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journal homepage: [www.elsevier.com/locate/jfec](http://www.elsevier.com/locate/jfec)Systemic risk and the refinancing ratchet effect<sup>☆</sup>Amir E. Khandani<sup>a,c</sup>, Andrew W. Lo<sup>b,c,d,\*</sup>, Robert C. Merton<sup>b</sup><sup>a</sup> Morgan Stanley, New York, United States<sup>b</sup> MIT Sloan School of Management, 100 Main Street, E62-618, Cambridge, MA 02142, United States<sup>c</sup> Laboratory for Financial Engineering, MIT Sloan School of Management, United States<sup>d</sup> AlphaSimplex Group, LLC, United States

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## ABSTRACT

The combination of rising home prices, declining interest rates, and near-frictionless refinancing opportunities can create unintentional synchronization of homeowner leverage, leading to a “ratchet” effect on leverage because homes are indivisible and owner-occupants cannot raise equity to reduce leverage when home prices fall. Our simulation of the U.S. housing market yields potential losses of \$1.7 trillion from June 2006 to December 2008 with cash-out refinancing vs. only \$330 billion in the absence of cash-out refinancing. The refinancing ratchet effect is a new type of systemic risk in the financial system and does not rely on any dysfunctional behaviors.

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## 1. Introduction

Home mortgage loans—one of the most widely used financial products by U.S. consumers—are collateralized

mainly by the value of the underlying real estate. This feature makes the market value of the collateral very important in measuring the risk of a mortgage.<sup>1</sup> To reduce the risk of default, mortgage lenders usually ask for a down payment of 10–20% of the value of the home from the borrower, creating an “equity buffer” that absorbs the first losses from home price declines. Any event or action that reduces the value of this buffer, e.g., an equity extraction or a drop in home values, increases the risk to the lending institution.

A number of secular trends over the last two decades, including the increased efficiency of the refinancing process and the growth of the refinancing business, have made it much easier for homeowners to refinance their

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<sup>1</sup> See, for example, Danis and Pennington-Cross (2005), Downing, Stanton, and Wallace (2005), Gerardi, Shapiro, and Willen (2007), Doms, Furlong, and Krainer (2007), Bajari, Chu, and Park (2008), Bhardwaj and Sengupta (2008a), and Gerardi, Lehnert, Sherlund, and Willen (2008).

mortgages to take advantage of declining interest rates, increasing housing prices, or both. Consequences of these trends have been documented by Greenspan and Kennedy (2008, p. 120), who observe, “since the mid-1980s, mortgage debt has grown more rapidly than home values, resulting in a decline in housing wealth as a share of the value of homes.” They attribute most of this effect to discretionary equity extractions via home sales, “cash-out” refinancing (where the homeowner receives cash after the refinancing), and home-equity loans.

In this paper, we focus on a previously unstudied dimension of risk in the mortgage market: the interplay among the growth of the refinancing business, the decline in interest rates, and the appreciation of property values. Each of these three trends is systemically neutral or positive when considered in isolation, but when they occur simultaneously, the results can be explosive. We argue that during periods of rising home prices, falling interest rates, and increasingly competitive and efficient refinancing markets, cash-out refinancing is like a ratchet. It incrementally increases homeowner leverage as real-estate values appreciate without the ability to symmetrically decrease leverage by increments as real-estate values decline. This self-synchronizing “ratchet effect” can create significant systemic risk in an otherwise geographically and temporally diverse pool of mortgages.

The potential magnitude of the risk created due to the refinancing ratchet effect is most clearly illustrated through a hypothetical scenario in which all homeowners decide to keep their leverage at a level generally associated with extreme prudence and good lending practices, for example, a loan-to-value (LTV) of 80% for a conventional fully amortizing 30-year fixed-rate mortgage. Suppose the refinancing market is so competitive, i.e., refinancing costs are so low and capital is so plentiful, that homeowners are able to extract any equity above the minimum each month. In such an extreme case, cash-out refinancing has the same effect as if all mortgages were re-originated at the peak of the housing market. When home prices fall, as they must eventually, the ratchet “locks” because homeowners cannot easily unwind their real-estate positions and incrementally deleverage due to indivisibility and illiquidity. The unintentional synchronization of leverage during the market’s rise naturally leads to an apparent shift in regime during the market’s decline, in which historically uncorrelated defaults now become highly correlated.

Indivisibility and occupant-ownership of residential real-estate are two special characteristics of this asset class that make addressing this issue particularly challenging. The impact of indivisibility can be crystallized by comparing an investment in residential real estate with a leveraged investment in a typical exchange-traded instrument such as shares of common stock. While the latter is subject to both an initial margin requirement as well as a maintenance margin requirement, home mortgages only have a homeowner equity requirement that plays a role similar to that of an initial margin. It is hard to imagine that homeowners would willingly finance large capital purchases using short-term debt like margin accounts, and long-term debt may have become the standard method for financing home purchases precisely because of the indivisible nature of

the collateral. Furthermore, the occupant is almost always the sole equityholder in an owner-occupied residential property, and moral hazard concerns preclude the owner from reducing leverage by raising incremental capital via issuing equity to others.

These two special features of residential real estate may be viewed as market frictions or institutional rigidities that create an important asymmetry in the housing market which does not exist in most financial markets. While a leveraged investor may decide not to incrementally deleverage as prices decline due to optimistic expectations of a price reversal, indivisibility and occupant-ownership make incremental deleveraging impossible, even for those who wish to reduce their exposure to real estate. Therefore, the only option available to homeowners in a declining market is to sell their homes, recognize their capital losses, and move into less expensive properties that satisfy their desired LTV ratio. The enormous costs—both financial and psychological—of such a transaction make it a highly impractical and implausible response to addressing the issue raised in this paper.

We propose to gauge the magnitude of the potential risk caused by the refinancing ratchet effect by creating a numerical simulation of the U.S. housing and mortgage markets. By calibrating our simulation to the existing stock of real estate, and by specifying reasonable behavioral rules for the typical homeowner’s equity extraction decision—which satisfy common standards of prudence and good lending practices in the U.S.—our simulation can match some of the major trends in this market over the past decade. Based on the calibrated simulation and using a standard derivatives-pricing model, we construct an estimate of losses absorbed by mortgage lenders—banks, asset management firms, and government-sponsored enterprises (GSEs)—from the decline in real-estate prices and compare these estimates with the scenario of no equity extractions over the same period. Our simulation yields an approximate loss of \$1.7 trillion from the housing-market decline since June 2006 compared to a loss of \$330 billion if no equity had been extracted from U.S. residential real estate during the boom.

Of course, a simple response to the refinancing ratchet effect might be to eliminate non-recourse mortgages. If all mortgages were recourse loans and borrowers had uncorrelated sources of income, their income streams would create an extra level of protection for lenders and, therefore, distribute the risk in the mortgage system between lenders and borrowers more evenly. Instead, current legal procedures for foreclosure and obtaining deficiency judgments are complex and vary greatly from state to state. As discussed by Ghent and Kudlyak (2009, Table 1), while home mortgages are explicitly non-recourse in only 11 states, in certain populous states with recourse such as Florida and Texas, generous homestead-exemption laws can make it virtually impossible for lenders to collect on deficiency judgments because borrowers can easily shield their assets. Nevertheless, the risks and potential losses calculated according to the framework proposed in this paper must be borne by some combination of borrowers and lenders; from our systemic-risk perspective, the precise combination is of less consequence than the aggregate magnitude.

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