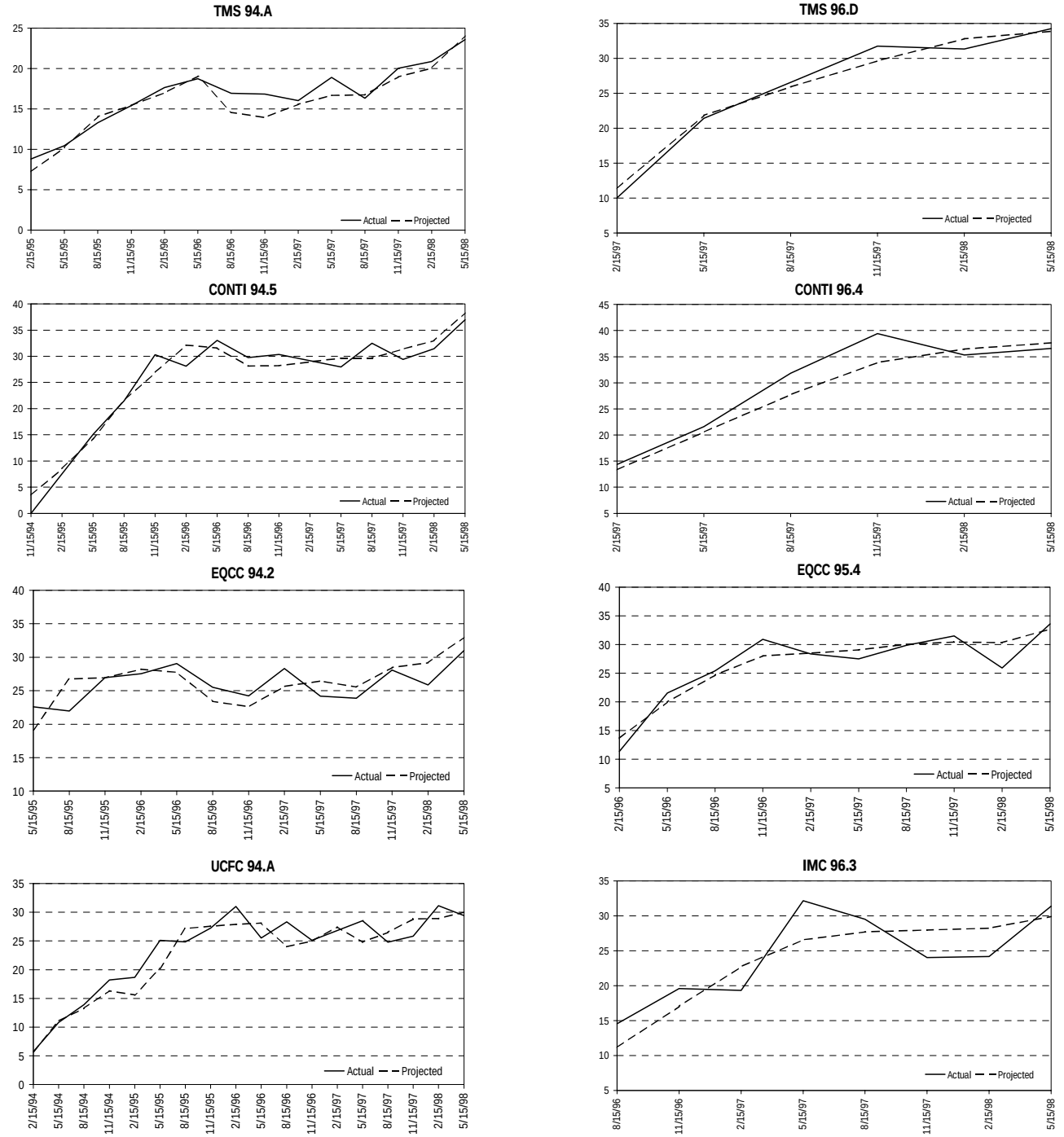
In addition to the generally good agreement between the actual speeds and the model projections both for baseline levels and when refinancings pick up in response to interest rates, several features are apparent from the graphs in Figure 16.

- The model successfully accounts for differences in baseline speeds between different vintages for the same issuer. For example, at the time of origination of the two Money Store deals displayed (late-1993 and late-1996), the conforming mortgage rates were about 80bp apart. Yet the difference in coupons between the two deals is much higher (original WAC is 9.30 for 94.A and 11.92 for 96.D), which could correspond, in part, to differences in credit composition of the deals. The baseline speeds for the two deals are also different, as is successfully captured by our model.
- Even though the low of mortgage rates in early-1996 is within 20bp of the low in January 1998, the prepayment data show considerably stronger refinancing activity in 1998. This is successfully accounted for by our prepayment projections. Much of this difference is a result of a stronger media effect in 1998 compared with 1996.

[22] Comparisons are made for deals available on Bloomberg.

[23] Sampling error is a major component of random month-to-month variation. See discussion in the next section. We also do not attempt to model the variation in business days from month to month. The differences can be significant. For example, March 1998 had 15% more business days than February 1998.

Figure 16. Actual and Projected Speeds on Selected Money Store, Conti, EquiCredit, UCFC and IMC Deals



Source: Salomon Smith Barney.

Figure 17 shows the one-year and long-term averages (life of the deal) of projected speeds for a number of HEL deals for the five issuers.

Three deals are shown for each issuer (except for IMC, which did not securitize in 1994). The 1994 deals were originated in late-1993 and early-1994, when the conforming mortgage rates were comparable to early 1998 and current levels; the 1996 deals were originated early in 1996, when the conforming mortgage rates were within 30bp of the current levels. Therefore, none of the deals displayed are significantly in-the-money. The prepayment projections under various interest rate scenarios, however, differ.

For 1996 deals, an instantaneous drop in interest rates of 100bp would trigger increases in long-term speeds of about 6%–8% CPR. This is slightly higher than the response observed in early 1996 and in 1997, when prepayment speeds generally increased by somewhat less than 6% CPR for the first 100bp in-the-money. The slightly greater increase for 1996 deals is the result of two factors. First, the deals displayed are already about 30bp in-the-money and hence closer to the steepest part of the refinancing curve. Second, a decline of 100bp would bring the conforming mortgage rate to below 6% — a level not seen in several decades. The strong media effect that would accompany such a decline would inevitably lead to an extra increase in speeds.

For 1994 deals, the media effect coupled with a decrease in LTV leads to significant cash-out refinancings and thus to a strong response to decreasing interest rates. Most of the decrease in LTV comes from the robust overall home appreciation over the past four years. In addition, differences between issuers become pronounced. For the first 100bp decline in rates, long-term speeds increase by 9%–12% CPR for the EquiCredit, Conti, and Money Store deals, and by just over 5% CPR for UCFC94.A. These differences are in line with the marked differences in the

Figure 17. Prepayment Speeds Under Various Interest rate Scenarios

					Historical			Projected Speeds													
	Issue	Original			Speeds (% CPR)			-300		-200		-100		0		+100		+200		+300	
Deal	Date	WAC	WAM	WALA	1-Mo.	3-Mo.	12-Mo.	1-Yr.	LT	1-Yr.	LT	1-Yr.	LT	1-Yr.	LT	1-Yr.	LT	1-Yr.	LT	1-Yr.	LT
EQCC 94.1	3/94	9.94%	12-09	56	31.1	28.9	28.9	49.9	49.2	44.6	44.1	38.8	36.8	30.8	28.1	28.5	25.0	23.4	17.3	20.9	13.5
EQCC 96.2	5/96	10.59%	14-09	28	35.2	35.8	31.2	53.4	51.6	47.4	46.1	40.9	39.4	32.2	31.4	30.1	28.5	24.0	20.3	17.9	12.0
EQCC 98.1	4/98	10.75%	15-02	8	16.3	-	-	47.4	46.8	42.0	42.5	36.0	37.3	28.3	30.4	26.9	28.4	22.0	22.1	13.9	11.6
TMS 94.A	2/94	9.30%	22-09	53	21.3	23.7	20.2	50.0	47.2	44.7	42.4	36.4	34.0	25.3	22.2	21.3	17.9	19.0	14.6	17.5	12.5
TMS 96.B	6/96	10.80%	24-04	27	32.3	32.6	28.7	51.2	50.0	45.9	45.2	40.9	39.7	32.9	31.7	29.2	26.7	25.1	20.3	22.6	16.2
TMS 98 A	3/98	10.65%	21-04	10	14.4	-	-	46.7	44.9	42.2	40.9	35.5	34.4	26.8	27.1	23.4	22.7	19.4	17.3	16.8	13.7
UCFC 94.A	2/94	11.61%	18-09	55	34.5	29.5	27.8	50.2	47.5	44.9	42.3	36.9	34.2	30.8	28.9	27.9	25.4	23.2	19.9	19.5	15.6
UCFC 96.B	6/96	11.70%	21-05	27	32.2	31.3	30.0	44.4	44.8	41.6	41.6	36.1	35.8	30.2	30.4	28.7	27.5	25.7	22.3	23.1	17.5
UCFC 98 A	3/98	11.38%	20-04	6	-	-	-	38.4	41.0	32.6	36.3	26.9	31.8	22.7	27.1	21.7	25.5	17.5	19.5	14.4	15.0
CONTI 94.3	6/94	10.53%	17-10	50	30.3	30.9	26.3	58.1	54.1	50.7	47.4	42.1	38.6	28.1	26.4	25.9	23.6	20.0	16.3	15.6	11.3
CONTI 96.2	6/96	11.18%	17-03	26	34.7	38.1	33.7	57.6	54.3	52.1	49.3	45.2	42.4	34.9	34.3	33.4	32.4	27.0	24.4	18.9	14.5
CONTI 97.3	6/97	11.57%	18-04	15	42.6	39.9	27.1	53.9	51.4	50.4	48.0	43.0	41.2	35.3	35.2	32.7	31.7	29.6	27.4	22.7	18.0
IMC 96.2	4/96	11.63%	18-00	30	36.8	29.2	27.0	53.0	50.0	46.3	43.9	39.3	37.1	30.5	30.0	29.0	28.0	23.6	21.3	19.1	15.8
IMC 98.1	3/98	11.20%	20-04	8	15.3	-	-	46.7	44.7	39.1	38.9	31.4	33.3	25.1	27.4	23.4	25.2	17.7	18.6	13.1	13.3

Ten-Year Treasury: 5.200%; Conforming Mortgage Rate: 6.92%
Source: Salomon Smith Barney.

WAC-OCC spreads for 1993 and 1994 between different issuers (see

Figure 10, which also shows that the differences have decreased since then). Deals originated at rates closer to the conforming mortgage rate are assumed to possess a greater proportion of fast refinancers and therefore respond more strongly to interest rate incentives. An example of different responses to interest rate rallies is provided by TMS94.A and UCFC94.A, shown in Figure 16. Finally, two extra years of seasoning for 1994 deals, compared with the 1996 ones, implies stronger housing turnover and therefore additional sensitivity to interest rates through the lock-in effect.

The most recent deals displayed respond somewhat more slowly to interest rate incentives than the 1996 ones. Most of the difference can be traced to the seasoning ramp.

With rising interest rates, all deals show a slowdown of prepayments. This is a result of the lock-in effect and the suppression of credit-driven refinancings. As pointed out earlier, the latter effect is small for the first 50bp rise in rates, but accelerates rapidly with further rate increases.

For seasoned deals, the one-year projection is generally higher than the long-term projection. This is mainly the effect of burnout (in the declining interest rate environments) and a decrease in credit-driven refinancings with loan age. Under slow speeds brought on by a sharp increase in rates, the WAL extends sufficiently so that long-term projections feel the slowdown in credit-driven refinancings (displayed in Figure 8). In extreme rallies, however, the two-to-three-month lag in response to the rate movement may actually become more important than burnout and make the one-year speed *lower* than the long-term average. This is evident, for example, in UCFC96.B. (For UCFC98.A the seasoning ramp plays a role.)

Limitations and Assumptions in Modeling: A User's Guide

While prepayment models are an essential tool for analyzing HELs, they incorporate a host of assumptions, and users should be aware of their limitations.

Projections Are for a Specified Scenario of Interest Rates. Thus, to the extent that prepayments vary with interest rates, actual speeds going forward will differ from projections for any static scenario. While projections over a variety of interest rate scenarios will give an indication of the likely range of speeds, actual speeds going forward will depend on future interest rates, which we cannot project.

The same comments apply to any other economic variable that influences speeds and that is explicitly or implicitly included in the model. Examples include **home price appreciation and volatility, the level of housing turnover**, and, most significantly, **the underwriting policies of lenders**.

In addition to coupon rates, the underwriting policies are most directly reflected in the costs of refinancing, such as points charged, application fees, etc. While our model includes the costs explicitly, their future values are a matter of conjecture. In an industry that is undergoing dynamic growth, along with a wave of consolidations, it is likely that market forces will alter the refinancing costs in the future.

Projections Are Conditional on Historical Relationships Holding Into the Future. Like any econometric model, a prepayment model is based on observed relationships over a given period in the past. There is no guarantee that relationships in the future will resemble those in the past, and significant changes could make the models obsolete (even if the input variables, such as costs, are correctly predicted).[24] For example, competitive forces could lead to increasing refinancing efficiency in the HEL market, so that the refinancing levels in a few years could be higher than predicted by current models.

Fitting Limitations. Most of the parameters in our model were estimated by direct fitting on pool-level data. As with any statistical procedure, the values obtained are subject to uncertainty (the confidence interval). Therefore, the projected speeds should be viewed as the most likely speeds under a given scenario, *not as the only possible* projections consistent with historical experience. The uncertainties are particularly large for issuers where relatively little historical data is available (such as IMC).

Random Error (or Noise) in Monthly Speeds. A projected speed represents an *expected* value for the speed. Even if the model is perfectly accurate, and the interest rates and other variables are known with certainty, the presence of statistical sampling error, or noise, implies that actual speeds will fluctuate randomly around projected speeds from month to month.[25] To illustrate the magnitude of fluctuations,

[24] This can be viewed, of course, as a failure of the model to *explicitly* include all the relevant variables. The distinction is academic, however. No realistic model can include *all* potentially significant variables, and then *predict their future values*.

[25] See *Prepayment Model Risk I: Random Error in Prepayment Projections*, Lakhbir Hayre, Salomon Brothers, June 1996, and *Bond Market Roundup: Strategy*, March 20, 1998.

we consider a hypothetical pool consisting of 6,000 loans that prepay on average according to the ramp: 6% CPR at month 0, increasing uniformly to 30% CPR in month 12. Initially, the 95% confidence interval for the one-month speed is 3.9%–8.1% CPR, which grows to the 24.9%–34.8% CPR range in month 24. The width of the confidence interval is approximately inversely proportional to the square root of the number of loans. Pools with few loans exhibit more fluctuation in month-to-month speed than pools with a large number of loans.

Summary

The HEL sector is a rapidly growing part of the ABS market, with issuance volume of close to $60 billion in 1997. However, the meaning of the term HEL has evolved over time. At one time, HELs meant second mortgages, vehicles through which homeowners could tap the equity in their homes. In recent years, though, the majority of loans backing HEL deals have typically been first liens. These loans tend to be of lower credit quality than those backing agency MBSs, and are typically the result of refinancings used to consolidate existing consumer debt.

The credit characteristics of HEL collateral lead to distinctive prepayment patterns. Base-case speeds tend to be much faster than on current-coupon-agency MBSs, due to lower-credit HEL borrowers improving their credit and being able to refinance into a new loan with a lower rate. On the other hand, lower credit and loan balances (relative to agency collateral) also imply lower prepayment sensitivity to changes in interest rates. Indeed, HEL speeds do not surge as much as those on agencies in a sharp rally — while agency speeds can sometimes reach 70% CPR, HELs rarely prepay above 40% CPR.

There also tend to be differences in the prepayment patterns of HELs from different issuers, because of differences in underwriting policies, targeted borrower demographics, geographic concentrations, and so on. We have developed an issuer-specific model for HEL prepayments. Despite the differences between HEL and agency collateral, the general framework of the Salomon Smith Barney Prepayment Model can also be used to model HEL prepayments. The one change that has been made is to split up the refinancing component into two parts: one to model refinancings driven by changes in borrower credit, and the other to model refinancings resulting from drops in interest rates. By using issuer- and time-dependent measures of borrower credit as well as variables such as loan balances, the model successfully captures differences not just between issuers, but also for the same issuer across time. Since reliable prepayment projections are obviously critical in the evaluation of HELs, the model should prove to be a very useful tool for participants in the HEL market.[26]

[26] The model can be accessed through SSB's analytic system, *Yield Book*.

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