William C. Dudley, Jennifer Roush, and Michelle Steinberg Ezer

The Case for TIPS: An Examination of the Costs and Benefits

- Some studies suggest that the issuance of Treasury Inflation-Protected Securities (TIPS)—inflation-indexed debt—has not been as cost-effective for the Treasury as the issuance of nominal securities.
- The studies base their conclusions on ex post analysis, that is, they look back from the actual inflation outcome to determine whether TIPS issuance costs exceeded the costs of nominal Treasury issuances of similar durations.
- This article argues that the ex post approach has drawbacks when it comes to assessing the costs and benefits of TIPS over the long run; instead, an ex ante approach is recommended.
- A comprehensive analysis of TIPS should also consider the program's other, more difficult-to-quantify, benefits—especially when cost analysis shows that TIPS are only marginally more expensive or about as expensive as nominal issuances.
- The ex ante costs of TIPS issuance are found to be about equal to the costs of nominal Treasury issuance; moreover, TIPS provide meaningful benefits to investors and policymakers.

1. Introduction

Slightly more than a decade has passed since the inaugural issuance of inflation-indexed debt by the U.S. Treasury Department. Eleven years and thirty issues later, we are at a good vantage point from which to evaluate the successes and failures of the Treasury Inflation-Protected Securities (TIPS) program.

From a purely financial perspective, a number of recent studies have suggested that the program has been a disappointment. After calculating the direct costs of TIPS issuance relative to issuance of nominal Treasury securities, the studies show that the first ten years of the TIPS program have cost the Treasury billions of dollars (Sack and Elsasser 2004; Roush 2008).

Importantly, these studies rely entirely on ex post analysis. In other words, the studies ask, Given the actual inflation outcome, did the costs of TIPS issuances exceed the costs of nominal Treasury issuances of similar durations? This approach depends on the actual inflation outcome, which may differ from expectations at the time the TIPS investment was made because investors do not have perfect foresight of inflation. If investors underpredict actual inflation when purchasing TIPS at auction, then these positive forecast errors would increase the payments that the Treasury has to make to

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TIPS holders to compensate them for realized inflation.[1, 2] Upside inflation surprises tend to increase the ex post cost of issuing TIPS compared with nominal Treasuries.

While inflation forecast errors are relevant for calculating the actual costs incurred over the first ten years of the TIPS program, we believe they are irrelevant in assessing the expected benefits or costs of the program over the long run—a theme we explore in this article. In other words, current ex post analysis suffers from the problem of small sample size, particularly since most of the issues have overlapping lifetimes and therefore are not necessarily independent of each other. In the long run, investors learn from their mistakes, and inflation shocks tend to average out. When investors make a particular forecast error, they adapt their future expectations accordingly

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so they do not persistently make the same error. This means that eventually, amid shifting economic conditions, their accumulated forecast errors will average to zero. Similarly, over time, the amount of upside and downside inflation surprises should average to zero. The implication of this process for the TIPS program is that, in the long run, factors other than inflation forecast errors will determine its cost relative to the cost of nominal Treasury issuance (Table 1).

What are these other factors? Two primary factors are the compensation investors require to hold a security that is less liquid than its nominal counterpart, termed the illiquidity premium, and the insurance value they attach to obtaining protection against inflation risk, known as the inflation risk premium.[3] With regard to the first factor, when investors are worried about their ability to resell TIPS in a liquid secondary market, they require compensation for holding the securities compared with more liquid alternatives. This illiquidity premium tends to drive up TIPS yields and increase the Treasury's borrowing costs. The second factor works in the opposite direction. To the extent that investors are willing to pay for inflation protection, they would purchase TIPS at a price above that implied by their expected payment stream. As such, inflation risk premiums result in lower expected borrowing costs for the government and savings for the TIPS program compared with nominal issuance.

Table 1

Impact of Changes in Factors on TIPS Break-Even Inflation

Factor	Impact on TIPS Break-Even if Factor Increases
Inflation expectations	Increase
Illiquidity premium	Decrease
Inflation risk premium	Increase

Source: Authors' calculations.

To determine which factor has been historically dominant, we conduct an ex ante cost analysis: We compare the amount that the Treasury received for inflation compensation at auction with an observable measure of contemporaneous inflation expectations.[4] The difference between these series yields a measure of the net savings or loss incurred by the Treasury that is independent of inflation forecast errors. It is also equal to the net value of the illiquidity and inflation risk premiums associated with each TIPS issue. We find that prior to 2004, the break-even inflation rate is below a survey measure of inflation expectations.[5] This indicates that the illiquidity premium exceeded the inflation risk premium over this period. Since 2004, however, we find that break-even rates were approximately equal to expected inflation, indicating that the two factors were roughly in balance.

[1] Conversely, negative inflation forecast errors decrease the inflation payments by the Treasury relative to the amount it received for providing investors with protection against inflation.

[2] As we discuss, there are other factors that also help determine whether an issue brings in more revenue than it generates, including illiquidity and inflation risk premiums.

[3] In addition to these primary factors, TIPS yields also reflect the taxation difference between TIPS and nominal issuances, the convexity difference between real and nominal yields, and the price of the embedded deflation floor. Regarding the tax differential, because an investor has to pay taxes currently on the accrual of the principal amount payable at maturity on inflation-protected issues, non–tax-exempt investors may require a higher yield on TIPS (a lower TIPS break-even) than what would be associated with their true inflation expectations. As a result, it may be more difficult for the Treasury to capture investors' full inflation expectations and inflation risk premiums. In contrast, the attractiveness of TIPS may be enhanced as a result of the fact that, at maturity, TIPS holders receive the higher of the inflation-adjusted principal amount or the par amount.

[4] The measure of contemporaneous inflation expectations may differ from that embedded in TIPS break-evens at TIPS auctions because the subset of investors is slightly different. Primary dealers, which have been awarded an average of 54 percent of the competitive bids accepted at TIPS auctions since mid-2003, are not the end-users of TIPS, and likely put in an underwriting bid at auction. That said, because the Treasury is paid at the auction stop-out rate, we believe this measure is most appropriate for our analysis.

[5] The break-even inflation rate is the spread between a TIPS yield and a nominal yield with a similar maturity. It is the inflation rate that will equate the return on a TIPS with the return on a nominal security.

There are two possible reasons for the change in fortune for TIPS issued after 2004. Over time, as the TIPS market developed, the illiquidity risk premium shrank and/or inflation risk premiums increased. Evaluating the two components independently, we conclude that a decline in the illiquidity premium is the more convincing explanation. In particular, our review of the evidence shows a downward secular trend in the TIPS illiquidity premium. In contrast, the inflation risk premiums appear to have remained relatively low and stable in recent years.

These findings have important implications for assessing the benefits and costs of future TIPS issuances. The TIPS illiquidity that persisted during the first several years of the program and that appears to explain much of the cost of past issuances no longer seems to be an important factor.[6] As a result, as long as the illiquidity premium and inflation premiums do not shift in systematic ways, future TIPS issuances should be much more cost-effective for the Treasury.

A second theme of this article is that relative cost calculations, on either an ex ante or ex post basis, are just one aspect of a comprehensive analysis of the costs and benefits of the TIPS program. We believe that TIPS issuance provides the taxpayer with other benefits that should be taken into account when evaluating the program—especially when cost analysis shows that TIPS are either only marginally more expensive or about as expensive to issue as nominals. Some of these benefits, such as a broadening of the Treasury's investor base and a diversification of its funding sources, were cited by Treasury Deputy Assistant Secretary for Federal Finance Timothy S. Bitsberger as a way for the Treasury to "reduce our borrowing costs over time."[7] As such, some of the difficult-to-measure benefits of the TIPS program are consistent with the Treasury's current debt management objectives. In a November 2001 speech, Under Secretary of the Treasury for Domestic Finance Peter Fisher emphasized that "The debt management strategy of Treasury has been to strive to be regular and predictable in the issuance of debt while minimizing borrowing costs over many years and interest rate cycles."[8] This strategy has meant issuing and paying down debt in a manner that promotes market liquidity and obtains financing across the yield curve.

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To assess the net benefits and costs of the TIPS program more fully, we discuss other benefits that we believe are central to a complete evaluation of the program. Although these benefits are not easily measured, they may be considerable. For example, we describe how the program provides important advantages for investors with real saving objectives as well as valuable information for policymakers whose directive is to contain inflation.

The remainder of this article is organized as follows. The next section examines the ex ante costs of TIPS issuance. Measures of illiquidity and inflation risk premiums embedded in TIPS are reviewed in Section 3. In Section 4, we discuss other economic benefits of inflation-indexed debt that are not captured in relative cost measures. Section 5 summarizes our main conclusions.

2. Ex Ante Cost Analysis

Studies that have evaluated the issuance costs of TIPS compared with nominal Treasuries have typically compared ex post costs. These studies usually show that TIPS issuance has resulted in a higher net cost to the Treasury. For example, Sack and Elsasser (2004) find a net cost to the Treasury from the start of the program through early 2004 of slightly less than $3 billion. Roush (2008) finds that total ex post costs of TIPS through March 2007 were in the range of $5 billion to $8 billion.[9]

A problem with current ex post analysis, however, is that it depends upon the performance of inflation over a relatively short period of time. If inflation proves to be meaningfully different than what was expected at the time of TIPS issuance, then this difference—the "inflation surprise"—affects the costs of TIPS relative to nominal Treasuries. For instance, if inflation turns out to be higher than expected, then TIPS issuance becomes more expensive relative to nominal Treasury issuance. If inflation turns out to be lower, however, an ex post analysis would show higher savings (lower costs) from the TIPS program.

The importance of the inflation surprise in determining ex post costs can be seen in other developed countries with

[6] Roush (2008) finds that outstanding TIPS issuances under the counterfactual assumption that there was no illiquidity premium imply significant cost savings.

[7] See Bitsberger (2002).

[8] See Fisher (2001). See Gensler (1998) and Stigum and Crescenzi (2007) for an overview of Treasury debt management.

[9] To put the range in perspective, we note that the average annual increase in publicly held outstanding Treasury marketable debt since 2002 is approximately $227 billion. Furthermore, $5 billion to $8 billion represents 0.1 to 0.2 percent of total outstanding Treasury marketable debt held by the public as of June 2008.

similar programs of inflation-linked sovereign debt issuance. In fact, several other developed countries' inflation surprises have resulted in lower costs of inflation-linked debt issuance compared with the costs of nominal debt issuance. For example, in its 2000-01 *Annual Review*, the United Kingdom Debt Management Office notes that the "significant reduction in the cost of funding [from the inflation-linked debt program] … has partly been due to the reduction of inflation risk but more importantly because of the fact market expectations of inflation have exceeded the inflation outturn ('outcome') for much of the last twenty years."[10] Similarly, a 2006 ex post cost study by the Agency France Trésor finds that its inflation-linked debt program saved the government €120 million between 1998 and 2004.[11] In that study, the authors observe that any analysis of this type is difficult because it does not include some of the hard-to-measure benefits of the program, such as the diversification of the government's debt portfolio, and it only applies in retrospect. In other words, if actual inflation turns out to be higher than expected, the inflation-linked program could instead appear costly.

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Over the long run, however, inflation surprises should not matter. This is because investors are likely to learn from their mistakes and not repeat their forecast errors indefinitely. If investors incorporate all known information into their predictions, inflation surprises should be unbiased, with as many downward surprises in inflation performance as upward surprises.

When considering the performance of TIPS over the expected life of the program, we believe this longer term perspective is most relevant. If an experiment were to be run thousands of times drawing from the underlying distribution of possible inflation outcomes, would the Treasury's costs have been lower, on average, with TIPS or with nominal Treasuries? Alternatively, we can ask whether the Treasury obtained the financing it needed at a low cost on an ex ante basis—that is, independent of inflation forecast errors.

To answer this question, we apply a concept that TIPS analysts call the break-even inflation rate. Essentially, this is a value that makes the marginal investor indifferent between buying TIPS or nominal securities. It includes investors' expectations about the amount of inflation they will be compensated for as well as any premium they are willing to pay for protection against inflation. It also includes the component of the TIPS yield that investors require as compensation for any deficiency in TIPS market liquidity relative to market liquidity for nominal Treasury securities.

We conduct an ex ante analysis by comparing the auction break-even rate with a measure of inflation expectations.[12] Ideally, we would like to use a measure of inflation expected by TIPS investors at the time of the auction. Unfortunately, such a measure is not available. Instead, as an approximation, we use real-time estimates of expected inflation from the Survey of Professional Forecasters (SPF), conducted by the Federal Reserve Bank of Philadelphia.[13] Although the survey's median estimate of the CPI inflation rate over the next ten years is available only quarterly,[14] it is unlikely that inflation expectations are very volatile at a high frequency, leading us to expect that the SPF measure may be a reasonable gauge of market expectations.[15]

Chart 1 compares the auction break-even rate at the ten-year maturity point with the SPF long-run estimate of CPI inflation. It shows that during the early years of the TIPS

[10] United Kingdom Debt Management Office (2001, p. 39).

[11] Coeuré and Sagnes (2005).

[12] We apply the same methodology as Roush (2008) to calculate the auction break-even rate. In particular, we estimate the break-even rate received at auction to be the implied inflation rate that equates the price of the TIPS at auction to a hypothetical on-the-run nominal security with the same real payment stream as the TIPS issue. For further details on the calculation, see Roush (2008).

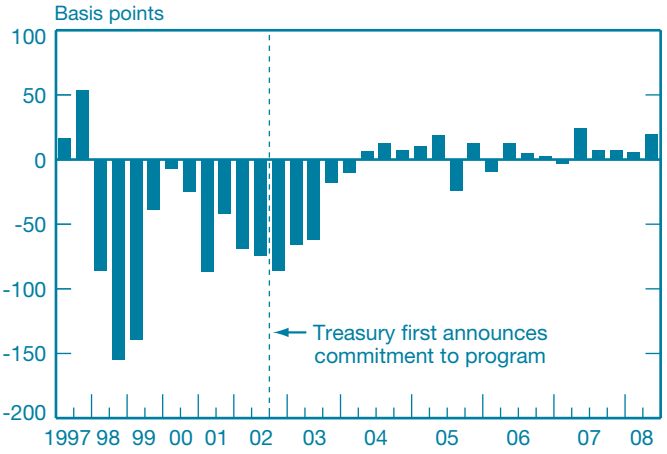
[13] The SPF is conducted on a quarterly basis. Survey respondents are professional economic forecasters in business and on Wall Street.

[14] We use the median ten-year-ahead CPI inflation forecast, which represents the median expectations of respondents for the average annual headline CPI inflation rate over the next ten years. As such, this forecast is for a similar inflation index and an almost similar time period as a newly issued ten-year TIPS. The SPF forecast is based on the seasonally adjusted headline CPI; if it were based on a non–seasonally-adjusted CPI, there should be no difference between the two because they would be forecasts of average annual rates, and therefore assumptions about seasonality over the year would be irrelevant. The time period of the survey is slightly off, given that TIPS are linked to non–seasonally-adjusted CPI lagged by approximately 2.5 months.

[15] Although there are no direct measures of inflation expectations, we believe that the Survey of Professional Forecasters is a good proxy. An alternative survey is the University of Michigan's Survey of Consumers, which is a median long-term (five-year) inflation expectations measure. The Michigan measure is based on the forecasts of consumers, as opposed to professional economists. A similar analysis using this measure shows a comparable pattern, where the early years of the TIPS program appear more costly.

Chart 1

Ten-Year TIPS Auction Break-Even Minus SPF Median Consumer Price Index over Next Ten Years



Sources: Federal Reserve Bank of Philadelphia, Survey of Professional Forecasters (SPF); Board of Governors of the Federal Reserve System.

program, the auction break-even inflation rate was lower than median inflation expectations of professional forecasters. This indicates that the ex ante cost of ten-year TIPS issuances was higher than the cost of nominal ten-year Treasury issuances.

As of June 2008, however, the break-even inflation rate at the ten-year maturity point was about 2.50 percent, which is equal to the most recent SPF long-run estimate of 2.50 percent CPI inflation. If we assume that the SPF fairly represents the expectations of investors, then the current constellation of data indicates that on an ex ante basis, it appears that the cost of issuing TIPS is currently about equal to the cost of issuing nominal Treasuries.[16] From this perspective, there appears to be little net benefit or cost from TIPS in terms of expected financing expenses.

The break-even inflation rate obtained from a comparison of TIPS yields and nominal Treasury yields includes two other key elements beyond expectations about the future inflation rate: the inflation risk premium that investors pay for inflation protection and the illiquidity premium associated with TIPS compared with nominal Treasuries. If the insurance value of inflation protection exceeds the illiquidity premium, then the break-even rate will be greater than expected inflation and the ex ante cost of TIPS will be lower than it is for nominal Treasuries. If, however, the illiquidity premium is greater than the inflation risk premium, then the break-even rate will be below the expected rate of inflation and the ex ante cost of TIPS issuance will be greater. The fact that break-even rates were below expected inflation during the first several years of the program indicates that the illiquidity premium must have been a dominant influence on ex ante costs over this period.[17] More recently, however, break-even rates and inflation expectations appear to be approximately equal, implying that the two factors more or less cancel each other out. This shift could be attributable to a decline in the illiquidity premium in TIPS yields and/or an increase in the inflation risk premium.

3. TIPS Illiquidity Premiums and Inflation Risk Premiums

There is no direct evidence on the illiquidity premiums in TIPS yields and on inflation risk premiums, so we rely on indirect evidence and model-based estimates. In this section, we consider several approaches to modeling both types of premiums as well as review observable evidence on changes in TIPS market liquidity.

3.1 Illiquidity Premiums

Over the past decade, TIPS issuance has grown nearly five times as quickly as nominal issuance, to where it now represents almost 10 percent of the Treasury's marketable debt portfolio.[18] During this period, the TIPS investor base appears to have widened and, according to Federal Reserve 2004 data—information on market activity collected by the Federal Reserve

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[16] Although the sample size is limited, the median ten-year-ahead CPI inflation rate forecasted by the SPF has typically overpredicted actual ten-year CPI inflation for the forecasts made between 1979 and 1997. If, in a longer sample period, the SPF proves to always overpredict ten-year-ahead CPI inflation, then the ex ante cost estimates in our analysis may be overstated. That said, we believe that over a longer sample period, the forecast errors of the SPF should net out to zero.

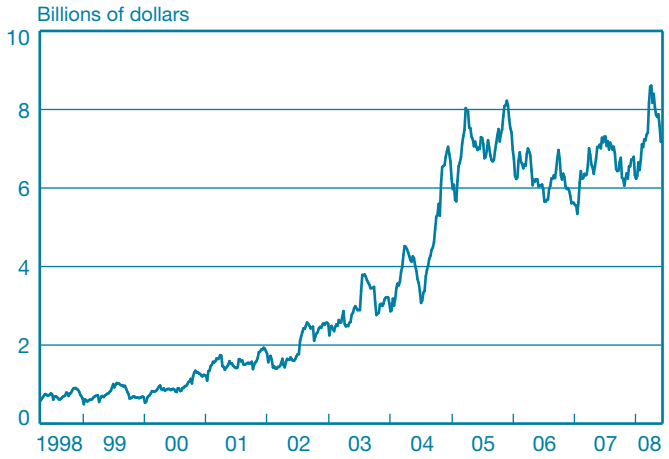
[17] Roush (2008) finds that the illiquidity premium in TIPS accounts for most of the ex post cost of TIPS during this period.

[18] This estimate does not account for the current principal inflation accretion on TIPS issues. If that amount is included, the share increases to 11.9 percent (U.S. Treasury Department, Bureau of the Public Debt, Monthly Statement of the Public Debt of the United States, January 2008).

Chart 2

Average Daily Secondary-Market Trading Volume in TIPS

Twelve-Week Moving Average

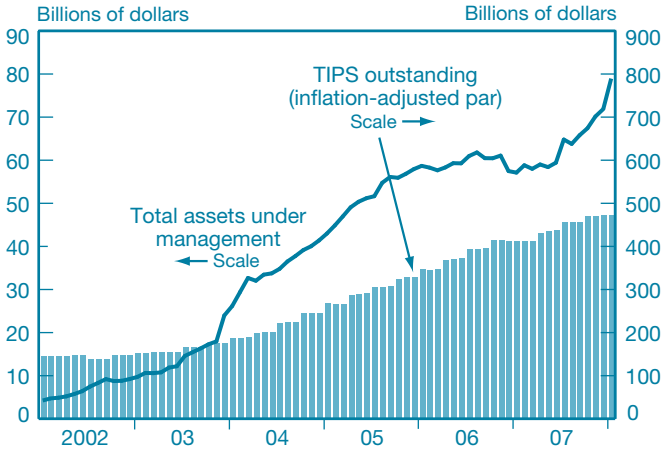


Source: Board of Governors of the Federal Reserve System, FR 2004 reporting forms.

Note: Figures reflect interdealers and customers; interdealer volumes represent one side of a trade.

Chart 3

Assets under Management in Inflation-Protected Bond Funds



Sources: Investment Company Institute; U.S. Treasury Department.

from primary dealers in U.S. government securities—trading volume among primary dealers in the secondary market has increased ten-fold (Chart 2).[19]

While data on the distribution of TIPS holders are not available, there are some signs that TIPS market participation has increased and that the market has become less concentrated. For example, in our conversations with TIPS investors about TIPS market liquidity, they noted the ability to execute trades with a larger number of primary dealers compared with five to ten years earlier. Similarly, a review of the Federal Reserve 2004 data reveals that primary dealer trading in TIPS has become somewhat less concentrated across institutions.[20] For example, the top quintile (by volume) of primary dealers was responsible for an average of 68 percent of total TIPS volume in 2007, 10 percentage points lower than the 2001 average.[21, 22] In addition, there has been a notable increase in the size of mutual funds that hold inflation-indexed securities. According to the Investment Company Institute, assets under management in inflation-protected mutual funds have grown 712 percent over the past five years (Chart 3).

TIPS traders and investors have reported increased confidence in the longevity of the program and the ability to execute transactions in the secondary market over the past ten years.[23] Of note, volume in TIPS was sufficient to support the expansion of electronic trading platforms—such as BrokerTec, Bloomberg, and TradeWeb—to enable TIPS electronic trading in 2003, 2001, and 2003, respectively. Furthermore, a review of bid-ask spreads reveals that TIPS liquidity appears to have improved somewhat in longer term markets since 2003, and is roughly the same in the five- and ten-year sectors. For example, according to Fleming and Krishnan (2008),[24] when there were bid and ask quotes in the interdealer broker market, bid-ask spreads averaged approximately 2/32s, 3/32s, and 7/32s in the five-, ten-, and twenty-year benchmark issues, respectively,

[19] The increase in average daily trading volumes exceeds the increase in TIPS outstanding over the same period. Over the past ten years, the inflation-adjusted par amount of TIPS outstanding has increased almost six-fold.

[20] The TIPS traders and the representatives of one electronic brokerage firm with whom we spoke observed that a large majority of trading in TIPS occurs through the primary dealer community.

[21] By comparison, the nominal total transaction volume among the top quintile of primary dealers averaged 44 percent and 49 percent in 2007 and 2001, respectively.

[22] According to Federal Reserve 2004 data on primary dealers, the breakdown of total TIPS transaction volume between the interdealer market and the dealer-to-customer market has also changed since 2001. Trading between primary dealers and customers accounted for 78.4 percent of total primary dealer transaction volume in 2001. In 2007, this percentage declined to 73.4 percent, while interdealer trading increased.

[23] Most notably, TIPS market participants cited the Treasury's 2002 public affirmation of its commitment to the program (<http://treas.gov/press/releases/po3149.htm>), which it has reaffirmed in public statements as recently as the August 2008 refunding (<http://www.treas.gov/press/releases/hp1095.htm>).

[24] Fleming and Krishnan note that a drawback of using the bid-ask spread to analyze TIPS market liquidity is that there is not always a two-sided market. For example, they estimate that between March 2005 and March 2008, there was a two-sided market in the on-the-run ten-year TIPS approximately 60 percent of the time in the interdealer broker market. As such, information on the extent to which there is a two-sided market complements the bid-ask spread when analyzing liquidity. Unfortunately, a longer time series of these data is not available.

Chart 4
Illiquidity Premium in Ten-Year TIPS Yield

Source: D'Amico, Kim, and Wei (2008).

between March 2005 and March 2008.[25] Although figures are not directly comparable given the different data sources, Sack and Elsasser (2004) estimate bid-ask spreads of 2/32s for TIPS maturing between five and ten years and between 4/32s and 16/32s for TIPS maturities beyond ten years in 2003. Our discussions with TIPS market participants also suggest that secondary-market liquidity has improved over the past five years.

The important question concerning future issuances is not whether TIPS liquidity has improved, but whether TIPS liquidity has improved enough to shrink the illiquidity premium sufficiently to make TIPS issuance cost-effective from the perspective of the Treasury.

Even if TIPS liquidity has improved, it undoubtedly remains below that of on-the-run nominal securities. Daily trading volumes in on-the-run nominal securities far exceed those described for TIPS (Fleming and Mizrach 2008). The important question concerning future issuances is not whether TIPS liquidity has improved *enough to shrink the illiquidity premium sufficiently to make TIPS issuance cost-effective from the perspective of the Treasury*. More precisely, are investors currently demanding substantial compensation in order to hold TIPS relative to a more liquid security? The larger such premiums are going forward, the greater the costs to the Treasury of future issuances, all else equal.

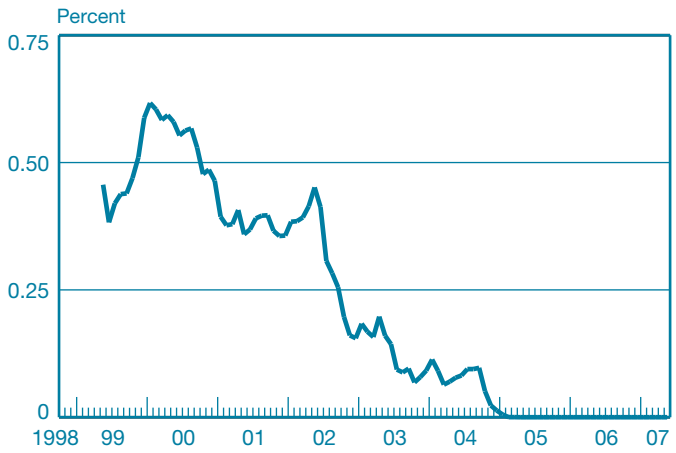
D'Amico, Kim, and Wei (2008) estimate the illiquidity premium in TIPS yields compared with off-the-run nominal securities from a no-arbitrage latent-factor model of the real and nominal term structure. The authors derive this measure by comparing observed TIPS yields with predictions based on an affine model of nominal term structure and an estimated process for inflation.[26]

D'Amico, Kim, and Wei estimate that the liquidity premium in the ten-year TIPS yield was as large as 200 basis points in the early years of the program (Chart 4). Since then, however, the premium has trended down, and within the last six months has fluctuated below 50 basis points. The fact that the premium is positive for most of the sample indicates that TIPS have remained illiquid relative to off-the-run nominal securities, and thus even more so compared with their on-the-run counterparts. Nonetheless, the fact that the premium investors demand in compensation for this illiquidity has shrunk to lower levels in recent years suggests that TIPS market liquidity has improved enough to have a dramatic effect on the cost-effectiveness of TIPS issuance. Indeed, as we discuss

[25] Bid-ask spreads are measured in 1/32s of a point, where a point roughly equals 1 percent of the security's par value.

[26] See the appendix for more details on the D'Amico, Kim, and Wei model.

Chart 5
Sack Measure of the TIPS Liquidity Premium since 1999
Five-Year Five-Year-Forward Rate



Source: Macroeconomic Advisers.

below, it now compares favorably with estimates of the size of the inflation risk premium.

Sack (2007b) provides an alternative measure of the illiquidity premium in five-year-forward TIPS yields beginning in five years. His measure is derived from a regression of TIPS yields on a variety of macroeconomic variables as well as the secondary-market turnover in TIPS.[27] Consistent with D'Amico, Kim, and Wei (2008), Sack finds that the TIPS yields in the early years of the program were above the level predicted by macroeconomic fundamentals alone, and interprets the part of the TIPS yield that is predicted by TIPS turnover as a proxy for the illiquidity premium. This measure, shown in Chart 5, also points to a notable improvement in TIPS liquidity during the 2001-04 period. Of note, the level of Sack's illiquidity measure is different from the D'Amico, Kim, and Wei estimate because Sack measures the illiquidity premium indirectly through a multifactor regression.

3.2 Inflation Risk Premiums

The notable declines in estimates of the illiquidity premiums in TIPS yields in recent years suggest that it now costs the Treasury relatively less to issue TIPS than nominal securities. This raises an important question about the size of the illiquidity premiums vis-à-vis the size of the inflation risk premiums.

To better estimate the size of the inflation risk premiums, we consider several models. A simple measure of the inflation risk premium can be calculated based on the term structure of forward inflation compensation rates at distant horizons, as described in Sack (2007a). The rationale is that most factors affecting movements in inflation tend to die out after a few years, so that investors are unlikely to expect inflation to be different at adjacent forward rates, for example, at nine and ten years ahead.[28] Thus, the spread between one-year-forward inflation ending in nine and in ten years is likely to be driven mostly by inflation risk premiums.[29]

Chart 6 presents a time series of the inflation risk premium from nine to ten years ahead measured according to this approach.[30] The estimates in the chart are based on smoothed zero-coupon yield curves for real and nominal bonds (Gürkaynak, Sack, and Wright 2006, 2008). The inflation risk premium has varied between 0 and 25 basis points since 1999, with an average value of 11 basis points.

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Another method for estimating the inflation term premium embedded in nominal Treasury yields is the no-arbitrage model used by D'Amico, Kim, and Wei (2008). Chart 7 presents a time series of the inflation risk premium for ten-year zero-coupon inflation compensation from their model. This measure of the inflation risk premium varies between 40 and 120 basis points over the history of the TIPS program. The levels of the two measures of inflation risk premiums are not directly comparable because one is a short-term far forward rate and one is long-term spot rate. However, it is useful to note that the correlation between the two measures is positive and

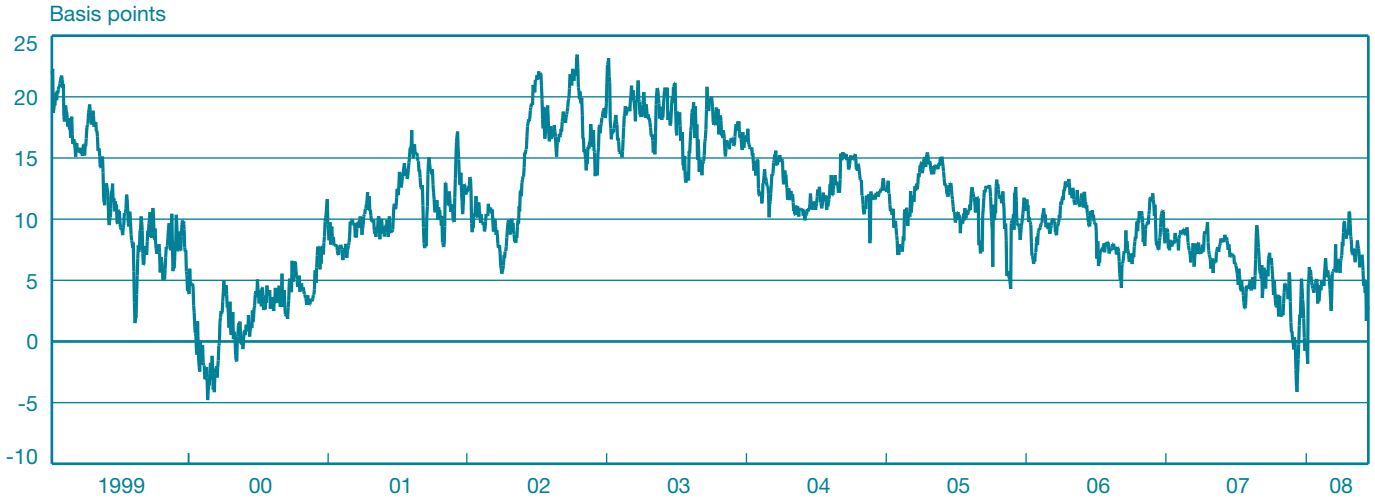
[27] In his regression, Sack includes a measure of the difference between the unemployment rate and the Non-Accelerating Inflation Rate of Unemployment, expected real GDP over the subsequent year, the spread between West Texas Intermediate (WTI) futures and spot prices, lagged WTI oil price inflation, the three-month moving average of correlation between daily changes in the stock market and break-even rates, and the squared difference between TIPS volume at each point in the sample with the end period volume.

[28] This simplifying assumption ignores factors that affect the level of long-run inflation expectations. However, these factors are likely to occur infrequently.

[29] Although this approach does not explicitly account for liquidity effects, the fact that the illiquidity premium at nine years is unlikely to be very different from the premium at ten years signifies that, in essence, liquidity effects are more or less excluded by taking the spread at these adjacent horizons.

[30] We use a smoothed spline to abstract from small deviations in yields based on liquidity. Furthermore, we believe that any differences between our estimates, which are derived from a smoothed spline, and those derived from a bid, ask, or mid-spline would be small.

Chart 6
Inflation Risk Premium at Ten Years from Term Structure of Forward Inflation Compensation



Source: Gürkaynak, Sack, and Wright (2008).

Chart 7
Ten-Year Risk Premium

Source: D'Amico, Kim, and Wei (2008).

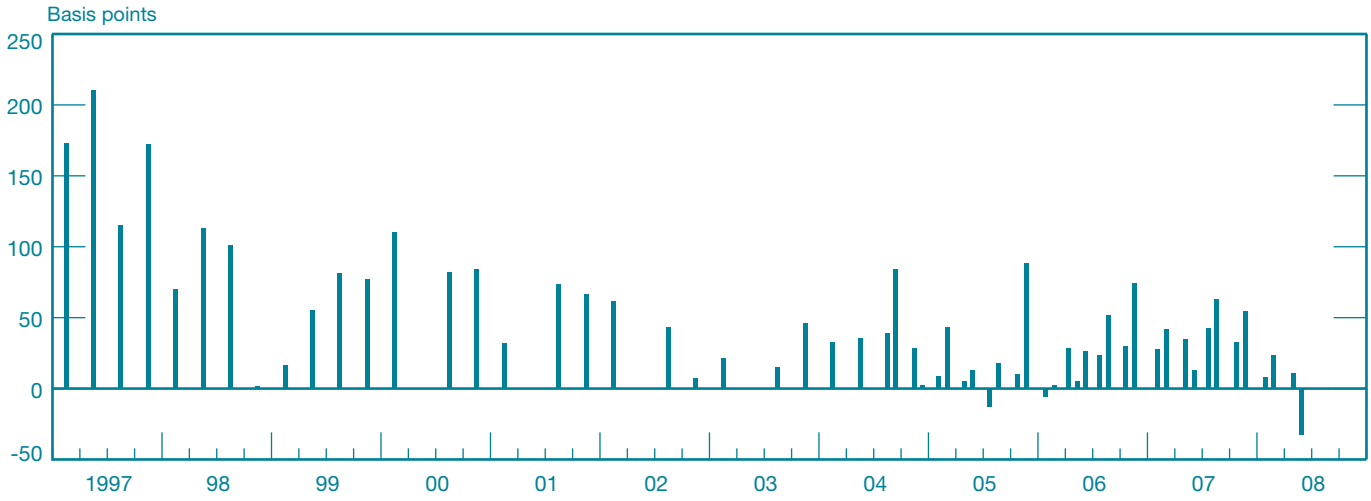
statistically significant, albeit at only 0.28. More importantly, although the D'Amico, Kim, and Wei measure exhibits somewhat different variation, particularly in the first half of the sample, both series generally declined between 2004 and 2008, before picking up recently. This provides further evidence that the recent improvement in the cost of TIPS issuance was associated with a decline in TIPS illiquidity premiums rather than an increase in inflation risk premiums.

3.3 The Inflation Risk Premium Earned by the Treasury at Auction

We conclude this section by explicitly decomposing our ex ante cost analysis into the components associated with illiquidity in TIPS and inflation risk premiums. We again compare the break-even rate of inflation with a measure of expected inflation from the Survey of Professional Forecasters. However,

Chart 8

Inflation Risk Premiums at Historical TIPS Auctions



Source: Authors' calculations, based on data from the U.S. Treasury Department and the Board of Governors of the Federal Reserve System.

we now exclude the illiquidity premium in TIPS yields estimated in D'Amico, Kim, and Wei (2008) before computing the break-even rate.[31] A comparison of this break-even rate with inflation expectations yields an estimate of the premium investors were willing to pay for inflation protection at previous TIPS auctions.

Chart 8 uses this method to present estimates of the inflation risk premium on TIPS auction days.[32] The average risk premium over the sample is within the range of the other estimates, at 47 basis points. Furthermore, this measure of auction inflation risk premiums appears to have decreased over time. This may indicate that the initial purchasers of inflation-indexed bonds were also those investors who put the highest value on inflation protection.[33] An alternative explanation is that as inflation has stayed low, inflation expectations have become better anchored. As this has occurred, the inflation risk premium that investors have been willing to pay for inflation protection has diminished somewhat over time.[34]

Table 2 presents the average inflation risk premium by maturity of the securities auctioned. Although the size of the premium does not appear to increase consistently with maturity, this result may be misleading as it is attributable, at least in part, to changing issuance patterns. For example, with the exception of the July 2002 TIPS, five-year TIPS have only been issued during the past three years—a period in which oil prices increased more than 175 percent. This could contribute to the high estimate of the inflation risk premium for five-year TIPS. In contrast to the relatively limited issuance of five-,

[31] D'Amico, Kim, and Wei calculate the liquidity component for five- and ten-year TIPS yields, which we use to adjust the auction prices of five- and ten-year TIPS issues. For twenty- and thirty-year TIPS issues, we assume that the liquidity component is equal to the component for a ten-year security, which in the event that these securities are less liquid than the ten-year note, understates this effect and thus underestimates the risk premium at this horizon. D'Amico, Kim, and Wei also do not calculate liquidity yield components before 1999, because there were too few TIPS issues to construct a zero-coupon yield curve. For auctions occurring between 1997 and 1999, we assume that the liquidity yield component is equal to its value at the start of 1999.

[32] Note that the maturity of TIPS changes at each auction in the chart, complicating comparison with the time series of the inflation risk premiums. Put another way, the inflation risk premiums presented in the chart are not for a constant time horizon, but vary between five, ten, twenty, and thirty years, depending on the maturity of the TIPS being auctioned on a given date.

[33] The fact that the inflation risk premiums by this measure are sometimes negative suggests possible measurement error in the estimation of inflation expectations. Furthermore, except for the two recent negative estimates of inflation risk premiums, the other negative estimates are not significantly different from zero.

[34] The -32.3 basis point estimate of the inflation risk premium at the April 2008 five-year TIPS auction may reflect market conditions at the time of the auction as opposed to the actual value investors placed on inflation protection. In particular, the historically low level of five-year TIPS yields (and the low expected coupon rate) reportedly may have deterred some investors from participating in the auction. Of note, the pre–auction-day yield of the five-year TIPS, at 0.53 percent, was the lowest pre–auction-day level compared with prior five-year TIPS auctions and was notably below the 1.79 percent average five-year TIPS yield since the Treasury brought back the five-year maturity point in 2004. In addition, part of the negative inflation risk premium may also reflect the flight-to-quality bid in the nominal market at the time. When we calculate the inflation risk premium that assumes that TIPS are as liquid as an on-the-run security (instead of an off-the-run security), the premium increases to -10.3 basis points.

Table 2
Estimate of Inflation Risk Premium by Maturity of Issue

Maturity	Premium (Basis Points)
Five-year	52.0
Ten-year	41.0
Twenty-year	37.5
Thirty-year	83.0

Source: Authors' calculations.

twenty-, and thirty-year TIPS, ten-year TIPS were issued throughout the sample and thus may provide the best overall estimate that is also maturity-constant. According to this estimate, a typical risk premium over this period has been about 40 basis points.

The fact that investors appear willing to pay about 40 basis points for inflation protection indicates that the TIPS program does satisfy a real demand that is not met by nominal Treasuries. It also suggests a potential for significant gains to the Treasury from enhanced secondary-market trading liquidity. For example, if the TIPS market were as liquid as the market for off-the-run Treasuries, the Treasury would have realized a total cost savings from the TIPS program of $22 billion to $32 billion.[35, 36]

The fact that investors appear willing to pay about 40 basis points for inflation protection indicates that the TIPS program does satisfy a real demand that is not met by nominal Treasuries. It also suggests a potential for significant gains to the Treasury from enhanced secondary-market trading liquidity.

[35] We estimate the ex ante cost of the TIPS program as the present discounted value of the difference in the payment stream paid by the Treasury to TIPS holders from the expected payment embedded in TIPS prices, assuming that actual inflation equals the SPF measure of expected inflation and that no illiquidity premium exists.

[36] Similarly, if the TIPS market were as liquid as the market for on-the-run Treasuries, the Treasury would have realized a total cost savings from the TIPS program of $28 billion to $37 billion.

4. Other Benefits of Inflation-Indexed Debt

The Treasury's ability to issue TIPS at lower inflation-adjusted yields because of a significant inflation risk premium is one of several benefits that inflation-linked debt issuance provides to investors and monetary policymakers. Other benefits of the TIPS program, although difficult to quantify, are potentially considerable. We now discuss how some of these benefits may make TIPS issuance more favorable to the Treasury and U.S. taxpayers than additional issuances of nominal securities.

4.1 Inflation Hedge for Households

Economist James Tobin made one of the most convincing arguments in favor of inflation-indexed debt on behalf of households with real saving objectives:

> "… markets do not provide, at any price, a riskless way of accumulating purchasing power for the future, whether for old age, or for college education or for heirs…. Meanwhile we force savers to take risk, even if they would gladly pay for the privilege of avoiding it…. No private institution can fill this gap. No insurance company or pension fund could assume the risk of offering purchasing power escalation to its creditors without similarly (inflation) escalated securities in which to invest at least some of their funds."[37, 38]

The key point of this argument is that even if nominal bond yields are high enough on average to compensate investors for the expected rate of inflation, an individual investor at any time may be overcompensated or undercompensated vis-à-vis the realized rate of inflation. By providing individuals with a way to insure against inflation risk, TIPS embed less risk than any other asset class. With virtually no credit risk or inflation risk, TIPS are one of the safest investments.[39] Equities or other assets with uncertain nominal returns provide only an imperfect hedge depending on their correlation vis-à-vis inflation (Chu, Lee, and Pittman 1995).

[37] Tobin (1963, pp. 204, 206).

[38] While investors could purchase short-term debt and renegotiate the interest rate every three months, they would be exposed to roll-over risk.

[39] There is some inflation basis risk in that TIPS are based on the non–seasonally-adjusted consumer price index, and a household's expenditure basket might differ from the basket in the CPI. Also, pension and endowment liabilities may be more closely related to other inflation or wage measures than the CPI.

This benefit has implications for individual investors as well as for the broader economy.[40] By enabling investors to insure against inflation risk, the government allows them to choose the amount of inflation risk they hold, resulting in a more optimal allocation of risk among investors with different tolerances (Campbell and Shiller 1996). In addition, as Tobin (1963) argues, the existence of a risk-free inflation hedge may in turn encourage saving behavior by households.

4.2 Improved Monetary Policy

The existence of TIPS helps to improve the conduct of monetary policy in a number of ways. Foremost, the program provides up-to-date information about the evolution of inflation expectations and real ex ante interest rates,[41] which

The existence of TIPS helps to improve the conduct of monetary policy in a number of ways. Foremost, the program provides up-to-date information about the evolution of inflation expectations and real ex ante interest rates, which are important inputs to monetary policy decisions.

are important inputs to monetary policy decisions. Because increases in inflation expectations are often difficult to predict and to reverse, up-to-date information from TIPS about expectations may be important in helping monetary policymakers keep inflation expectations in check. This is critical because inflation expectations are a major element influencing the inflation process.[42] In this role, TIPS are particularly useful because survey measures of inflation expectations, such as those from the University of Michigan and the Survey of Professional Forecasters, are available only with a lag and are updated much less frequently. Although inflation swaps provide an alternative market source of daily information on inflation expectations, these securities are much less liquid than TIPS (Beechey and Femia 2007).[43] Moreover, it is unclear whether the U.S. inflation swaps market would exist without the TIPS market because TIPS provide a benchmark security that can be used to hedge the inflation payments on swaps.

TIPS are also valuable in helping economists and policymakers understand the forces that influence inflation expectations. For example, minute-by-minute data on inflation compensation from financial markets provide a gauge of the effects of monetary policy actions and macroeconomic data releases on inflation expectations. In this way, TIPS help inform macroeconomic models that are important in the policymaking process.

4.3 Improved Fiscal Policy

TIPS may also offer incentives for improved fiscal policy. They provide an explicit incentive for the fiscal (as well as monetary) authorities to conduct policy with an eye toward the consequences for inflation. Recognition by the public that the government is accountable for higher inflation in the form of

TIPS may also offer incentives for improved fiscal policy. They provide an explicit incentive for the fiscal (as well as monetary) authorities to conduct policy with an eye toward the consequences for inflation.

higher inflation payments to TIPS holders may help hold down inflation expectations and cause inflation expectations to be more firmly anchored, that is, less responsive to inflation shocks.

Moreover, TIPS can help improve the management of the national debt. Because payments on TIPS are tied to realized inflation, the receipts and expenditures of the Treasury

[40] It should be noted that there are potential income distribution effects if TIPS are more expensive to issue than nominal securities and TIPS holders are not evenly distributed across income groups. We do not address these effects here, however.

[41] Raw inflation compensation rates are not pure measures of inflation expectations because they contain inflation risk premiums and, potentially, distortions attributable to illiquidity. However, estimates of expected inflation can be derived using measures of these later components, as demonstrated by D'Amico, Kim, and Wei (2008). Furthermore, significant changes in TIPS liquidity tend to be slow compared with inflation expectations; as a result, over short periods of time, changes in inflation compensation rates can reflect a change in inflation expectations and/or inflation risk premiums.

[42] If long-run inflation expectations become less anchored, shocks to inflation may result in a larger effect on inflation expectations and trend inflation. Consistent with this idea, Mishkin (2007) notes that "because long-run inflation expectations are a key driver of trend inflation, monetary authorities monitor long-run inflation expectations closely. If they find that they are losing credibility with the markets, so that inflation expectations begin to drift and rise above (or fall below) a desired level, they will take actions to restore their credibility."

[43] Trading in CPI futures, which provides another financial market read on inflation expectations, was introduced on the Chicago Board of Exchange in March 2004; however, market liquidity had declined to nearly zero by the summer of 2005.

Department are (all else equal) likely to be better matched—since tax receipts are also nominal and likely to rise and fall with shifts in the underlying inflation rate. Thus, TIPS issuance may help reduce the overall volatility of the Treasury's financing needs.[44] A reduction in volatility helps promote the regularity and predictability of the issuance calendar, which increases the liquidity of outstanding Treasury securities and helps to foster demand at Treasury auctions.

Because payments on TIPS are tied to realized inflation, the receipts and expenditures of the Treasury Department are (all else equal) likely to be better matched—since tax receipts are also nominal and likely to rise and fall with shifts in the underlying inflation rate. Thus, TIPS issuance may help reduce the overall volatility of the Treasury's financing needs.

In addition, as noted by Timothy S. Bitsberger, Treasury Deputy Assistant Secretary for Federal Finance, TIPS may give the Treasury access to a broader investor base,[45] which may reduce the Treasury's overall funding costs. Bitsberger further observes that "by diversifying our [the Treasury's] borrowing, we reduce exposure to a single adverse shock and both lower and smooth our borrowing costs." The comparison between the prevailing interest rates on TIPS and on nominal Treasuries provides insight into the relative costs associated with issuing the last dollar of debt. However, just as important is the answer to the question whether TIPS issuance, by displacing nominal Treasury issuance, reduces the level of interest rates that the Treasury pays on its nominal issuances. In principle, a substantial shift in the composition of Treasury issuance into TIPS from nominal Treasuries could lead to lower interest rates paid on the remaining nominal Treasury issuance. This would occur if TIPS were not perfect substitutes for nominal Treasury securities and if the demand for nominal Treasuries was downward-sloping—that is, not completely elastic.

The first condition almost certainly holds given the different attributes of TIPS and nominal Treasuries. If they were perfect substitutes, there would not be a liquidity premium for nominal Treasuries relative to TIPS. The second condition seems likely to hold, as evidenced by a number of studies finding that an increase in the net amount of Treasury borrowing leads to higher expected borrowing costs for the Treasury.[46]

While it is very difficult to estimate the effect that additional supply would have on Treasury yields, a few studies have touched upon the subject. Fleming (2002) suggests that a $1 billion increase in issuance size for the most recently issued three- or six-month bill raises its yield, relative to neighboring bill yields, by approximately 0.35 basis point. At the longer end, Krishnamurthy (2002) finds that a $1 billion increase in bond supply would raise the bond yield, relative to the yield on the previously issued bond, by 0.2 basis point. These results suggest that by issuing securities in a segmented TIPS market, the Treasury may keep realized yields on bill and nominal coupon securities lower than they otherwise would have been.

5. Conclusion

This article offers an in-depth evaluation of the Treasury Inflation-Protected Securities program. Our investigation reaches several important conclusions.

First, a decision on whether the continued issuance of TIPS is beneficial to U.S. taxpayers should be based on a comparison of the ex ante costs of TIPS and nominal Treasury issuance and, especially when these costs are negligible, on a consideration of the more difficult-to-measure benefits TIPS issuance provides taxpayers and policymakers. This decision should not be based on an ex post cost analysis because such analysis depends on the realized inflation rate over a relatively short history, which is irrelevant in assessing the expected costs of TIPS issuance compared with nominal Treasury issuance on a prospective basis.

Second, on an ex ante basis, the cost of TIPS issuance is about equal to or less than the cost of nominal Treasury issuance. The reason is that the value of inflation protection—the implicit premium that investors are willing to pay in terms

[44] Since payments on nominal Treasury debt are tied to expected inflation at the time of the security's auction, differences in Treasury assets and liabilities can arise from divergences between realized and expected inflation.

[45] Presentation by Bitsberger to the Bond Market Association's Inflation-Linked Securities Conference, June 26, 2003 (<http://treas.gov/press/releases/js505.htm>).

[46] Tests of market segmentation of different types of Treasury debt have yielded mixed results (Fleming 2002; Krishnamurthy 2002; Laubach 2003). However, this work is generally limited to consideration of different maturities of nominal debt and does not consider segmentation of real versus nominal debt. That there might be more evidence for the latter is suggested by conventional wisdom that TIPS market participants tend to be buy-and-hold investors, including institutions such as pension funds. The Treasury auction allotment data consistently show that pension funds and investment funds have taken down an average of 30 percent of the amount issued at TIPS auctions since 2000. In contrast, these investors have taken down only 10 percent of the amount offered at nominal coupon auctions over the same period.

of lower TIPS yields—is now greater than or equal to the yield premiums investors demand for holding relatively illiquid TIPS compared with nominal Treasuries.

Third, although the costs of TIPS issuance over the life of the program appear to have exceeded the costs of comparable nominal issuance, these costs were concentrated during the early years of the program, when the illiquidity premium associated with TIPS was large. That premium has shrunk significantly as the TIPS program has matured. Therefore, these early costs are "sunk" and should not be used to determine whether TIPS issuance is costly on an ongoing basis.

Fourth, TIPS issuance has other significant benefits that are not captured by an analysis of net issuance costs. These include the value to investors of having a risk-free asset that offers protection against inflation, the value to the monetary authority of having a real-time guide to shifts in inflation expectations, and the fact that a TIPS program likely displaces nominal debt issuance to some degree, allowing for a reduction in the average cost of nominal issuance as that supply is reduced.

Finally, our analysis of the ex ante costs of the TIPS program and the more difficult-to-measure benefits suggests at least a modest net benefit to the Treasury. Because TIPS issuance appears to be attractive from the Treasury's standpoint, a natural next step is answering the question, What is the optimal allocation of the Treasury's liability portfolio between TIPS and nominal Treasury securities?

Appendix: Estimation of the Illiquidity Premium

We briefly describe how D'Amico, Kim, and Wei (2008) estimate the illiquidity premium in yields on Treasury Inflation-Protected Securities (TIPS). Their first step is to estimate yields on hypothetical real bonds that have the same liquidity as nominal Treasury securities, using a joint model of nominal yields and inflation. Intuitively, the authors are constructing these yields by considering the time-series properties of nominal Treasury yields and inflation, but they do so in a coherent asset pricing framework that rules out the possibility that investors are leaving arbitrage opportunities unexploited.

Modern asset pricing theory starts from the premise that the absence of arbitrage implies the existence of a pricing kernel, m_{t+1}, such that the price of any asset satisfies the relationship $P_t = E_t(P_{t+1} m_{t+1})$. Because bond prices are not complicated by uncertain cash flows, the price of an n-period nominal zero-coupon bond is given just by $E_t(m_{t+1} m_{t+2} \ldots m_{t+n})$. This imposes tight restrictions on the relationship between the time-series and cross-sectional properties of these bond prices. Following many researchers in the finance literature, D'Amico, Kim, and Wei assume that the pricing kernel, m_{t+1}, depends on the short-term interest rate, $y_s(t)$, and prices of risk, $\lambda(t)$. If investors were risk-neutral, then $\lambda(t)$ would be zero, but the authors make no such assumption. The short-term interest rate and prices of risk are assumed to be "affine" (linear plus a constant) functions of three unobserved factors, represented by $X(t)$,

$$y_s(t) = \delta_0 + \delta_1 X(t)$$

$$\lambda(t) = \nu_0 + \nu_1 X(t).$$

In turn, these factors are assumed to follow a vector autoregression of the form

$$X(t+1) = \mu + \Phi X(t) + \varepsilon(t+1).$$

This implies that the yield on an n-period zero-coupon bond is given by an affine function of the factors

$$y_n(t) = a_n + b_n' X(t),$$

where $a(n)$ and $b(n)$ are functions of the parameters of the model including μ, Φ, δ_0, δ_1, ν_0, and ν_1. Finally, a novel feature of the D'Amico, Kim, and Wei study is its assumption that expected inflation is also an affine function of the same factors, $X(t)$,

$$\pi^e(t) = \phi_0 + \phi_1 X(t).$$

Because it jointly models the nominal term structure and inflation, the model can be used to price a hypothetical real bond, the yield on which also turns out to be an affine function of the factors

$$y_n^{real}(t) = a_n^{real} + b_n^{real} X(t).$$

The model is estimated using data on nominal Treasury yields, CPI inflation, and survey forecasts of nominal short-term interest rates and inflation.[47] The survey forecasts are treated as noisy measures of true expectations of future rates and inflation. In addition, substituting the parameter estimates into the last equation gives the estimated real yields.

Estimating the Illiquidity Premium in TIPS Yields

Because D'Amico, Kim, and Wei derive estimated real yields from the nominal off-the-run term structure rather than directly from TIPS themselves, the resulting estimated real yields implicitly embody the same liquidity characteristics as nominal off-the-run securities. Thus, by differencing these estimated real yields and observed TIPS yields, the authors obtain an estimate of the portion of observed real yields that owes to differences in nominal and real bond liquidity. A positive difference results when TIPS are less liquid than the nominal off-the-run securities, since in this case TIPS investors require a yield premium for holding the less liquid securities.

Chart 4 in the text shows that this difference series is indeed positive throughout its history. It also exhibits a secular decline, which is consistent with improved liquidity as one would expect from a developing financial market. It also shows a small amount of variation around its downward trend. This may reflect high-frequency changes in the liquidity premium, but it is probably also importantly influenced by model fitting error, as the model-implied nominal yields are close—but not identical—to the actual observed yields.

[47] TIPS are not included directly in the version of the D'Amico, Kim, and Wei model discussed here because the sample of available TIPS is too short. Instead, the authors model inflation and use it to price synthetic real bonds. The authors also estimate a version of the model that incorporates TIPS; however, the shortness of the available TIPS sample means that their estimates are likely associated with greater estimation error.

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William L. Silber

Why Did FDR's Bank Holiday Succeed?

- After a month-long run on banks, on March 5, 1933, President Franklin Delano Roosevelt declared a nationwide Bank Holiday that shut down the banking system.
- The following week, in his first Fireside Chat, Roosevelt appealed directly to Americans to prevent a resumption of bank withdrawals; when the banks reopened on March 13, depositors stood in line to return their hoarded cash.
- The success of the Bank Holiday and the turnaround in public confidence can be attributed to the Emergency Banking Act of 1933, passed by Congress on March 9.
- The President used the emergency currency provisions of the Act to encourage the Federal Reserve to create de facto 100 percent deposit insurance in the reopened banks.
- The Bank Holiday and the Emergency Banking Act reestablished the integrity of the U.S. payments system and demonstrated the power of credible regime-shifting policies.

1. Introduction

On Sunday, March 5, 1933, after a month-long run on American banks, the newly inaugurated President of the United States, Franklin Delano Roosevelt, proclaimed a four-day suspension of all banking transactions, beginning the following day. The nation's stock exchanges also closed, even though they were not mentioned in the President's executive order. On Thursday, March 9, Roosevelt did not reopen the banks as planned; rather, he extended the closure for three days. Americans should have reacted in horror to the President's proclamation and his decision to abandon his original schedule. Instead, they waited to hear his plan.

Roosevelt's fifteen-minute radio address to the American people on Sunday evening, March 12—his first Fireside Chat—informed the public that only sound banks would be licensed to reopen by the U.S. Treasury: "I can assure you that it is safer to keep your money in a reopened bank than under the mattress."[1] Much to everyone's relief, when the institutions reopened for business on March 13, depositors stood in line to return their hoarded cash to neighborhood banks. Within two weeks, Americans had redeposited more than half of the currency that they had squirreled away before the suspension.

[1] *New York Times*, March 13, 1933, p. 1 cont.

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The market registered its approval as well. On March 15, 1933, the first day of trading after the extended closure, the New York Stock Exchange recorded the largest one-day percentage price increase ever.[2] With the benefit of hindsight, the nationwide Bank Holiday in March 1933 ended the bank runs that had plagued the Great Depression.

How, then, did Roosevelt manage to accomplish in one week what Herbert Hoover failed to do in three years?

Contemporary observers consider the Bank Holiday and the Fireside Chat a one-two punch that broke the back of the Great Depression. According to Beard and Smith (1940, p. 78), "the sudden nationwide holiday performed the same function for the bank panic as may a slap in the face for a person gripped by unreasoning hysteria." Allen (1939, p. 111) notes that the bank reopening succeeded because "the people had been catapulted and persuaded by a president who seemed to believe in them and was giving them action. . . ." Alter (2006, p. 269) confirms the importance of Roosevelt's communication skills by quoting Will Rogers on the President's description of the reopening: "He made everyone understand it, even the bankers."

Roosevelt's oratory certainly played an important role, but only the financially naive would have believed that the government could examine thousands of banks in one week to identify those that should survive. According to Wigmore (1987, p. 752), "The federal review procedure for reopening banks also had too many weaknesses to create much confidence, given the number of banks reopened, the speed with which they opened, and the lack of current information on them. There were no standards for judging which banks

Contemporary observers consider the Bank Holiday and the Fireside Chat a one-two punch that broke the back of the Great Depression.

should reopen." Thus, Temin and Wigmore (1990, p. 491) dismiss the importance of the Bank Holiday: "The value of stocks . . . rose sharply from its trough in March—at the time of the Bank Holiday—to a peak in July. . . . This abrupt turnaround was hardly the result of the interregnum or the Bank Holiday itself. They contained bad news about the health of the economy. Only after Roosevelt's commitment to inflationary policies became clear during the Hundred Days did the value of stocks rise. The stock market rose and fell with the value of the dollar during 1933, illustrating dramatically the link between devaluation and expectations for the economy."

[2] See Siegel (1998, p. 183).

Temin and Wigmore (pp. 488-9) ignore the March 15, 1933, stock price increase in their assessment of the Bank Holiday. They go further to state: "For the first month the administration was absorbed with the Bank Holiday and preparing for action. Stock, bond, foreign exchange, and commodities markets *were quiet and little changed*" [italics added].

This article demonstrates that the Bank Holiday that began on March 6, 1933, marked the end of an old regime, and the Fireside Chat a week later inaugurated a new one. The Emergency Banking Act of 1933, passed by Congress on March 9—combined with the Federal Reserve's commitment to supply unlimited amounts of currency to reopened banks—

People . . . believed the President on March 12, 1933, when he said that the reopened banks would be safer than the proverbial "money under the mattress."

created de facto 100 percent deposit insurance. Moreover, the evidence shows that people recognized this guarantee and, as a result, believed the President on March 12, 1933, when he said that the reopened banks would be safer than the proverbial "money under the mattress." Confirmation of the turnaround in expectations came in two parts: the Dow Jones Industrial Average rose by a statistically significant 15.34 percent on March 15, 1933 (taking into account the two-week trading halt during the Bank Holiday), and by the end of the month, the public had returned to the banks two-thirds of the currency hoarded since the onset of the panic.

Together, the Emergency Banking Act and the de facto 100 percent deposit insurance created a safety net for banks and produced a regime shift with instantaneous results, similar to Sargent's (1986) description of "The Ends of Four Big Inflations." This result would come as no surprise to Friedman and Schwartz (1963, p. 434), who observe that "Federal insurance of bank deposits was the most important structural change in the banking system to result from the 1933 panic, and . . . the structural change most conducive to monetary stability since state bank notes were taxed out of existence immediately after the Civil War."[3] However, Friedman and Schwartz (pp. 421-2) simply review the provisions of the

[3] The Banking Act of 1933, which included a provision for creating the Federal Deposit Insurance Corporation (FDIC), was passed on June 13, 1933. FDIC insurance, which was not retroactive, became effective on January 1, 1934. Although Roosevelt himself opposed deposit insurance legislation (Calomiris and White 2000, p. 193), as we discuss, the President's opposition did not interfere with his commitment to the success of de facto depositor protection that began with the earlier Emergency Banking Act of 1933.

Emergency Banking Act of 1933 and do not recognize the implicit guarantee for deposits in the reopened banks. Both Meltzer (2003, p. 423) and Wicker (1996, p. 146) maintain that the government understood the need to guarantee deposits in reopened banks, but they do not show that the public recognized this new policy and acted accordingly.

Friedman and Schwartz correctly praise the stabilizing role of deposit insurance, but they do not distinguish between a 100 percent guarantee and the insurance program created by the FDIC that began on January 1, 1934. FDIC insurance caps its guarantee at a maximum dollar amount for each deposit account, initially set at $2,500. Small depositors with FDIC insurance did not have to worry about their accounts, but large depositors, who were only partially insured, could still be panicked into a run. Roosevelt's implicit 100 percent guarantee on March 12, 1933, convinced all depositors to trust the reopened banks.

The nationwide Bank Holiday in March 1933 was a unique event in American financial history. In the past, banks had suspended the convertibility of deposits into currency, but never had there been a complete stoppage of the entire U.S. payments system. The evidence presented here on the speed with which the Bank Holiday and the Emergency Banking Act of 1933 reestablished the integrity of the payments system demonstrates the power of credible regime-shifting policies.

The article is organized as follows. Section 2 describes the February 1933 banking system crisis that culminated in the formal suspension of all banking transactions upon Roosevelt's proclamation of a nationwide Bank Holiday. Section 3 reviews the reasons for the suspension, and Section 4 describes the solution to the crisis: the Emergency Banking Act of 1933. Evidence from the contemporary press confirms that an important segment of the American public understood the implicit federal guarantee for all deposits of reopened banks. Section 5 shows that people responded by redepositing the currency they had withdrawn and by bidding up stock prices.

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2. The Collapse

"The straw that broke the camel's back occurred in Detroit, Michigan," in February 1933, according to Acting Comptroller of the Currency Francis Awalt.[4] Michigan Governor William A. Comstock declared a statewide banking holiday on February 14, 1933, to prevent the failure of the Union Guardian Trust Company of Detroit, a bank with close ties to Henry Ford. The story of the battle between Ford—Union Guardian's largest depositor—and Under Secretary of the Treasury Arthur Ballantine over how to save the bank from insolvency has been told many times (Kennedy 1973; Wigmore 1985; Wicker 1996). The failure of Ford and Ballantine to arrive at a mutually agreeable solution forced the governor to suspend banking operations in the entire state. The fallout from that decision gave new meaning to the law of unintended consequences. Instead of preventing a panic, the Michigan bank holiday precipitated one. The suspension confirmed the public's worst fears—that the banks were unsafe—and sparked a nationwide rush to cash.

The damage from the February 14 Michigan proclamation came from contagion. According to Wicker (1996, p. 121), the Michigan bank holiday "spread fear and uncertainty quickly to the contiguous states of Ohio, Indiana, and Illinois." The contemporary press suggests, however, that those states recognized the danger of imitating the Michigan example. On February 17, the office of Ohio Governor George White issued this statement: "There is no occasion for a proclamation by Governor White of a banking holiday in the state of Ohio."[5] On February 23, the *New York Times* reported that Indiana Governor Paul McNutt declared that there would be "no bank moratorium in Indiana" in order to quiet "unwarranted reports from Chicago that there would be [one]."[6]

Unlike Michigan's Midwestern neighbors, Maryland failed to hold the line. On February 24, Governor Albert Ritchie remarked: "I attended the meeting of bankers this evening with the idea of doing whatever is best for the depositors. . . . I believe there is no justification for the withdrawals which have recently been taking place. But to protect the property and saving[s] of the people of the city [of Baltimore] and the State these large withdrawals should stop. It was the consensus of opinion that a bank holiday should be declared tomorrow."[7]

In the weeks following the Michigan moratorium, there were large increases in the demand for currency (Table 1). For the six weeks ending February 8, 1933, currency in circulation was quite stable, averaging $5.36 billion. After February 8,

[4] Awalt (1969, p. 349).
[5] *New York Times*, February 18, 1933, p. 5.
[6] February 23, 1933, p. C31.
[7] *New York Times*, February 24, 1933, p. 21.

Table 1
Currency in Circulation, January-July 1933

Date	Amount (Billions of Dollars)
January	
4	5.38
11	5.30
18	5.32
25	5.32
February	
1	5.37
8	5.47
15	5.56
22	5.70
March	
1	6.43
8	7.25
15	6.98
22	6.32
29	6.07
April	
5	5.97
12	5.86
19	5.78
26	5.71
May	
3	5.67
10	5.67
17	5.57
24	5.51
31	5.53
June	
7	5.48
14	5.44
21	5.41
28	5.39
July	
5	5.47
12	5.38
19	5.35
26	5.31

Source: Board of Governors of the Federal Reserve System, *Banking and Monetary Statistics* (1943, p. 387).

currency held by the public rose steadily, reaching $7.25 billion in the week ending March 8, 1933. The $1.78 billion jump in currency held by the public between February 8 and March 8—an increase of more than 30 percent—confirms the hoarding of cash.[8] Almost all of the increase occurred after February 15.

[8] The weekly data in Table 1 are not seasonally adjusted, but monthly seasonal factors show that virtually no adjustment is required for February and March (see *Banking and Monetary Statistics*, Table 111, Board of Governors of the Federal Reserve System, 1943).

The rush to cash during the weeks following the Michigan bank holiday triggered bank closures or deposit restrictions in every state, even before Roosevelt's proclamation of March 5, 1933 (Wicker 1996, p. 128). According to the *New York Times*, "A bank holiday 'until further notice' was declared tonight [March 4] in Delaware, the last of the forty-eight states in which restrictions have been made."[9] However, there is disagreement over the precise number of *bank holidays* in force before Roosevelt's presidential decree. According to Friedman and Schwarz (1963, p. 325), "By March 3, holidays in about half the states had been declared"; Meltzer (2003, p. 382) indicates "By inauguration day [March 4], thirty-five states had declared bank holidays"; and Alter (2006, p. 190) maintains "By the early evening of Friday March 3, banks in thirty-two of forty-eight states were closed."

Why is there such confusion? To some extent, the disagreement stems from the use of different sources or time periods; only Wicker (1996) provides a reference for his discussion (the *New York Times*). The more likely source of confusion is that some states went to great lengths to avoid a *de jure* holiday. For example, the *Chicago Tribune* reported that "Indiana Governor Paul V. McNutt today informed state officials . . . [that] Indiana banks, under the new bank code law recently rushed through the state legislature, have the power to limit withdrawals to one-tenth of one percent. Therefore, no state-wide bank moratorium will be declared in Indiana."[10]

A detailed examination of the Associated Press list of banking restrictions by state (including the District of Columbia) as of the close of business on March 4, 1933, reveals that "Banks in 28 states are 'closed'; Banks in 10 states are 'some or mostly closed'; Banks in 11 states have deposits that are 'restricted to withdrawals of 5 (or some unspecified) percent.'"[11] The Associated Press characterized Indiana as: "About half [of the banks] restricted to 5 percent [withdrawals] indefinitely." If the term *bank holiday* means an unqualified shutdown of banking transactions by state governments, then the Associated Press limited the number to twenty-eight.[12]

As these accounts suggest, Franklin Delano Roosevelt did not invent the bank holiday. So why is his March 5 proclamation credited with launching a process that was crucial to restoring confidence in America's banking system? The answer is that Roosevelt's initiative turned a maze of state restrictions into a uniform national policy. This action was the key first step to resolving the banking crisis: It shifted the

[9] March 5, 1933, p. F24.

[10] March 5, 1933, p. A5.

[11] *New York Times*, March 5, 1933, p. F24.

[12] Although the Associated Press listed New York as "closed," the *New York Times* (March 5, 1933, p. 23) reported that "At least two banks in New York City did not avail themselves of the banking holiday proclaimed yesterday by Governor Lehman. They were the Sterling National Bank, 1410 Broadway and the National Bank of Far Rockaway."

responsibility for the integrity of the payments system to the federal government, where it belonged.

3. The Challenge

Roosevelt's challenge was to figure out how to reopen the banks without triggering a resumption of the deposit withdrawals that led to the suspensions. His solution—the Bank Holiday—was a more extensive form of bank suspension that had last occurred in the United States in 1907 under the national banking system. Indeed, Congress had established the Federal Reserve System in 1913 precisely to prevent banks from suspending the convertibility of deposits into currency. Friedman and Schwartz (1963, p. 330) compare the Bank Holiday with earlier restrictions: "One would be hard put to . . . find a more dramatic example of how far the result of legislation can deviate from intention."

Why did the national banking system fail in 1933? Friedman and Schwartz (p. 330) acknowledge that, even with the benefit of hindsight, "the answer is by no means clear." However, a number of points are worth considering.[13] First, the weakened capital position of the commercial banks made them vulnerable to even minor drains.[14] Second, the public's demand for currency during February and March 1933 was exacerbated by a demand for gold.[15] Third, although the Federal Reserve Act provided for an elastic currency by allowing a Reserve Bank to discount eligible commercial paper and ship currency in the form of Federal Reserve Notes to a commercial bank, the Act also imposed a reserve requirement of 40 percent gold backing for Federal Reserve Notes outstanding. Finally, by March 3, 1933, the gold drain at the Federal Reserve Bank of New York reduced its gold reserve ratio to 24 percent. Meltzer (2003, p. 387) states that the Federal Reserve Board then suspended the gold reserve requirement, but quotes Federal Reserve Bank of New York Governor George Harrison, saying that "he would not take the responsibility of running [the] bank with deficient reserves" (p. 386). Perhaps Wicker (1996, p. 145) sums up the situation best: "[Using] the pre-1914 remedy of suspension of cash payments can be explained quite easily. Bold and courageous leadership was absent. Neither the Fed nor the RFC [Reconstruction Finance Corporation] was willing to accept lender of last resort responsibilities."

The absence of leadership created a vacuum filled with fear and uncertainty, making the reopening of banks a precarious undertaking. According to Acting Comptroller of the Currency Awalt, "No one knew how the public would react when the banks reopened. If they demanded their money they either had to have it or the reopening would be a failure."[16]

To prevent a resumption of bank withdrawals, the President appealed directly to the people on March 12, 1933, in his first Fireside Chat.[17] His opening words set the tone: "My friends, I want to talk for few minutes with the people of the United States about banking—with the comparatively few who understand the mechanics of banking, but more particularly with the overwhelming majority of you who use banks for the making of deposits and the drawing of checks. I want to tell you what has been done in the last few days, and why it was done, and what the next steps are going to be." In clear and simple terms, Roosevelt explained the procedure for reopening the banks and claimed that only sound banks would be reopened.

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The novelty of this event is captured by the description, the day after the talk, in the *Christian Science Monitor*: "He speaks to the nation over the radio in what is quite possibly the most remarkable address ever made by any President. In man-to-man fashion, in words of only one syllable, he uses the tones of a friend on the inside to assure a people . . . that the bank situation is sound. He recites the problems [and] explains the remedy: 'when people find they can get their money when they want it the phantom of fear will soon be laid [to rest]. . . . It was the government's job to straighten out this situation and the job is being performed.'"[18]

[13] See Meltzer (2003, pp. 381-9) and Friedman and Schwartz (1963, pp. 324-32).

[14] Friedman and Schwartz (1963, p. 330) emphasize that "The recorded capital figures were widely recognized as overstating the available capital because assets were being carried on the books at a value higher than their market value."

[15] According to Wigmore (1987, p. 744), weekly data show a $1.8 billion increase in currency in circulation and a gold drain of $563 million from the Federal Reserve System. Wigmore also provides daily data showing a larger gold outflow from the Federal Reserve Bank of New York during the first few days of March.

[16] Awalt (1969, p. 368).

[17] The text of the Fireside Chat, and the excerpts that follow, can be found in the *New York Times* (March 13, 1933, p. 1).

[18] March 13, 1933, p. 1.

Frederick Lewis Allen, the contemporary social historian, confirmed the power of the President's oratory (Allen 1939, p. 110): "Roosevelt's first Fireside Chat was perfectly attuned. Quiet, uncondescending [sic], clear, and confident, it was an incredibly skillful performance." However, Allen also emphasized that most people did not understand how the government could accomplish its objective: "The banks opened without any such renewed panic as had been feared. They might not have done so had the people realized that it was impossible, in a few days, to separate the sound banks from the unsound" (p. 110).

Allen suggests that most people did not care what the President said—only the way he said it. But the President's opening words identified two groups of people: the "comparatively few who understand the mechanics of banking . . . [and] the overwhelming majority." How did the President assure the more sophisticated public—and a skeptical press—who could blow the whistle if there was no substance to his promises?

Roosevelt, in fact, delivered a double-barreled message during his Fireside Chat—one for the general public and one for the financiers. To those who understood the mechanics of banking, he said, "Last Thursday [March 9] was the legislation promptly and patriotically passed by the Congress . . . [that] gave authority to develop a program of rehabilitation of our banking facilities. . . . The new law allows the twelve Federal Reserve Banks to issue additional currency on good assets and thus the banks that reopen will be able to meet every legitimate call. The new currency is being sent out by the Bureau of Engraving and Printing to every part of the country."

Roosevelt . . . delivered a double-barreled message during his Fireside Chat—one for the general public and one for the financiers.

The Emergency Banking Act, passed by Congress on March 9, 1933, gave the President the backing that he needed to ensure the safety of the reopened banks.[19] Without that legislation, the President's words could not have carried the day.

[19] The text of the Emergency Banking Act of 1933 appears in its entirety in the *New York Times* (March 10, 1933, p. 2).

4. The Emergency Banking Act of 1933

The key provision of the Emergency Banking Act, mentioned by Roosevelt, allowed the Federal Reserve Banks to issue emergency currency, similar to that issued in 1914 under the Aldrich-Vreeland Act. According to the *New York Times*: "To many of the President's closest advisors the Aldrich-Vreeland Act, repealed when the Federal Reserve Act came into effect, provides the model scheme for the projected expansion of currency through Federal Reserve Notes."[20] Titles I through IV of the Emergency Banking Act went much further, however, granting the President near dictatorial powers.

Title I of the Act approved the President's declaration of the Bank Holiday and allowed the President, during the period of emergency, to regulate all banking functions, including "any transactions in foreign exchange, transfers of credit between or payments by banking institutions as defined by the President, and export, hoarding, melting, or earmarking of gold or silver coin." Title II gave the Comptroller of the Currency the power to restrict the operations of a bank with impaired assets and to appoint a conservator, who "shall take possession of the books, records, and assets of every description of such bank, and take such action as may be necessary to conserve the assets of such bank pending further disposition of its business." Title III allowed the Secretary of the Treasury to determine whether a bank needed additional funds to operate and "with the approval of the President request the Reconstruction Finance Corporation to subscribe to the preferred stock in such association, State bank or trust company, or to make loans secured by such stock as collateral." Title IV provided for issuance by the Federal Reserve Banks of emergency currency, called Federal

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[20] March 9, 1933, p. 2. The emergency currency provision of the Aldrich-Vreeland Act, passed in May 1908 to prevent a replay of the Panic of 1907, had been scheduled to expire by legislative design on June 30, 1914. The Federal Reserve Act, passed in December 1913, extended the expiration date for one year, until June 30, 1915, to provide protection against panics while the Federal Reserve System was being organized. The extension allowed Treasury Secretary William McAdoo to invoke the Aldrich-Vreeland Act to prevent a panic in August 1914 at the outbreak of the Great War (see Silber [2007b]).

Reserve Bank Notes, backed either by "(A) any direct obligations of the United States or (B) any notes, drafts, bills of exchange, or bankers' acceptances, acquired under the provisions of this act." Federal Reserve Bank Notes would circulate alongside normal Federal Reserve Notes, even though they were not backed by gold, because the Act provided that the new notes "shall be receivable at par in all parts of the United States . . . and shall be redeemable in lawful money of the United States on presentation at the United States Treasury."

Title I of the Emergency Banking Act conferred on the President considerable power to deal with the crisis. The Administration did not shy away from using that power. In his Fireside Chat on Sunday night, March 12, Roosevelt ordered banks to be opened sequentially: "First in the Twelve Reserve Bank cities—those banks which on first examination by the Treasury have been already found to be all right . . . followed on Tuesday . . . by banks already found to be sound in cities where there are recognized clearing houses . . . [and] on Wednesday and succeeding days, banks in smaller places . . . subject, of course to the government's physical ability to complete its survey."[21] The Treasury issued emergency regulations designed to prevent runs on the reopened banks, including: "No banking institution shall permit any withdrawal by any person when such institution, acting in good faith, shall deem that the withdrawal is intended for hoarding."[22]

Roosevelt recognized that the restoration of confidence was the most important ingredient for a successful reopening: "Confidence and courage are the essentials of success in carrying out our plan."[23] Friedman and Schwartz (1963, p. 440) confirm the role of confidence: "Panics arose out of or were greatly intensified by a loss of confidence in the ability of banks to convert deposits into currency." However, Roosevelt did not inspire great confidence when he said the first banks to be reopened were those that "on first examination by the Treasury have been already found to be all right." Nor did regulations against hoarding assure people that the banks were sound; if anything, the reverse was more likely. The key to creating confidence in the reopened banks rested with Titles III and IV of the Emergency Banking Act.

Title IV gave the Federal Reserve the flexibility to issue emergency currency—Federal Reserve Bank Notes—backed by any assets of a commercial bank. The contemporary press recognized the power of the emergency currency provision: "The new currency feature of the law is one of the most important of the many extraordinary powers given to this administration . . . which stem from the Aldrich-Vreeland Act . . . invoked in 1914 for the issuance of about $386,000,000 in emergency currency."[24] The link to Aldrich-Vreeland currency, which succeeded in defusing the financial crisis at the outbreak of World War I, conferred credibility on the power of Title IV of the Emergency Banking Act of 1933.[25] The *Wall Street Journal* wrote: "Banks which are believed to be 100% sound would be reopened as soon as their condition could be checked. . . . All banks so reopened, it was pointed out, could under Title 4 and under machinery already in existence obtain the cash resources necessary from the Federal Reserve banks."[26]

Title IV of the Emergency Banking Act promised more than just the availability of cash to reopened banks. It also created the expectation that the government would guarantee all depositors against loss, without limit. As the *New York Times* reported: "Some bankers who were here today . . . interpreted the emergency banking act as a measure under which the government practically guarantees, not officially but morally, the deposits in the banks which it permits to reopen. This point of view was based on the fact that banks permitted to open are characterized as 100 per cent sound and assured of sufficient currency to meet *all obligations*" [italics added].[27]

Roosevelt recognized that the restoration of confidence was the most important ingredient for a successful reopening [of banks].

Title III of the Emergency Banking Act added to the public's perception of a guarantee, according to the *New York Times*: "The privilege to be extended to banks to issue preferred stock to be taken over by the Reconstruction Finance Corporation when they are in need of funds for capital purposes or reorganization, is also pointed to as another feature of the governmental program which fits in with the theory that a virtual guarantee is extended to depositors."[28] Two days earlier, a *New York Times* headline had announced: "Deposit Guarantee Seen in Bank Law," and the newspaper attributed the view to "an interpretation of the measure . . . by some officials in one of the government departments it concerns."[29]

The availability of capital funds through the Reconstruction Finance Corporation would certainly help a bank's balance

[21] *New York Times*, March 13, 1933, p. 1 cont.
[22] *New York Times*, March 13, 1933, p. 2.
[23] *New York Times*, March 13, 1933, p. 1 cont.
[24] *New York Times*, March 10, 1933, p. 3.
[25] See Silber (2007a) for a discussion of the 1914 financial crisis.
[26] March 10, 1933, p. 1 cont.
[27] March 13, 1933, p. 1 cont.
[28] March 13, 1933.
[29] March 11, 1933, p. 2.

sheet, but only the Federal Reserve could provide unlimited currency to banks to meet a run on deposits. Acting Comptroller of the Currency Awalt confirmed the implicit guarantee many years later, but also hinted at concern over Federal Reserve support: "It was felt that the various Federal Reserve Banks must back the reopened banks to the hilt, and that it was no time for any conservative head of a Federal Reserve Bank to exercise his conservatism, should demand be made for currency. We reasoned, therefore, that if the Federal Reserve agreed to a reopening of a particular bank, it would necessarily be forced to back it *one hundred percent*" [italics added].[30]

How could a conservative Federal Reserve throttle the guarantee? A bank in need of cash could get the new Federal Reserve Bank Notes, according to Title IV of the Emergency Banking Act, by discounting with its regional Federal Reserve Bank "(A) any direct obligations of the United States or (B) any notes, drafts, bills of exchange, or bankers' acceptances, acquired under the provisions of this act." However, an individual Federal Reserve Bank could refuse to accept a bank's assets as collateral if the assets were considered too risky. Central bankers are always concerned with credit risk. The Federal Reserve Banks may have been especially sensitive because they are private corporations owned by the commercial banks that are members of the System. In a discussion titled "Tragic Interlude in March, 1933," Emanuel A. Goldenweiser, Director of Research and Statistics at the Federal Reserve Board from 1926 through 1945, wrote: "The Federal Reserve Banks and their management were still under the spell of commercial banking practice and theory and were dominated by the concept of liquidity as protection to a bank. They were also concerned about protecting the liquidity and solvency of the Federal Reserve Banks themselves as custodians of the country's ultimate reserves."[31]

An agreement to indemnify the Federal Reserve Banks against losses ensured their cooperation in lending freely to banks in need of cash.

An agreement to indemnify the Federal Reserve Banks against losses ensured their cooperation in lending freely to banks in need of cash. The promise to protect the Reserve Banks came in the form of a telegram, dated March 11, 1933, from Roosevelt's Treasury Secretary, William Woodin, to Governor George Harrison of the Federal Reserve Bank of New York, quoting President Roosevelt: "It is inevitable that some losses may be made by the Federal Reserve banks in loans to their member banks. The country appreciates, however, that the 12 regional Federal Reserve Banks are operating entirely under Federal Law and the recent Emergency Bank Act greatly enlarges their powers to adapt their facilities to a national emergency. Therefore, there is definitely an obligation on the federal government to reimburse the 12 regional Federal Reserve Banks for losses which they may make on loans made under these emergency powers. I do not hesitate to assure you that I shall ask the Congress to indemnify any of the 12 Federal Reserve banks for such losses. I am confident that Congress will recognize its obligation to these Federal Banks should the occasion arise, and grant such request."[32] Roosevelt clearly went out on a limb to ensure the Federal Reserve's cooperation.

The key question is: When the banks reopened, did the public behave as though it believed in the newly guaranteed safety of the banking system?

Congress understood the role of emergency currency in guaranteeing bank deposits. As the *New York Time*s observed: "the framing and adoption of the emergency banking law . . . went far to offset demands in Congress for a separate guarantee bill."[33] Of course, the public did not know the details of the Federal Reserve's reluctance to lend, nor did it know of Roosevelt's indemnification scheme.[34] Most Americans, in fact, did not read the *New York Times*, so they were unaware of the publicity accorded the implicit guarantee.

[30] Awalt (1969, p. 368).

[31] Goldenweiser (1951, p. 165).

[32] Federal Reserve Bank of New York Archives, Central Files Unit, 017.1. The Honorable Ogden Mills, outgoing Treasury secretary, was invited to the Board of Directors meeting of the Federal Reserve Bank of New York to read the telegram and to brief the Directors on "recent discussions of the problems involved in reopening the banks of the country which have taken place in Washington, D.C." (Minutes, March 11, 1933, p. 179, Federal Reserve Bank of New York Archives). William Woodin, incoming Treasury secretary, had asked Mills to stay on and help draft the Emergency Banking Act. Also see Alter (2006) and Meltzer (2003) for discussions of the role that Mills played.

[33] March 13, 1933, p. 1 cont.

[34] The Directors of the Federal Reserve Bank of New York were sufficiently worried about the riskiness of loans to reopened banks that they transmitted the following resolution to the Treasury secretary: "Pending the legal assumption of the responsibility of the government [to indemnify the Reserve Banks] . . . we believe that banks should be licensed to reopen only with our approval, as the principal burden of taking care of such banks as are reopened will be ours" (Minutes, March 12, 1933, p. 189, Federal Reserve Bank of New York Archives).

Perhaps the articles in the *New York Times* reflected the strategy outlined by Raymond Moley, a member of Roosevelt's brain trust. Moley had worked with Treasury Secretary William Woodin to formulate the Emergency Banking Act and had helped draft the March 12 Fireside Chat. He stated: "Those who conceived and executed . . . the policies which vanquished the bank crisis . . . were intent upon rallying the confidence, first, of the conservative business and banking leaders of the country and then, through them, of the public generally" (Moley 1939, p. 155).

Indicative evidence of the strategy described by Moley comes from comparing the Minutes of the Board of Directors of the Federal Reserve Bank of New York with comments in the *New York Times*. On March 10, 1933, the following entry appeared in the Minutes: "Under this law, enacted as a part of the program for reopening the banks, the Federal Reserve Banks become in effect guarantors of the deposits of the reopened banks. While they are not legally bound there is a large *moral responsibility*" [italics added].[35] Two days later, the *New York Times* echoed precisely that sentiment: "Some bankers who were here today . . . interpreted the emergency banking act as a measure under which the government practically guarantees, not officially but *morally*, the deposits in the banks which it permits to re-open" [italics added].[36] There is no evidence of a purposeful leak, but Treasury Secretary William Woodin had been a member of the Board of Directors of the Federal Reserve Bank of New York until March 3, 1933, and could have easily arranged a discreet disclosure.[37]

In sum, the contemporary commentary suggests that Roosevelt's rhetoric in his first Fireside Chat gave the public confidence in the opened banks. Business and banking leaders—and the press—could rely on the Emergency Banking Act to deliver on the government's moral obligation to guarantee all deposits. The key question is: When the banks reopened, did the public behave as though it believed in the newly guaranteed safety of the banking system?

5. The Evidence

On the very first day that the banks reopened, the press described depositors anxious to redeposit their cash. A front page headline in the *Chicago Tribune* read: "City Recovers Confidence as 34 Banks Open."[38] The front page of the *New York Times* carried similar news: "Rush to Put Money Back Shows Restored Faith as Holiday Ends."[39] The *Times* article explained: "The public plainly showed that it recovered from the fear and hysteria which characterized the last few days before the banking holiday was proclaimed. It was obvious that the people had full confidence in the banks which received licenses to reopen from the Federal Reserve Bank . . . there was a general 'run' yesterday [March 13] to deposit or redeposit money. . . . Conditions in New York were duplicated in each of the other Federal Reserve cities throughout the country where full banking facilities were restored."[40] The process continued the following day, according to the *Times*: "With the reopening of the banks in clearing house centers . . . currency poured in from private hoards and from the tills of business houses to be deposited in the banks."[41]

On the very first day that the banks reopened, the press described depositors anxious to redeposit their cash.

The success of the reopening had the somewhat anomalous result of making the emergency currency appear redundant. On March 15, a *Times* headline announced: "New Currency Put at $2,000,000,000: Bureau made first Delivery of Money 24 Hours after Receiving Order."[42] The newspaper then concluded: "If this movement [of returning currency] keeps up, bankers remarked, only a comparatively small amount of the new Federal Reserve Bank Notes will be needed to supplement the existing supplies of regular currency." The public's behavior supports the old banker adage: "When they know they can get their money, they are not so eager to have it."[43]

The data on currency in circulation in Table 1 support the descriptive comments in the press. Currency held by the public had increased by $1.78 billion in the four weeks ending March 8, 1933. The public returned two-thirds of the increase—$1.18 billion—by the end of the month.[44] This remarkable turnaround is all the more impressive considering that when the government's initial licensing program ended on

[35] Minutes, March 11, 1933, p. 172, Federal Reserve Bank of New York Archives.

[36] March 13, 1933, p. 1 cont.

[37] This tactic is consistent with the approach of the new Administration. Alter (2006, pp. 179-81) confirms Roosevelt's Machiavellian side by documenting his failure to cooperate with Hoover in the month before the election. He suggests that "It is hard to avoid the conclusion that [Roosevelt] intentionally allowed the economy to sink lower so that he could enter the presidency in a more dramatic fashion."

[38] March 14, 1933.

[39] March 14, 1933.

[40] March 14, 1933.

[41] March 15, 1933, p. 5.

[42] March 15, 1933, p. 5.

[43] The quote comes from the *Wall Street Journal* (September 15, 1914, p. 5). It refers to British investors not liquidating their American investments as the crisis of 1914 came under control. See Silber (2007a, p. 128).

Table 2
Significance Tests for Stock Returns: March 3-15, 1933

	Dow Jones Industrial Average	S&P 500 Index	CRSP Equally Weighted Index	CRSP Value-Weighted Index
Return over Bank Holiday (percent)	14.27	15.37	18.48	14.41
Post-election standard deviation of returns (percent)	2.48	2.45	1.81	1.94
t-statistic (with eight trading days)	2.03	2.22	—	—
t-statistic (with ten trading days)	—	—	3.23	2.35

Source: University of Chicago, Booth School of Business, Center for Research in Security Prices (CRSP).

Note: All data are continuously compounded.

April 12, 1933, a total of 4,215 banks, with deposits of nearly $4 billion, remained closed (Wicker 1996, pp. 146-7).[45]

The stock market provides a second assessment of the events from March 3, 1933 (the last trading day before the Bank Holiday), to March 15, 1933 (the day the New York Stock Exchange resumed trading). The Dow Jones Industrial Average increased by a record 15.34 percent on March 15, 1933—the largest one-day percentage price increase ever recorded, according to Siegel (1998, p. 183). However, Siegel omits this day from his ranking of largest daily stock price increases, presumably because trading had been suspended for almost two calendar weeks. Recall that Temin and Wigmore (1990, p. 488) dismiss entirely the March 15 price increase, maintaining that the market was quiet and little changed.

Is the 15.34 percent jump in the Dow Jones Industrial Average significant after accounting for the trading suspension? A simple *t*-test on the continuously compounded return of 14.27 percent on March 15, 1933, can determine whether this increase is statistically significant. The relevant daily standard deviation of returns is 2.48 percent.[46] Allowing for eight regular trading days between March 3, 1933, and March 15, 1933, the *t*-statistic has a value of 2.03, which is significant at conventional levels.[47] Table 2 presents the same set of statistics for three other stock market indexes: the S&P 500 Index (which consisted of ninety stocks at that time); the Chicago Booth Center for Research in Security Prices (CRSP) equally weighted index; and the CRSP value-weighted index. The *t*-statistics for the Bank Holiday returns using the CRSP indexes allow for ten trading days between the two dates because, unlike the Dow Jones Industrial Average and the S&P 500 Index, the CRSP data include abbreviated Saturday sessions.[48] All of the *t*-statistics are significant.

Stock prices fluctuate for many reasons—and sometimes for no reason at all—but the magnitude of the favorable response on March 15, 1933, implies that the successful reopening of the banking system cannot be ignored. The contemporary press confirms the connection. The day after the market reopened, the *New York Times* observed: "The robust advance in stocks and bonds was interpreted—and correctly so—as Wall Street's mark of approval of the steps taken by the President and Congress in the interval to end the financial disorder."[49] The *Wall Street Journal* added: "The emergency banking act lifted

[44] The weekly data are not seasonally adjusted, but the monthly seasonal adjustments for March are minimal (see footnote 8). Moreover, the changes in currency in circulation for the corresponding weeks in each of the three previous years are small and show no pattern. In 1932, currency in circulation declined from $5.26 billion in the second week of March to $5.15 billion in the last week of March; in 1931, it grew from $4.27 billion to $4.33 billion; in 1930, it rose from $4.21 billion to $4.23 billion (source: *Banking and Monetary Statistics*, pp. 384-7, Board of Governors of the Federal Reserve System, 1943).

[45] The history of bank suspensions provides some perspective. Over the 1930-32 period, bank suspensions averaged 1,699 per year; from 1934 through 1940, they averaged 45 per year (source: *Banking and Monetary Statistics,* Table 66, Board of Governors of the Federal Reserve System, 1943).

[46] To measure the normal variability of returns during this period, we first calculate the daily standard deviation of returns (continuously compounded) on the Dow Jones Industrial Average from January 4, 1932, through March 3, 1933. We then split the sample on November 8, 1932, the date of Roosevelt's election, and perform an *F*-test to determine whether the pre-election (January 4, 1932, through November 7, 1932) daily standard deviation of 3.45 percent equals the post-election (November 9, 1932, through March 3, 1933) daily standard deviation of 2.48 percent. The *F*-statistic equals 2.03, with 213 and 77 degrees of freedom, implying a *p*-value of .001. Thus, we reject the hypothesis of equality for the pre- and post-election standard deviation of returns. Daily data on the Dow Jones Industrial Average (and the estimate of the daily standard deviation) did not include the abbreviated Saturday trading sessions.

[47] The eight trading days between March 3 and March 15 exclude Saturdays. Recognition that variance over nontrading days is lower than variance over trading days (see French and Roll [1986] and Lockwood and Linn [1990]) would increase the *t*-statistic.

[48] The reduced daily standard deviations for the CRSP indexes compared with the S&P 500 Index and the Dow Jones Industrial Average are due, in part, to the lower standard deviation of returns on the abbreviated Saturday sessions compared with the rest of the week.

[49] March 16, 1933, p. 25.

from security and commodity markets an enormous weight of potential liquidation."[50] And the *Chicago Tribune* waxed eloquent in its assessment: "The zooming upward of prices on the reopened stock markets today is regarded as barometrical indication of the economic weather test that is settling in. . . . The courage, determination, and resourcefulness of the new President have apparently taken the country by storm. The reopening of the banks with deposits everywhere exceeding withdrawals crowned with success the first action taken by the administration."[51]

6. Conclusion

A number of forces contributed to the success of the Bank Holiday declared by Franklin Delano Roosevelt in 1933. The President placed the responsibility for safeguarding the integrity of the payments system with the federal government. Congress passed the Emergency Banking Act of 1933, giving the President the power to restore confidence in the banking system by establishing 100 percent guarantees for bank deposits. And Roosevelt did not hesitate to use that power to end the banking crisis.

We can draw three main conclusions from this event. First, management of the banking crisis required bold and decisive action. Second, rhetoric alone did not solve the crisis; a substantive component was required to restore the banking system to normal operations. Finally, the speed with which the Bank Holiday and the Emergency Banking Act reestablished the integrity of the payments system demonstrates the power of credible regime-shifting policies.

[50] March 16, 1933, p. 6.

[51] March 16, 1933, p. 1. The press cited a second factor buoying stock prices: favorable Congressional legislation giving Roosevelt the power to reduce veterans' benefits and federal salaries. According to the *Chicago Tribune* (March 16, 1933, p. 1): "What the country is witnessing is a president doing swiftly and certainly what the overwhelming majority of the people demanded. . . . No sooner had he ended the bank panic than Mr. Roosevelt began pushing through Congress the bill for a 500 million dollar reduction in the cost of the federal government and the bill to legalize and tax beer."

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Andrew F. Haughwout and Ebiere Okah

Below the Line: Estimates of Negative Equity among Nonprime Mortgage Borrowers

- Evidence from the current downturn suggests that declines in borrower equity are fundamental contributors to the rise in delinquencies and defaults on nonprime mortgage loans.
- Measures of housing units with negative equity—in which the mortgage balance exceeds the value of the collateral property—have become a key component in crafting policies to address the foreclosure crisis.
- An analysis of the prevalence and magnitude of negative equity in the U.S. nonprime mortgage market finds that negative equity is closely associated with the time and place of mortgage origination and with the existence of subordinate liens against the property.
- Borrowers in negative equity are twice as likely as those in positive equity to be seriously delinquent, or in default, on their first-lien mortgage.

1. Introduction

The boom in nonprime mortgage lending that occurred in the United States between 2004 and 2006 was quickly followed by rapid increases in the rate of delinquencies and foreclosures on these loans.[1] This pronounced deterioration alarmed investors, the public, and policymakers.[2] Significantly, uncertainty about the source of the decline in loan quality has played a key role in the credit crunch that began in mid-2007.

Nonprime loan originations rose sharply after 2003 (Chart 1), and these loans became delinquent far more quickly than had earlier vintages. Indeed, loans originated in 2004 performed poorly compared with earlier vintages, and the 2005 and 2006 vintages became seriously delinquent within a year of origination at rates that the 2003 vintage took twenty and thirty months to reach, respectively.[3]

[1] In this article, the nonprime market consists of subprime and alt-A loans. Compared with prime mortgage loans, subprime mortgages are typically of smaller value and made to borrowers with some blemish on their credit history. Alt-A, or "near-prime," mortgages are typically larger value loans made to borrowers who, for a variety of reasons, may not choose to provide the documentation of income or assets typically required to obtain a prime mortgage.

[2] As reported, for example, at CNNMoney.com (<http://money.cnn.com/2007/11/04/news/companies/citigroup_prince/index.htm>) and BBC News (<http://news.bbc.co.uk/2/hi/business/7070935.stm>). See also Bernanke (2008).

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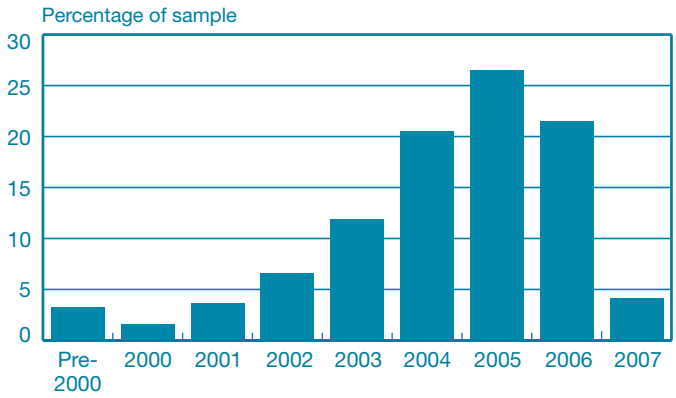
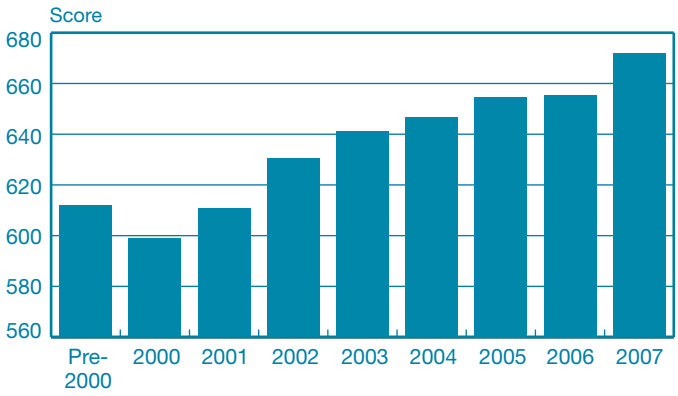
Chart 1
Nonprime Loan Originations by Year



Source: FirstAmerican CoreLogic, LoanPerformance data.

Chart 2
Mean FICO Score by Vintage



Source: FirstAmerican CoreLogic, LoanPerformance data.

The mortgage industry's standard view of default risk has historically focused on four underwriting characteristics at mortgage origination: borrower credit rating, loan-to-value (LTV) ratio, debt-to-income (DTI) ratio, and the extent of third-party income and asset verification. However, changes in these characteristics alone seemed insufficient to explain the severe and rapid erosion in the status of nonprime loans (Demyanyk and van Hemert 2008; Haughwout, Peach, and Tracy 2008). While some underwriting criteria deteriorated as the nonprime market share expanded, others changed little or even improved. For example, mean credit bureau (FICO) scores of nonprime borrowers increased steadily after 2001 (Chart 2), largely as a result of a shift in the composition of the nonprime pool to alt-A loans.

In light of these mixed developments, some analysts turned to the economy to explain the poor mortgage performance. However, because economic growth between 2005 and 2007 was fairly steady—real GDP expanded 3.1, 2.9, and 2.2 percent, respectively, in those three years while the unemployment rate fell below 5 percent—sharp income declines seemed to be an unlikely source of the widespread increases in nonprime delinquencies and foreclosures.

To be sure, aggregate statistics may mask changes in individual circumstances. When a borrower experiences a deterioration in personal finances, the borrower's amount of home equity largely influences his or her course of action. One underlying economic factor that did deteriorate concurrently with mortgage performance was house price appreciation. After peaking at an annual growth rate of 12.1 percent in the second quarter of 2005, the Office of Federal Housing Enterprise Oversight's (OFHEO) national house price index began to slow, and ultimately declined. By the fourth quarter of 2008, the annual growth rate of the index was -4.5 percent (Chart 3), and the reversal was even sharper in certain areas of the country.

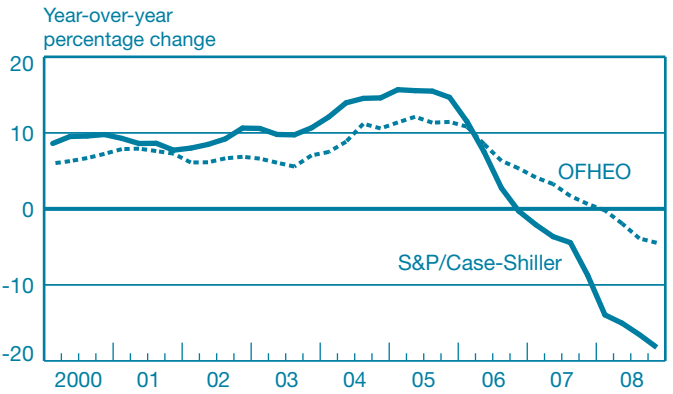
Observers in the popular media and in the research community quickly pointed to the confluence of house price declines and mortgage defaults as more than coincidence (Gerardi, Shapiro, and Willen 2007; Haughwout, Peach, and Tracy 2008; Demyanyk and van Hemert 2008). Indeed, a large body of research on mortgage defaults indicates that declines in house prices—or, more precisely, reductions in borrower equity—are fundamental contributors to default (see, for example, Vandell [1995] and Elul [2006]); evidence from the current downturn, although limited, confirms this hypothesis (see, for example, Foote, Gerardi, and Willen [2008]).[4]

Measures of housing units with negative *equity . . . have become a* necessary *component in crafting policies to address the current foreclosure crisis.*

For this reason, measures of housing units with *negative* equity—that is, homes whose mortgage balance exceeds the value of the collateral housing unit—have become a necessary component in crafting policies to address the current foreclosure crisis. In this article, we estimate negative equity in

[3] These figures include loans that are at least ninety days delinquent, are in foreclosure, or are Real-Estate-Owned (REO)—that is, ownership of the collateral has been transferred to the lender.

Chart 3
Home Price Indexes
Comparison of OFHEO and S&P/Case-Shiller



Sources: Office of Federal Housing Enterprise Oversight (OFHEO); Standard and Poor's.

the U.S. nonprime mortgage market for 2008-09, and beyond, with the goal of describing the sources of the problem and the characteristics of borrowers in a negative equity position. Our results suggest that the prevalence and magnitude of negative equity are closely associated with the time and place of mortgage origination and with the existence of subordinate liens against the property. In addition, borrowers in negative equity are much more likely to be seriously delinquent, or in default, on their first-lien mortgage than borrowers in positive equity.

Our study is organized as follows. Section 2 describes our sample of mortgage data and our methods as well as discusses how changes in mortgage underwriting and house price dynamics can affect borrower equity. In Section 3, we present estimates of negative equity mortgages as well as examine the static relationship between negative equity and mortgage default. In Section 4, we discuss our results and use information from other studies and from housing price futures contracts to examine the relationship between borrower equity and house price dynamics. Section 5 summarizes our key findings.

[4] We define equity as the book equity of a loan, where the mortgage balance is subtracted from the home's value. This definition is not to be confused with the difference between mortgage value and home value. Because the market value of the mortgage will neither be larger than its balance (since the loan is discounted for risk) nor greater than the underlying asset of the home, it is possible to have both positive equity and negative book equity. While market equity is an important concept, we focus on the difference between the balance on the mortgage and the value of the house; thus, we refer to book equity simply as "equity."

2. Data and Methods

We combine information from several sources to obtain our estimates of negative equity nonprime mortgages in the United States. Our primary source of information on individual loans is FirstAmerican CoreLogic's LoanPerformance data set. As of February 2009, the data set provided monthly loan-level information on approximately 4.8 million active, securitized subprime and alt-A loans with total balances of more than $1 trillion. While LoanPerformance captures more than 90 percent of securitized nonprime loans after 1999 and nearly 100 percent of the crucial 2003-05 vintages, it excludes all loans held in bank portfolios (Mayer and Pence 2008). Pennington-Cross (2002) argues that securitized subprime mortgages differ systematically from those retained in portfolios; loans held in bank portfolios may look substantially different. Because our data are limited to securitized loans, any inferences should be limited to this set of loans.

We rely on two sources of house price growth to estimate negative equity: the widely used [Office of Federal Housing Enterprise Oversight] house price index and the S&P/Case-Shiller home price index.

The LoanPerformance data set offers a rich source of information on the characteristics of securitized nonprime loans, such as the date of loan origination, the Zip code in which the collateral property is located, details of the mortgage contract, and underwriting information. Also included are monthly updates of dynamic information such as current interest rates, mortgage balances, and the borrower's payment record.

We analyze a 1 percent random sample of the first-lien subprime and alt-A loans reported in the data set as of December 1, 2008.[5] Our data include more than 49,000 active, or not yet repaid, loans. We combine the loan-level data with aggregate data on house price dynamics for each metropolitan statistical area (MSA) in the sample. Because our data set is a sample, it is subject to sampling variation, but for ease of exposition we report only point estimates, not standard errors.

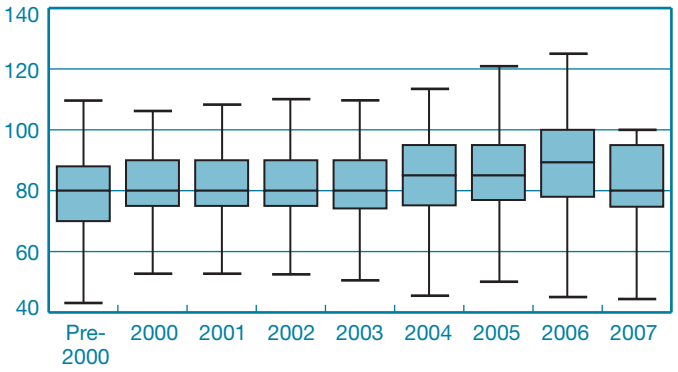
[5] Because observations in the LoanPerformance data set are loans coded to Zip code, we choose our data set from the universe of first-lien loans only. This approach avoids the possibility of double counting subordinate-lien loans on the same property. While the LoanPerformance data set also includes information on nonprime subordinate liens, it is impossible to match these loans to the first liens. Nonetheless, as we discuss, we do observe the balance on subordinate liens at origination of the first lien.

We rely on two sources of house price growth to estimate negative equity: the widely used OFHEO house price index and the S&P/Case-Shiller home price index.[6] Although both indexes are based on repeat transactions on the same property over time, they differ in important ways. OFHEO, which provides separate indexes for 381 MSAs, enables us to estimate house price changes for the great majority of properties in our loan-level data set. However, the OFHEO index is based on the sale price or appraisal value of homes with prime, conforming mortgages, that is, those securitized by government-sponsored enterprises.[7] Because the properties we study are by definition financed with a nonprime mortgage, OFHEO's focus on these government-sponsored mortgages introduces the possibility of measurement error in our estimate of house price appreciation, with the sign and magnitude of the error depending on how appreciation varies across market segments.

An interesting feature revealed by the data is that while first-lien loans remained at relatively stable [loan-to-value ratios] throughout the 2000-08 period, subordinate liens became more common and rose in value as a percentage of house value.

The S&P/Case-Shiller index addresses this problem in two ways. First, it covers all sales, not just those in the prime market segment. Second, it provides supplementary indexes for three tiers in each of the markets it covers. The tiers divide each market into thirds—low, middle, and high—based on area house prices as of December 2008. For example, Los Angeles MSA properties with prices under $309,184 are in the low tier, prices between $309,184 and $470,182 make up the middle tier, and prices above $470,182 are considered high tier. Inspection of the house price dynamics in these tiers indicates that they indeed differ from the composite measure, suggesting that, for our purposes, measurement error using the OFHEO index is likely nontrivial. This suspicion is confirmed by Leventis (2008), who finds that differences between the two indexes are influenced importantly by the treatment of lower priced houses. Using the S&P/Case-Shiller price parameters as a guide, we determined that its middle- and high-tier indexes best estimate house prices for subprime and alt-A loans, respectively.[8]

Chart 4
Combined Loan-to-Value Ratios by Vintage



Sources: FirstAmerican CoreLogic, LoanPerformance data; authors' calculations.

Notes: For each year, the shaded box indicates the middle 50 percent of the data. Thus, the top of each box represents the 75th percentile value and the bottom the 25th. The line intersecting each box shows the median value. The thin lines extending from the boxes represent the upper and lower adjacent ranges, which extend at most 1.5 times the interquartile range in both directions.

To estimate equity in properties, we perform a series of basic calculations. First, we use data from LoanPerformance to calculate the borrower's net equity in the property at the origination of each first-lien loan. This measure captures both the balance of the first lien as well as the balances of all subordinate liens, if any exist. An interesting feature revealed by the data is that while first-lien loans remained at relatively stable LTVs throughout the 2000-08 period, subordinate liens became more common and rose in value as a percentage of house value. Chart 4 plots combined (all liens) LTV ratios by vintage. It shows that until 2003, LTVs were fairly steady, with a median of 80; after 2003, however, the median LTV began climbing. By 2006, the median origination LTV of nonprime loans was 89.3, and fully 25 percent of the loans had an LTV of at least 100. That is, a quarter of borrowers who took nonprime mortgages in 2006 had no equity at origination.

We calculate origination equity, which is house value of the first-lien loan (HV_0) minus total balances on all L liens $\sum_{l=1}^{L} M_0^l$ at origination. Equity at time t is then simply initial

[6] For more details, see <http://www.fhfa.gov/Default.aspx?Page=14> and <http://www2.standardandpoors.com/spf/pdf/index/SP_CS_Home_Price_Indices_Factsheet.pdf>. In July 2008, OFHEO became the Federal Housing Finance Agency, but we continue to refer to the index as the OFHEO index.

[7] Concerns have been raised that appraisals during the "boom" years of nonprime lending were biased upward. OFHEO does publish a national "purchase-only" index that incorporates data only from actual sales, but this index is not available for individual MSAs.

[8] In each S&P/Case-Shiller MSA, the mean price of a home collateralizing a subprime mortgage was in the middle tier, while alt-A home prices were in the high tier.

equity plus any house price appreciation, minus any increase in mortgage balances after origination:

$$E_t = \left[HV_0 - \sum_{l=1}^{L} M_0^l \right] + \left[\Delta HV_t - \sum_{l=1}^{L} \Delta M_0^l \right].$$

Net equity can change in three distinct ways:

- principal amount on the first-lien mortgage changes $\Delta M_t^1 \neq 0$ (typically, mortgage balances will decline over time, meaning that $\Delta M_t^1 < 0$),
- principal amount(s) on subordinate liens changes $\sum_{l=2}^{L} \Delta M_0^l \neq 0$,
- house value changes $\Delta HV_t \neq 0$.

We have direct, micro-level evidence on only the first component, because LoanPerformance tracks monthly balances on each first-lien loan we observe. We use each MSA's OFHEO and S&P/Case-Shiller indexes to estimate changes in house values since loan origination. For balances on subordinate liens, we assume that the borrower makes regular interest payments, but that principal amounts remain unchanged. Note that this is somewhat of a "middle-ground" assumption: borrowers may either make progress reducing the balances on subordinate liens ($\sum_{l=2}^{L} \Delta M_t^l < 0$) or they may layer additional liens on top of those we observe ($\sum_{l=2}^{L} \Delta M_t^l > 0$).

3. Negative Equity among Nonprime Borrowers

Two developments important for understanding homeowner equity occurred after 2002. First, full loan-to-value ratios rose sharply as junior liens became more common and larger. This change is present throughout the post-2002 period, but it is especially significant in 2006—when more than 25 percent of nonprime originations had initial LTV ratios of 100 or more (Chart 4).

Second, starting in 2005, the house price environment, whether measured by the OFHEO or the S&P/Case-Shiller index, became much less favorable for building borrower equity (Chart 3). This reversal was especially sharp in some areas that had experienced the highest growth prior to 2005. The Las Vegas MSA, for instance, saw its house price growth rate, measured by the S&P/Case-Shiller index, decline from more than 42 percent in 2003 to -15 percent in 2007. Parts of the Midwest experienced a similar phenomenon, but it resulted from a different set of dynamics. In Cleveland, for example, the S&P/Case-Shiller index declined just 1.7 percent in 2007. However, the decline followed a long period of relatively sluggish growth: the city's peak growth year was 2003, when prices rose just 5.4 percent.[9]

Table 1
OFHEO-Based Negative Equity Estimates
December 1, 2008

	Number of Loans	Negative Equity (Percent)
First lien	10,144	21
All liens	13,766	29
Total loans	47,876	100

Source: FirstAmerican CoreLogic, LoanPerformance data.

Note: House value changes are estimated using the Office of Federal Housing Enterprise Oversight (OFHEO) indexes for individual metropolitan statistical areas.

The combination of a falling housing market and a large number of homeowners holding little or no equity at mortgage origination created a perfect storm for generating negative equity. Note that for a mortgage with an apparently safe origination LTV ratio of around 80, a 20 percent decline in house value—not uncommon in many metro areas in 2007—could potentially erase essentially all of the homeowner's equity. One should not be surprised, therefore, to find that the incidence of negative equity grew substantially in 2006 and 2007. What we now consider is exactly how large and how common nonprime negative equity mortgages have become, where they are concentrated, and their consequences for borrower behavior.

The combination of a falling housing market and a large number of homeowners holding little or no equity at mortgage origination created a perfect storm for generating negative equity.

Our December 1, 2008, OFHEO-based estimates indicate that 21 percent of borrowers were in negative equity on their first lien while 29 percent were in negative equity when junior liens were included (Table 1). By comparison, the percentage of nonprime borrowers facing negative equity was 3 percent and 13 percent in April 2008, calculated using first and combined liens, respectively. At that time, borrowers

[9] Growth rates in this discussion are measured as December-over-December percentage growth.

Table 2
Comparison of S&P/Case-Shiller and OFHEO Indexes
December 1, 2008

	Number of Loans	Negative Equity (Percent)
S&P/Case-Shiller negative equity estimates[a]		
First lien	7,150	34
All liens	9,989	47
Total loans	21,164	100
OFHEO negative equity estimates[b]		
First lien	4,945	23
All liens	7,367	35
Total loans	21,164	100

Source: FirstAmerican CoreLogic, LoanPerformance data.

[a]House value changes are estimated using the S&P/Case-Shiller high- and medium-tier indexes for individual metropolitan statistical areas.
[b]House value changes are estimated using the Office of Federal Housing Enterprise Oversight (OFHEO) indexes for individual metropolitan statistical areas.

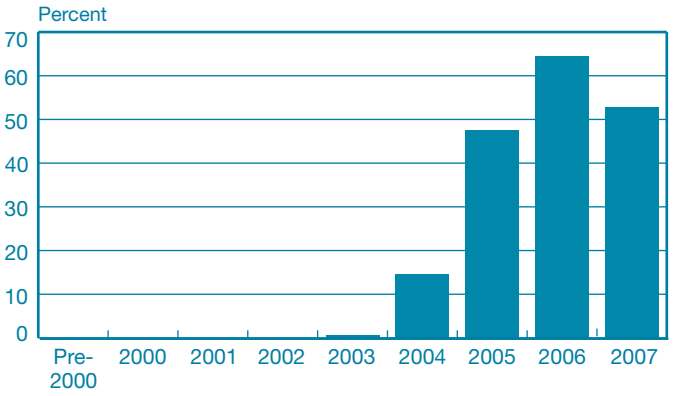
with junior liens were more than four times as likely to be in negative equity, an incidence that demonstrates the importance of second liens in determining negative equity. However, home prices have dropped markedly since then, placing many more borrowers in negative equity—even those who had made a sizable down-payment or had just a single lien on their property.

Limiting our analysis to the seventeen cities covered by the S&P/Case-Shiller tiered indexes paints a bleaker picture (Table 2). Using this measure of house price changes, we estimate that 47 percent of housing units with nonprime mortgages—nearly 1 million households in these seventeen cities alone—are in a negative equity position. However, application of the OFHEO index to this restricted set of cities produces a lower estimate of 35 percent, or 736,700 mortgages, in negative equity.[10]

This disparity highlights the difference in market segments tracked by both indexes. While neither measure exactly captures the nonprime securitized market, the S&P/Case-Shiller index includes properties covered by these loans, while the OFHEO's reliance on conforming mortgages prevents it from doing so. However, OFHEO's national coverage offers an enormous advantage when estimating the prevalence of negative equity in aggregate. We have opted to concentrate on what we consider the more accurate data set available for a

[10] These figures are population estimates based on the sample information reported in Table 2.

Chart 5
Negative Equity by Origination Year



Source: FirstAmerican CoreLogic, LoanPerformance data.

restricted set of cities; thus, we focus on the seventeen cities for which we have S&P/Case-Shiller tiered information. Nonetheless, we also report OFHEO results—especially when analyzing the entire United States—to provide a broader view of nonprime mortgages.

Recall that the time of loan origination is important for determining negative equity because the two determinants of negative equity—the value of the home and the ratio of the loan to the initial value of the home—both correlate with vintage. Increases in full LTV ratios at origination, combined with the sharp reversal in home prices in 2006, suggest that borrowers who took mortgages later in the period would be more likely to find themselves with no equity in their property. As Chart 5 shows, very small shares of nonprime mortgages that originated before 2003 were in negative equity by December 2008, but negative equity rates were sharply higher in subsequent vintages. All told, we estimate that the difference between house values and nonprime balances in these cities totals more than $58 billion (Table 3).

The importance of vintage suggests that one would expect areas that experienced housing booms during 2004-06, especially locations where borrowers took loans with small down-payments, to have the highest prevalence of negative equity. Our data support this hypothesis.

Table 3
Negative Equity by Metropolitan Statistical Area

Area	Negative Equity (Percent)	Average Difference between Mortgage Balance and House Value (Dollars)	Total Amount in Negative Equity (Thousands of Dollars)
Atlanta	45	18,016	983,660
Boston	21	17,156	202,440
Chicago	35	18,201	964,670
Cleveland	32	9,865	114,440
Denver	33	12,607	267,280
Las Vegas	89	83,654	7,871,870
Los Angeles	52	80,484	13,593,690
Miami	69	68,357	10,417,590
Minneapolis	61	32,839	1,155,940
New York	13	22,119	822,840
Phoenix	80	73,314	9,024,990
Portland	24	18,676	190,500
San Diego	61	84,371	4,496,990
San Francisco	39	65,986	2,830,800
Seattle	21	17,125	236,330
Tampa	60	37,110	1,888,910
Washington, D.C.	47	52,113	3,397,760
Seventeen-area composite	47	58,496	58,460,690

Source: FirstAmerican CoreLogic, LoanPerformance data.

Notes: House value changes are estimated using the S&P/Case-Shiller high- and medium-tier indexes for individual metropolitan statistical areas. Mortgage balances on junior and senior liens are combined. The last column represents the population counts.

The importance of vintage suggests that one would expect areas that experienced housing booms during 2004-06, especially locations where borrowers took loans with small down-payments, to have the highest prevalence of negative equity. Our data support this hypothesis. Almost a quarter of the negative equity properties in the seventeen S&P/Case-Shiller cities are in one of the three California MSAs, with more than 15 percent in Los Angeles alone (Table 3). In addition, negative equity is much larger in the California (and to a lesser extent Florida) cities than elsewhere in the country. The California cities saw relatively large declines in housing prices and had larger than average mortgages—factors that led to a greater prevalence and intensity of negative equity. Thus, borrowers who received high LTV loans in 2006-07 in areas that experienced sharp house price reversals are very likely to find themselves in a negative equity position.

3.1 Borrower Characteristics and Behavior

An examination of borrower and loan characteristics by equity status shows that, not surprisingly, the most striking difference between positive and negative equity loans is the combined (senior plus junior) LTV ratio at origination; in each MSA, average initial LTVs are significantly higher on negative equity loans (Table 4; Table 5 provides the same information for states, using the OFHEO index). Debt-to-income ratios are typically higher among negative equity borrowers as well. Interestingly, credit bureau scores are generally higher among the negative equity borrowers.[11] The fact that "borrower quality" at origination is roughly the same for positive and negative equity loans is a relevant consideration when interpreting default behavior.

To gain an understanding of mortgage repayments, it is crucial to analyze the relationship between equity status and default behavior. Recent research on defaults has shown the importance of house price appreciation in influencing nonprime mortgage outcomes (Demyanyk and van Hemert 2008; Gerardi, Shapiro, and Willen 2007). Demyanyk and van Hemert (2008) find that borrowers whose houses have

[11] Table 5 reports these results using the OFHEO index of the broader set of states. While the estimated shares in negative equity in the broader sample are consistently lower than the shares in Table 4's more narrow sample of seventeen MSAs, they demonstrate similar spatial patterns—with the bulk of negative equity properties concentrated in boom states, especially California. In addition, the broader sample's concentration of negative equity loans among borrowers with relatively high credit scores, high DTI ratios, and high combined LTV ratios at origination is similar to the more narrow sample's concentration. Neither sample demonstrates a clear relationship between equity and documentation level.

Table 4

Underwriting Characteristics by Equity Status and Metropolitan Statistical Area

Area	Equity Status (Percent)	Debt-to-Income Ratio	FICO Score	Loan-to-Value Ratio	Fully Documented (Percent)
Seventeen-area composite					
Positive equity	53	38	673	73	43
Negative equity	47	40	678	91	36
Atlanta					
Positive equity	55	35	673	80	56
Negative equity	45	40	668	98	61
Boston					
Positive equity	79	39	662	72	42
Negative equity	21	42	678	98	42
Chicago					
Positive equity	65	39	641	80	53
Negative equity	35	42	667	97	40
Cleveland					
Positive equity	68	37	636	82	62
Negative equity	32	41	646	97	78
Denver					
Positive equity	67	38	675	82	57
Negative equity	33	42	671	99	61
Las Vegas					
Positive equity	11	34	689	65	39
Negative equity	89	39	683	88	33
Los Angeles					
Positive equity	48	38	692	63	35
Negative equity	52	41	690	89	22
Miami					
Positive equity	31	38	654	67	42
Negative equity	69	39	667	88	33
Minneapolis					
Positive equity	39	36	673	76	52
Negative equity	61	41	668	95	54
New York					
Positive equity	87	40	663	75	38
Negative equity	13	42	686	98	22
Phoenix					
Positive equity	20	35	693	70	48
Negative equity	80	39	673	87	41
Portland					
Positive equity	76	37	685	79	47
Negative equity	24	41	691	98	44
San Diego					
Positive equity	39	36	703	60	33
Negative equity	61	40	699	88	26
San Francisco					
Positive equity	61	36	716	65	32
Negative equity	39	40	693	91	24
Seattle					
Positive equity	79	39	678	81	50
Negative equity	21	39	694	97	44
Tampa					
Positive equity	40	35	659	73	49
Negative equity	60	39	666	90	40
Washington D.C.					
Positive equity	53	39	675	71	44
Negative equity	47	41	677	94	38

Source: FirstAmerican CoreLogic, LoanPerformance data.

Notes: House value changes are estimated using the S&P/Case-Shiller high- and medium-tier indexes for individual metropolitan statistical areas. Mortgage balances on junior and senior liens are combined. Details may not sum to totals because of rounding.

Table 5

Underwriting Characteristics by Equity Status and State

State	Equity Status (Percent)	Debt-to-Income Ratio	FICO Score	Loan-to-Value Ratio	Fully Documented (Percent)
Non-boom and non-bust states					
Forty-three-state composite					
Positive equity	91	38	655	83	55
Negative equity	9	42	672	98	44
Boom states					
Arizona					
Positive equity	57	37	674	75	46
Negative equity	43	40	676	93	40
California					
Positive equity	43	37	695	64	37
Negative equity	57	40	685	88	28
Florida					
Positive equity	51	38	657	75	46
Negative equity	49	39	666	91	35
Nevada					
Positive equity	20	37	687	69	39
Negative equity	80	39	683	89	34
Bust states					
Indiana					
Positive equity	98	37	640	87	70
Negative equity	2	40	623	98	79
Michigan					
Positive equity	47	37	637	77	65
Negative equity	53	40	646	93	65
Ohio					
Positive equity	89	38	638	86	67
Negative equity	11	41	645	99	76

Source: FirstAmerican CoreLogic, LoanPerformance data.

Notes: House value changes are estimated using the Office of Federal Housing Enterprise Oversight indexes for individual states. Mortgage balances on junior and senior liens are combined. Details may not sum to totals because of rounding.

appreciated less, or depreciated more, tend to default more, all else equal. In much of this work, borrower default is treated as a continuous function of house value; in contrast, we analyze a sharp break at zero equity. The idea that borrower behavior might change markedly as properties pass into negative equity is supported by both theory and empirical evidence. Theory predicts that borrowers with positive equity will rarely default, but those with little or no equity will sometimes determine that default is the best option. When equity declines by a particular amount—that is, if house values fall enough after loan origination—borrowers reach a critical value where they are certain to default (Vandell 1995).

Haughwout, Peach, and Tracy (2008) study the probability that a borrower will fall at least ninety days behind on scheduled payments within the first year of a nonprime mortgage. The authors report very large ceteris paribus jumps in this probability as LTV ratios rise above 100, particularly among borrowers who are not owner-occupants. They find that negative equity adds approximately 7 percentage points to default probability for owner-occupants and between 15 and 20 percentage points for investors, compared with similar owners with slightly positive equity in their properties (that is, those with LTV ratios between 95 and 100).

Table 6
Loan Status by Borrower Equity
Percent

	Days Delinquent				
	Thirty	Sixty	Ninety or More	Foreclosure	Real-Estate-Owned
First lien					
Positive equity	8	4	8	8	4
Negative equity	9	6	12	17	9
All liens					
Positive equity	7	4	7	7	3
Negative equity	8	5	11	16	9

Source: FirstAmerican CoreLogic, LoanPerformance data.

Note: House value changes are estimated using the S&P/Case-Shiller high- and medium-tier indexes for individual metropolitan statistical areas.

In related work, Foote, Gerardi, and Willen (2008) study ownership experiences of prime and nonprime borrowers in Massachusetts beginning in the late 1980s. They produce two findings of relevance for our analysis: subprime borrowers are much more likely to default in general than those holding conforming mortgages, and borrowers with negative equity are more likely to default after five years (and are less likely to sell their properties) than those with positive equity.

As expected, we find that the share of positive equity loans ninety or more days delinquent is a little more than half the rate for loans with negative equity (Table 6). However, borrowers with negative equity are just as likely to be thirty days delinquent—but twice as likely to be in foreclosure and three times as likely to have passed through the foreclosure process and be in REO by the lender. Thus, a fall in home prices may not precipitate initial delinquency, but it may encourage default by a homeowner who is already having difficulty making payments. This outcome is consistent with results from a model in which some borrowers experience shocks to their income and fall a month or two behind on their mortgages, then decide whether to prepay (sell or refinance) or default. When their equity is below zero, the tendency to default is relatively strong.

We find that the share of positive equity loans ninety or more days delinquent is a little more than half the rate for loans with negative equity.

While only 10 percent of positive equity homes are in foreclosure or REO on all liens, we estimate that 31 percent of properties in foreclosure or REO are in a positive equity position (Table 6). This conclusion may appear to contradict the argument that negative equity is a necessary condition for default. The high number of positive equity properties in foreclosure may reflect mismeasurement of housing equity or the presence of transaction costs that make default a better option than continuing to make payments on the loan.[12] We find that our estimates of borrower equity are lower for those properties that are delinquent ninety days or more, in foreclosure, or in REO (Table 7). When prepayment penalties and the possibility of mismeasurement of house values are considered, these borrowers may perceive themselves to be in negative equity on their mortgages, a factor that helps explain their behavior.

Our foreclosure rates . . . reflect not only the prevalence of entering foreclosure, which itself is influenced by both borrower and lender behavior, but also the time that a property in default spends in foreclosure.

Although these results are qualitatively consistent with those of Foote, Gerardi, and Willen (2008) and Haughwout, Peach, and Tracy (2008), a direct comparison is difficult. In particular, because our mortgage data set consists entirely of nonprime loans, we observe the effect of negative equity on that subsample

[12] Recall that we describe negative *book* equity. It is possible that many of the loans that we measure as having positive equity have prepayment fees or other features that put the default option "in the money." It is also possible that we underestimate house price declines for some of these loans.

Table 7
Loan Status among Positive Equity Borrowers

		Days Delinquent				
	Current	Thirty	Sixty	Ninety or More	Foreclosure	Real-Estate-Owned
Average difference between mortgage balance and house value (dollars)	137,610	86,294	71,683	76,291	59,898	42,954
Average difference as a percentage of house value	28	22	20	17	15	13

Source: FirstAmerican CoreLogic, LoanPerformance data.

Notes: House value changes are estimated using the S&P/Case-Shiller high- and medium-tier indexes for individual metropolitan statistical areas. Mortgage balances on junior and senior liens are combined.

of the Foote, Gerardi, and Willen population. In addition, we observe a single cross-section of properties in foreclosure at a point in time, as opposed to the Foote, Gerardi, and Willen approach of observing the timing of entry into default and the Haughwout, Peach, and Tracy analysis of delinquency within the first year of origination. Our foreclosure rates thus reflect not only the prevalence of entering foreclosure, which itself is influenced by both borrower and lender behavior, but also the time that a property in default spends in foreclosure.

4. Looking Ahead

Negative equity's important effect on borrower default underscores the value of understanding the potential future path of negative equity. Accordingly, we look at two possible relationships between negative equity and nonprime borrowing going forward.

We begin by using the S&P/Case-Shiller home price index. The index has the advantage of covering a large number of homes in the small number of markets for which it is available. Another advantage is that futures contracts on the index trade on the Chicago Mercantile Exchange.[13] As a result, the path of the indexes in individual MSAs can be predicted. The futures contracts currently provide estimates of house price appreciation in several cities for various months through November 2012.[14]

Our examination of futures contracts on S&P/Case-Shiller indexes points to further deterioration in home prices in the cities covered. As of December 2008, the five cities with contracts expiring in November 2009 had a combined negative equity rate of 45 percent, very near the average rate of 47 percent for the seventeen cities tracked by the S&P/Case-Shiller index. We estimate that the trajectories implied by the futures contracts would increase the negative equity rate to 61 percent by late 2009 and add 135,500 borrowers to the ranks of those whose homes are worth less than their mortgage balances in these five cities. The contracts forecast the percentage of borrowers with negative equity in their homes to decrease by the end of 2010 (Chart 6). These calculations are derived using the percentage changes in home prices predicted for the S&P/Case-Shiller composite index and applying the changes to its high- and medium-tier indexes, assuming that borrowers fall no further behind on their mortgages.

Negative equity's important effect on borrower default underscores the value of understanding the potential future path of negative equity.

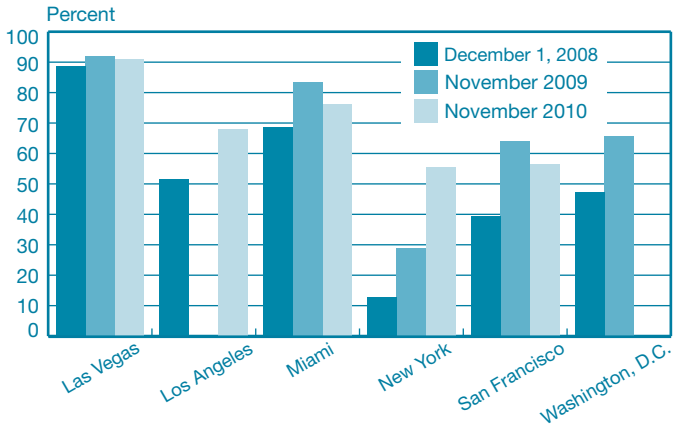
A second potential relationship between negative equity and house prices is somewhat more general. Chart 7 presents the number of borrowers in various equity categories as of December 2008, where equity is expressed as a percentage of house value. Here we use the OFHEO index, which offers the broadest coverage. Assuming that no changes in mortgage balances occur, one can estimate the number of new negative equity borrowers by moving the chart's "zero line."[15] For example, the effect of a 10 percent decline in house prices can be estimated by moving this line two bars to the right. According to this scenario, approximately 1.5 million (719,600 plus 770,000) new nonprime borrowers would see their house

[13] See <http://housingrdc.cme.com/index.html> for more information.

[14] The cities are Boston, Denver, Las Vegas, Los Angeles, New York, San Diego, San Francisco, and Washington, D.C.; futures prices for Miami are available only through November 2010. While these markets are relatively thinly traded, activity picks up following release of the S&P/Case-Shiller home price index. We thus use the futures prices for contracts that had "open interest" on March 31, 2009: the release date for the January 2009 S&P/Case-Shiller index.

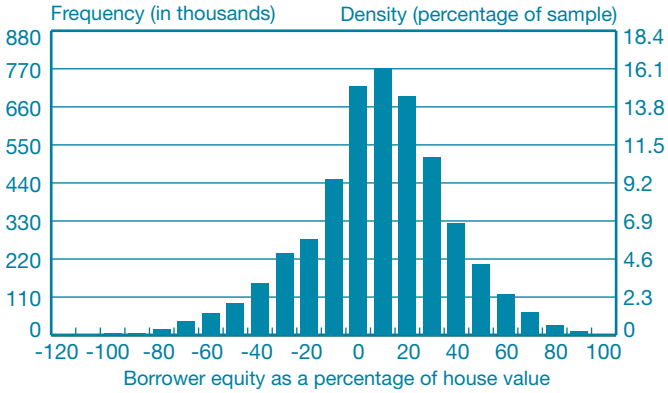
[15] Alternatively, if one believes that the OFHEO index is 10 percent overvalued, one might conduct a similar exercise to estimate current negative equity rates.

Chart 6
Potential Path of Negative Equity



Sources: FirstAmerican CoreLogic, LoanPerformance data; Chicago Mercantile Exchange.

Chart 7
Ratio of Equity to House Prices
As of December 2008



Sources: FirstAmerican CoreLogic, LoanPerformance data; Office of Federal Housing Enterprise Oversight.

value fall below their current mortgage balance. This path of house prices would raise our OFHEO-based estimate of the negative equity share to roughly 45 percent. Conversely, a turnaround in the housing market that resulted in a 10 percent increase in house values would lift 729,200 borrowers into positive equity, reducing the rate to just 14 percent.[16]

These arguably plausible changes in the value of the OFHEO index have very large effects on the incidence of negative equity among nonprime borrowers because, as Chart 7 shows, many hundreds of thousands of borrowers are very near zero equity. Relatively small changes in house prices from this point forward can therefore have large influences on both the incidence of negative equity and, by extension, the risk of default by nonprime borrowers.

5. Conclusion

Recent declines in house values have put hundreds of thousands of nonprime borrowers in a negative equity position, that is, with a house value below the property's mortgage balance. Our study finds that nonprime borrowers in negative equity share several characteristics: for example, they took out loans near the peak of the housing market and their loans had high LTV ratios usually achieved with subordinate liens in addition to the first lien. We also find that while negative equity loans exist in most U.S. metropolitan areas, they are disproportionately concentrated in housing markets that experienced especially large swings in house price appreciation, particularly in California. We estimate that three California metropolitan areas account for more than a quarter of the negative equity mortgages in our sample. Moreover, because of the higher balances on these mortgages, the loans account for nearly half of the overall difference between house values and mortgage balances.

Going forward, further house price declines will lead to continued increases in the number of nonprime mortgages in negative equity. If house prices fall an additional 10 percent from their December 2008 levels, we estimate that approximately 1.5 million new mortgages nationwide will carry balances that exceed the value of the collateral homes. The aggregate difference between these balances and house values could approach $135 billion.

Although negative equity is a necessary condition for default, it does not always *lead* to default. As other studies, including ours, have shown, borrowers do not automatically default when their house value drops below their mortgage balance. Nonetheless, research has demonstrated that negative equity borrowers are far less likely to prepay their mortgages and are more likely to become seriously delinquent and thus default. We find that among nonprime borrowers, the default probability of an outstanding negative equity mortgage is two to three times as high as that of a positive equity borrower. In this context, the future direction of house prices will be a critical determinant of the payment behavior of nonprime borrowers.

[16] Note that these estimates are imprecise, as they do not account for changes in mortgage balances over time.

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