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Risk Management for Households—the Democratization of Finance[1]

By Robert J. Shiller[2]

The application of advanced principles of risk management to the risks of the household offers many opportunities to improving human welfare. For such application to be effective, the complex and long-term nature of the basic household maximization problem must be understood, and psychological factors that prevent households' effective use of risk management tools to solve this problem must be considered. Examples are given of recent financial innovations that focus on risks that are salient to households, home price risks, longevity risks, and energy risks.

All that matters for economics are individual people and the units that they put themselves into---families or households. Corporations and partnerships of course have no feelings, and exist only for the individual people who participate in them. And yet advanced risk management often seems to be for the benefit of these corporations or partnerships, and to be limited to the most advanced or significant of these. It typically does not give enough attention to the fact that the risk management methods could be extended to address some pressing concerns of households, if the tools are designed right. Shifting our methods from focusing on just these to methods that give similar support to the risk management needs of households represents a fundamental challenge for the future.

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[2] Stanley B. Resor Professor of Economics and Professor of Finance, Yale University, and co-founder and Chief Economist, MacroMarkets LLC.

Recent world trends appear to be putting greater risks upon the household. Income inequality appears to be getting worse. Jacob Hacker in his 2006 book *The Great Risk Shift* points out that in the United States lifetime income uncertainty, account of taxes and social welfare, has increased in recent decades. The same appears to be true in many other countries at a time when greater reliance is being put upon market forces. So, the problem of household risk management is all the more important. If we are going to be a more market-oriented society, we need to develop those markets and associated financial institutions to be up to the task. That is, we must democratize finance, make the basic principles of finance work for everyone [Shiller, 1993 and 2003]. We need to look ahead for institutional changes that would put household risk management on a more solid footing.

I will in this paper consider the kinds of psychological and family problems that inhibit the proper management of household risks, and some of the relevant lessons from behavioral-finance. Improving household risk management requires some major human-factors engineering, steering around the psychological obstacles that inhibit risk management, experimenting with new forms of risk management institutions to see what will work. Curiously, this innovation objective seems hardly to be recognized by most people who lament the rising inequality in our society.

I will then turn to specific methods of attaining better household risk management, notably for risks of housing prices, longevity, and energy price risks. I will discuss some of the efforts that many different people and institutions have been making, as well as some that my colleagues and I have been making to facilitate their better management, notably new home price derivatives – including Chicago Mercantile

Exchange (CME) housing futures and our new oil MacroShares traded on the American Stock Exchange.

Psychological Problems

Many patterns of investor errors have been noted, and these patterns need to be kept in mind when we design new risk management products to benefit households, since the same sorts of basic errors that have been made in the past are likely to appear again in the future. Even skeptics of much in the field of behavioral finance appear to accept that it must play a role in financial innovation.[3]

When offered choices of investment alternatives in retirement plans, many households follow simple rules of thumb for allocation (such as equal amounts in all plans) [Benartzi and Thaler 2001]. Employees who are offered the option of investing in the stock of the company they work for tend often to expose themselves excessively to that risk, and seem to do that especially if the price of their company's stock has been rising recently, suggesting that they make the error of simple extrapolation of their company's stock [Benartzi 2001]. Households seem to run into significant barriers to investing in certain asset classes. Few lower-income households invest in more sophisticated asset classes [Campbell 2006].

People seem to look upon investment categories as ends in themselves, rather than reflecting about what these investments will do for their economic interests. They are

[3] Robert C. Merton and Zvi Bodie [2004] write "Neo-institutional and behavioral theories are centrally important in analyzing the evolution of institutions including market instruments and financial intermediaries, but are unlikely to provide significant and stable explanations of asset prices and resource allocations." (p. 11.)

doing what the philosopher John Locke called "taking words for things."[4] Insurance became an attractive risk-management institution only after households learned to take the word insurance as standing for a virtuous institution. Experiments show that decisions whether to buy insurance are heavily influenced by superficial framing of the insurance [Johnson et al. 1993].

People are unlikely to adopt new risk management institutions partly since they fear betrayal or embarrassment if it turns out that those who promoted the institutions were duplicitous. Bohnet et al. [2007] show experiments that risk aversion is perceived much more strongly if the risk is one of malicious human action rather than a risk of acts of nature. This human tendency makes it difficult for people to convince others to adopt risk-management techniques. Since contracts that deal effectively with complex risks are themselves necessarily complex, it becomes impossible for most people ever to understand all the issues, and so they are thrust back onto trusting long-term relationships, which themselves become part of the essential risk management institutions [Allen and Gale, 2000].

Money illusion is a long-noted problem. Modigliani and Cohn [1979] showed persuasive evidence that the stock market is driven substantially by money illusion. The correlation between the earnings-price ratio and the nominal interest rate is substantial, and much higher than the correlation of the earnings-price ratio and the real interest rate. They note that analysts' reports on comparing the stock market with interest rates seem routinely to confuse nominal versus real rates, or, at least, take it as a tacit assumption that the market confuses the two. Ideally, there would be an indexed unit of account, such as the unidad de fomento in Chile, that helps people to think in real terms, Shiller [2003].

[4] Locke, *An Essay Concerning Human Understanding*, Book III, Chapter 10, 14 IV.

But, in the absence of that, we must design financial institutions around a pervasive tendency to err by confusing real and nominal.

Perhaps the most fundamental problem is that any attention people pay to investing tends to be irregular. Some people check stock prices several times a day. Other people go through decades without paying any attention to the allocations in their 401(K) plans. Part of the attentional differences has to do with different personal senses of importance to investing. Akerlof and Yellen [2000] have stressed the importance of identity in economics. Some people's sense of personal identity and self esteem is tied up with their investing skills, others have a view of themselves that makes consideration of investments a depressing activity that they avoid as much as possible, at least unless the vehicle is framed in a way that makes it attractive in dimensions that are meaningful to them.

The human behavior patterns are sufficiently unpredictable and poorly understood that experimentation needs to be a central method for achieving financial innovation. Which risk management vehicles will substantial numbers of people actually use? At the futures exchanges, they joke about the "spaghetti theory" of innovation. Chefs are said, when cooking spaghetti, to throw a piece against the wall: if it sticks, the spaghetti is done. Trying new futures markets is like that: one must just launch them and see what happens. We will never fully understand why some succeed and some do not, though presumably the reasons for their different outcomes are tied substantially to the kinds of psychological anomalies described above, as well as institutional constraints and assumptions.

We must never conclude that, if an effort to create public interest in managing a certain kind of risk fails, that the public is just not interested in managing that risk. Instead, the details of the innovation to manage that risk must be reconsidered, in light of the anomalies of human behavior and of the institutions they operate among. New experiments must be tried. The success of the next experiment will never be secure or sure, but the process of continued experimentation will eventually result in better risk management.

A Characterization of the Fundamental Maximization Problem

Individuals generally do not solve individual risk management problems, but instead are focused problems for their family, including people involved in their broader social purpose. A problem is that the family, including other non-related people that the individual values as well as family, is not a well-defined unit. It depends on psychological bonds, that are hard to observe, and which change through time. As children grow up they turn into young adults and then gradually leave the family and form new families. Divorce breaks up families and remarriage creates half-links between them.

The very concept of the household cannot be constant through time, for not only does culture change, but so does housing technology and availability and communications technology. A century ago, an extended family tended to live together in one house much more often than today. With the declining cost of basic housing relative to per capita incomes, people are no longer forced to live together, hence grandparents

tend to live separately, parents tend to divorce more, and grown children tend to set up their own apartments more. Improving technology tends to allow these different family elements, now as separate households, to maintain connections and hence a psychological bond as a family.

Ideally, an individual faces the problem of maximizing the utilities of multiple people, members of the family and others the individual cares about. This implies that an individual is facing a risk-management problem that unfolds over decades, and a younger person is likely to find an investment horizon well over a century, and to be maximizing for quite a large number of different people.

The random variables that enter into the optimization problem involve the prices of all goods as well as the prices of all endowments, as well as the random dates of births and deaths, and random events that affect utility functions. Note that some consumption goods may also be investment goods.

The risk management problem is actually even more complex than this, since the individual does not control the consumption of all the others, and can only leave gifts or bequests to them. As such, the maximization problem depends on the solutions to the maximization problems that others in the family make with their budget constraints, and the judgments individuals make of others' likely ability to manage the optimization problem.

Risk managing across households means exploiting all gains from trade. This means sharing risks between households, and adjusting risks to their own level of risk tolerance. The list of natural hedging vehicles that would be available would have to involve risk management for longevity risk, for risks of relative price change for assets,

for changes in endowment prices including labor endowment of the maximizing investor as well as of others he/she cares about [Shiller, 1993, 2003]. Moreover, there should be some reliance on long-term indexed annuities to adjust risk exposure [Campbell and Viceira 2001]. The problem is hardly one of just choosing the right portfolio of conventional stocks and bonds: new vehicles need to be created.

The risk management problem described here has such complexity that it is really beyond the ability of anyone to solve optimally. Moreover, the incomplete understanding that people do have of the problem is likely to evolve or change through time, especially as new financial products are presented as opportunities for them, and they have time to discuss them and absorb expert commentary on them.

The challenge for innovators is to experiment with different kinds of risk management products, to strive for something that people will actually recognize, maybe with a little help, as important devices to manage risks better. Consideration of some examples will make the issues clearer.

Efforts to Start Markets for Housing Risks

Risks to home values have been preoccupying people for decades, and especially so in the current environment of highly speculative real estate markets. It is very easy to engage people in a discussion of home values and discover significant anxieties. People today who have missed out on the housing boom by renting instead of buying often express great regret, sometimes even suggesting that a faulty decision has caused much of the opportunity for a good life to have passed them by. If home prices fall substantially in the next decade, as many suspect, then there will soon be many people who express the

opposite regret, regret for having gotten into a housing boom too late. The fact that people talk with such emotion about these problems is a sign that economists ought to be considering ways to change the basic situation for all these people.

Home price risk management has already been handled in some dimensions by various institutions, the most notable of which is the rental market: Investors can include apartment buildings in diversified portfolios, and the inhabitants of those buildings can then use the services of these buildings without incurring any investment risks. However, there are complications. Since people are natural demanders of housing services, being completely out of the market for houses is not optimal. People prefer to own their own homes, so that they can decorate and remodel it to their own taste, and so that they can avoid the risk that the rent of a property they have come to be attached to might go up. The home enters the household utility maximization problem both as a consumption good and as an investment asset (since the home tends to outlive the individual homeowner), creating significant complications for the maximization problem. It is not enough to say, as some do, that an individual should merely buy an exposure exactly equal to the home that he or she needs, it is more complicated than that. Certainly the homeowner may wish to hedge part of the risk of the home that he/she lives in, especially if a move or a retirement is contemplated, or may wish to take on more exposure than would be dictated by the consumption decision alone, and needs the help of new institutions that would make this possible.

In France, going back centuries, there has been an institution of “sale of remainder” whereby a homeowner can sell an interest in his or her house after death. Other people could take either side of that market to increase their exposure to real estate.

But, the institution was plagued by the lumpiness and illiquidity of the investments and the strong uncertainty of date of death of the inhabitant.

Updated versions of this institution were developed in the 1990s as 'shared appreciation mortgages," (SAMs) launched in the 1990s by SBC Warburg Dillon Read (acquired by UBS around the time of the launch) and the Bank of Scotland in the United Kingdom and by Bear Stearns in the United States. In their most popular form, home owners paid zero interest in exchange for a pledge to the lender of 75% of the future appreciation of their home value. The SAMs enabled people to afford larger homes or direct mortgage savings to non-housing consumption or investment, while sharing the risk of a future home price decline. The SAMs faded in popularity with the home price boom in the United Kingdom and the United States after the late 1990s, inducing a strong pang of regret amongst those who sold the equity interests in their homes, and with the decline of conventional mortgage interest rates. The SAMs ultimately failed, apparently, because of an accident of history and people's tendency to evaluate investments by looking at recent past returns on the investments.

Now, in the 2000s, there is another effort underway to create a slightly different product named "shared equity mortgages." (SEMs). According to Caplin et al., [2007], buyers of homes could take out a conventional mortgage for part of the down payment on the house, and borrow the remainder by, in effect, selling a share in the house that rises through time. They give an example of a "4% shared equity mortgage" taken out on 20% of the home value. The borrower owes 20.8% of the home value from the proceeds of the sale if the home is sold after one year, owes 29.6% ($=1.04^{10}\times 20\%$) of the home value at the time of sale if the home is sold after ten years and gives up the entire proceeds of the

sale if the home is sold after 41 years. Taking out such a mortgage for part of the purchase price enables the home buyer to reduce exposure to home price risk and at the same to lower interest payments while living in the home. But, there is a risk that home buyers will focus on the prospect of total loss of their interest in their home if they stay in it for 41 years, when they could have avoided this just by raising 20% in another way. Paying interest on a mortgage may be a self-control device, a way of forcing oneself to save, while the shared equity mortgage may result in the total loss of what is the most important component of saving for the median household.

Reverse mortgages, mortgages that pay the home owner in exchange for a claim on the home when the home owner sells or dies, and which provide steady income to the homeowner until then, have recently been growing in importance: in the US a record 76,300 such mortgages were issued in 2006.[5] Mortgage originators IndyMac Bancorp, Wells Fargo, Seattle Mortgage and Countrywide Financial all have substantial reverse mortgage programs. Lehman Brothers Holdings, UBS, Bank of America, and Deutsche Bank are securitizing these mortgages. Reverse mortgages can offer substantial risk management for an older or retired homeowner if the homeowner stays long enough and the amount borrowed is substantial relative to the value of the home, so that the mortgage originator becomes at risk that the value of the home falls short of the mortgage balance. However, many programs, such as the Home Equity Conversion Mortgage (HECM) program sponsored by the US government, have caps on the amount that can be borrowed, and this limits the risk-management function of these mortgages.

[5] Lingling Wei, "Reverse Mortgages Gain Favor," *Wall Street Journal*, May 23, 2007.

The first effort to manage directly the risk of home price changes through insurance appears to have been the Oak Park Home Equity Assurance program of 1977. The town of Oak Park, in the suburbs of Chicago, offered insurance policies to its residents. Only a tiny fraction of homeowners in the town purchased the policies, but the policy was considered a success in the sense that it appears to have stemmed the tide of "white flight" from the city, whose racial composition was changing. The white flight was thought to be a speculative response to fears that minorities moving in would depress home prices, and could be dealt with by offering home price insurance to those in the town who were most worried, thus allaying their fears and eliminating their perceived need to sell their houses. The Oak Park program was considered enough of a success that it has been copied in about a dozen other U.S. cities, and more recently in Europe as well, but always on a very small scale.

A notable innovation came in 2003 when the town of Syracuse New York in collaboration with the Neighborhood Reinvestment Corporation and William Goetzmann and Barry Nalebuff at the Yale School of Management launched the first index-settled home equity insurance contract, a contract that limits moral hazard problems by disconnecting the insurance from the actual idiosyncratic value of the home insured. But, here too, the amount actually purchased amounted to only about 100 homes. It appears that homebuyers were not animated by fears of price declines enough to take the initiative to buy the policies. Perhaps the tendency of home price changes to evolve slowly over time has deleted a sense of psychological urgency for hedging real estate risk.

Over the years since 1990, I and my colleague Allan Weiss have tried to interest private insurance companies in launching home equity insurance policies, see Shiller and

Weiss, 1994, 1999. The companies tended to express interest, but then question whether they could accept the correlated risks that such policies entail. So, with the advent of our company MacroMarkets LLC, we concentrated our attention on trying to launch home price derivatives contracts, through which shared equity mortgage originators, reverse mortgage lenders, home equity insurers, and other providers of risk management contracts for home owners could begin to hedge the risks the acquire in the course of their business. We also thought that the price discovery that futures markets entail would make for a futures contract that was rather volatile from one day to the next, thereby making home price risk more salient and encouraging home buyers to hedge. Benartzi and Thaler have shown that investors are more cognizant of risks to investing if they are shown daily returns every day rather than annual returns at annual intervals, reflecting apparently the greater psychological salience of the former.

Just as we were starting our campaign for a home-price futures market in the US, the first futures market for single-family home prices was attempted in the United Kingdom by the London Futures and Options Exchange in 1991. The market showed little volume in its opening days, and this unfortunately provoked some traders, wishing to make the volume numbers look more impressive, to pad the trades with wash trades. After this was discovered, the market was shut down, in a matter of months. It was more than ten years until home price risk contracts were attempted again. In 2002 in the United Kingdom spread betting markets for home prices were launched, by City Index, followed by IG Index, but these later shut their markets down due to lack of investor interest during a weakening housing market. More recently, spread betting markets for home prices have been created again in the UK by Cantor Index (www.spreadfair.com), based

on the Halifax home price index, but still the market remains small and is still promoted as a gambling venue, not a hedging market.[6]

Working with our firm MacroMarkets LLC, the Chicago Mercantile Exchange (CME) launched a futures market for single family home prices in the United States on May 22, 2006. The CME housing products – both futures as well as options on futures – are currently available for ten major cities, and a composite index that is a weighted average of the ten cities. The contracts are cash settled based on the S&P/Case-Shiller® Home Price Indices that are governed by an index committee at Standard & Poor's, headed by David Blitzer, and to which I belong[7]. We are not promoting our product as a gambling device, quite to the contrary, all our efforts in real estate indexing and property derivatives product development are intended to secure new opportunities for real estate hedging and investment.

The initial behavior of our futures markets is somewhat encouraging. There is trade in all the cities, and the prices show very different behavior through time than do the underlying home price indices. The futures prices fluctuate more in line with a random-walk model and show little correlation, so far, with the home price indices. We are inclined to interpret this behavior as revealing a true price, taking into account all information. The volatility seen in the futures market offers some confirmation of our suspicion that there would be significant price discovery in the futures market, so that investor interest in hedging may be kindled. When the CME launches longer-horizon

[6] The *Sunday Times* favorably quotes an expert saying that "spread betting on property is for professional speculators only." "Stake the House on It: Spread Betting on Property Market Fluctuations," Sunday Times, Feb 4, 2007.
[7] The S&P/Case-Shiller® Home Price Indices are computed by Fiserv Inc.

futures contracts later this year, the volatility and salience of home price futures may be even greater.

Less than $0.60 billion in notional contract value has traded in U.S. home price derivatives thus far, and open interest for all CME home price futures contracts is currently less than $100mm[8]. We interpret this slow start as typical of innovative launches of futures and futures options markets, and expect the market to grow over time, and as longer-dated contracts are made available. MacroMarkets has also been working with Goldman Sachs and several other Wall Street dealers to launch over-the-counter (OTC) markets for complementary U.S. housing-linked products, such as swaps, forwards, and index-linked notes. In May 2007, the International Swaps and Derivatives Association (ISDA) published standards for the use of the S&P/Case-Shiller Home Price Indices and other benchmarks to settle OTC property derivatives transactions.

We believe that liquidity within markets for home prices will develop in due course. Indeed, the recent growth of the UK commercial property derivatives market in the last couple years, using the International Property Databank (IPD), to a notional value of £2.9 billion in the first quarter of 2007, suggests that this is realistic.[9] Complementary marketplaces that afford opportunities to trade real estate price risk in several forms and a variety of durations can reinforce each other, ultimately creating significantly greater liquidity and price transparency for property price risks.

[8] The aggregate value of U.S. residential housing stock is approximately $22.7 trillion as of year-end 2006 according to the Federal Reserve Flow of Funds data.
[9] "UK Property Swaps Ease as Slowdown Concerns Rise," Reuters News, 3 May 2007.

Efforts to Start Markets for Longevity Risks

Given the centrality of life expectancy in the fundamental maximization problem described above, it would seem that there should be extensive markets for longevity risks. Those markets should form a central element of risk management for a variety of retail products that allow individuals to manage their life-cycle risk well and to manage the risk of outliving their money. But, neither the retail products nor the central markets for longevity risk are well developed.

Target income funds, or life cycle funds, have a curious history. It would seem to make basic sense that investing strategy should depend on an individual's age. And yet, there were none at all of these until the mid 1990s, when Wells Fargo, Bank of America, Fidelity Investments, the Vanguard Group, T. Rowe Price and Putnam Investments launched these funds. At first, there was little demand for these. Then demand began to grow, along a learning curve. The learning curve is a fundamental behavioral finance construct; it has been shown to characterize the acceptance of investment vehicles time and time again.

Inflation-indexed life annuities are also still at an early stage of acceptance. The principal suppliers of life annuities are governments, as part of their social security or social welfare programs. The programs insure both against fluctuations in life expectancy and against changes in relative prices. These programs do not seem to be designed as risk-management programs that consider the general risk management problem. Typically they have the effect that all risks of the retired elderly are erased: the payments are indexed to the consumer price index, without considering where the longevity risks

and the national income risks go. Necessarily the other generations must pay into the system to make the risk management possible, at the expense of their own effective risk management. A private system of lifetime risk management that is based on a market for longevity risk would be better.

In 2003, Swiss Re launched the first longevity bond, and this was followed in 2004 by an announcement from the European Investment Bank (EIB) of plans to launch, with BNP Paribas, UK longevity bonds. But, since then, the market for longevity risk has stagnated, although there is some activity as evidenced by J.P. Morgan's announcement in 2007 of an index of longevity risk, and Swiss Re's taking on £1.7 billion of longevity risk from Friends Provident in the UK (representing 78,000 annuities contracts they had written) in May of 2007.

The EIB bonds were designed to make it easier for pension plans to offer lifetime annuities to their clients. The payments on the 25-year EIB bonds were to be linked to the fraction of UK males, age 65 in 2003, who were still alive on the coupon date. Life annuities are supposed to insure annuitants against the risk of outliving their money. Indeed, lacking a market for longevity, it is inherently difficult for issuers of life annuities to do this, since, while they can in effect pool the individual idiosyncratic risks of time of death, there is no way that they can pool the risk that life expectancy will rise or fall for everyone.

One interpretation of the slowness of the development of the longevity bonds has been that they could not "find the other side." Issuers of life annuities to pensioners are obvious buyers of the bonds, but it has been less easy to find the sellers. Or the other side did not find the market in time for this issue to succeed. Risk management institutions

have to come to understand which is more impacted by the risk of increases in longevity, and which less impacted, so that a trade between them can be executed. Unfortunately, understanding of these issues was not far enough along to encourage institutions to take their places as long or short the contracts. Such an understanding can only come with time.

Another problem with their EIB longevity bonds is that they were done in nominal, not real, terms. They were tackling one problem at a time, longevity risk, but leaving inflation risk alone. The kinds of people who are talented enough to recognize longevity risk might well recognize inflation risk as well. But the product was not there to do what they would want.

The initial lack of convincing success of these longevity risk bonds should not be taken as evidence of lack of importance of the concept, or of lack of risk-sharing opportunities.

People do not want to trade in markets that are not liquid, for various reasons. There is a startup cost to learning about the possibilities offered in any new market, and if it is impossible to fill a large order at the posted price, then a potential buyer or seller is likely to conclude that it is best to wait, and look at the market later, to see if the volume of trade has picked up enough. Market makers are unlikely to quote narrow spreads in such a market. Hedgers, who are thinking of rolling over short-term contracts to hedge long-term risks, look upon wide bid-asked spreads as evidence that the rollover costs will be significant. If one encounters a bid-asked spread of 1%, then one might conclude that if one needs to roll over a contract ten times over ten years, then that cost amounts to

something like 5% of the value being hedged, and this cost, apart from considerations of contango or backwardation, is significant relative to the potential loss.

MacroShares and Energy Risks

In an effort to create liquid markets for long-term risks, of the kinds that are of great economic significance but rarely traded, Allan Weiss and I in 1999 worked on ways to try to create markets for indices that fulfill the function of futures markets but that are more user-friendly, more accessible to a wide range of investors and hedgers. The markets would fulfill the function of futures markets in the sense that they provide price discovery for some well-defined risk in a way that is not clouded by special factors like issuer's creditworthiness. We also wanted to try to solve the problem, characteristic of futures markets, that liquidity tends to be confined to the extreme short term, so that the markets may fail to hedge against adverse information about the long term. Such securities would help people to focus on their long-term utility maximization problem.

Such securities could contribute towards a financial infrastructure for risks that can be measured by indices, securities that would also help encourage other risk-management institutions for households.

We patented a kind of security that we called "proxy assets," later renamed to "MacroShares." The patent is held by the company that we, with Sam Masucci, co-founded, called MacroMarkets LLC. The MacroShares create a new vehicle for trading long-term interests in indices. The concept was further developed by people in our firm (notably Bob Tull, formerly Vice President for New Products at the American Stock Exchange) and by people at our legal counsel, Skadden Arps, notably Richard Kadlick.

The MacroShares are created and redeemed in pairs, one long an index, the other short the index, but, after their issuance, traded separately. The first MacroShare, twenty-year securities issued November 2006, based on crude oil prices, will illustrate. The paired securities, each listed on the American Stock Exchange, are "Up Crude" (ticker symbol: UCR) and "Down Crude" (ticker symbol: DCR). The price of West Texas Intermediate was very near $60 a barrel when these were issued, and so the benchmark price for this issue was chosen to be $60. The price of a pair when issued was (and is and will be) $120. The entire proceeds of the issue is invested in U.S. 3-month Treasury Bills, and the returns on the Treasury bills are paid out to investors quarterly as dividends so that at ends of quarters the balance in the two accounts together is always $120. There is an account for the up security, and an account for the down security, together managed by a trustee. Simplifying somewhat, the UCR account balance is always kept at the price of oil on ex-dividend dates by the trustee, the DCR account balance is always kept at $120 minus the price of oil on those dates. Each of the two accounts receives the interest on their respective net asset value, and receives the net asset value upon maturity. Should the price of oil double (making it impossible for the trustee to continue to increase the up NAV) then the securities are immediately redeemed for their NAV.

The MacroShares are somewhat analogous to exchange traded funds (ETFs) in that they are automatically created and redeemed[10], but the difference here is that they are redeemed only in pairs. With this provision, no-arbitrage assures that the sum of the prices of the two securities is kept very nearly at twice the benchmark price, that is at

[10] Unlike exchange-traded funds (ETFs), the MacroShares can also be issued "in bulk" via initial public offerings, or secondary offerings of shares.

$120, and yet the price of the individual securities reflects long-term expectations and risk attitudes regarding the index that tracks the underlying asset[11].

The MacroShares are somewhat analogous to the bull and bear bonds that were issued for the Japanese stock market in 1986 by Swedish Export Credit (SEK) and Daiwa Securities, and, in the same year, the "Tom and Jerry's" for the German stock market by Deutsche Bank. These five-year index-linked bonds did not involve investment in the underlying: they were issued in pairs, one long the stock market the other short the stock market, so that the issuer could make the index-linked payouts without any stock market risk, but were traded separately, so that investors could choose between direct and inverse participation in the stock market. These shares were not an enormous success. They were issued just before the first stock-index futures markets were launched in those stock markets, and after that happened, investors saw the futures markets as superior. With the stock market already a liquid market, there was little difference between a long-term and a short-term claim on the market, and so there was perhaps no reason-for-being for these bonds alongside a liquid and successful stock-index futures market.

An important difference between the MacroShares and the bull and bear bonds, aside from the fact that they will be applied to difficult- or impossible-to-store and illiquid assets, is that in the former case the issuer is set up to do nothing at all but issue such securities. In the case of the oil MacroShares, the issuer is a subsidiary called Macro Securities Depositor LLC, which has no other business. The issuer is committed to creating or redeeming pairs whenever anyone (among the authorized participants, APs, who are any institution that satisfies certain requirements) wants to do so. They represent, therefore, a true market for the underlying index, uncolored by the activities or choices of

[11] The index can be a benchmark for an individual asset, asset class, economic indicator, etc.

the issuer. The issuer of bull and bear bonds could get into trouble for any of a number of reasons, and so those bonds have credit risk. Even apart from that, the issuer of the bonds is under no obligation to issue more if the sum of their price rises above the benchmark, or to redeem them at the benchmark if they fall below. Indeed, the bull and bear bonds (as with index-linked notes in general) may suffer from the same discounts and premiums that closed-end funds show. A substantial premium or discount for the pair would cloud the market, making investors wonder what the prices of the individual components would mean anyway. Of course, we expect to see discounts and premiums for the individual components of the MacroShares pair, but we do not want them to violate the adding-up constraints for the pair.

The oil MacroShares we issued in 2006 had a term of 20 years. This is a long time in the context of the oil market, since proven reserves will be exhausted in a few decades at the current rate of consumption. There is of course *considerable* price uncertainty over such a long time interval. The Nymex futures market goes out only 6 years, and long-term contracts see little activity. But, twenty years is not a long time from the standpoint of the long-term maximization problem that individuals face, as we saw above.

It is entirely possible that MacroShares could be made perpetual, subject to regulatory approval. Then, there is a simple interpretation of the price of the securities, at least under simplifying assumptions. If the interest rate is constant through time, then the MacroShare pays a constant multiple of the index each time period. In the oil application, the security is in effect providing to the owner a fixed number of barrels of oil each time period. If the investor is a consumer of oil, it is likely that, to a first approximation at least, the consumption is fairly stable through time, and hence the security would provide

a hedge. I argued in a recent *Forbes* magazine article that most investors, whose exposure to the oil market is as a significant buyer, may be well advised in most cases to invest in MacroShares. A typical household may consume $2000 per year in heating oil and $2000 per year in gasoline. The present value of that expenditure is something close to $100,000, a significant factor in most people's present value-calculations. Putting a sum of that order into oil MacroShares would hedge against risks to oil prices, though of course other investment considerations would have to be made.

If interest rates are not constant through time, then this simple interpretation needs adjusting. In this case, the dividend payments in terms of barrels of oil are not constant through time either. It is helpful to consider a very simple present value model. Assuming that future interest rates are known and that the securities are valued at the present value of the expectation $\hat{I}_{0t}$ at time 0 of the index I_t at time *t*, then, in continuous time, the price at time 0 of a perpetual MacroShare is:

$$P_0 = \int_0^\infty \hat{I}_{0t} r_t e^{-\int_0^t r_\tau d\tau} dt$$

Integrating by parts, we find this equals:

$$P_0 = I_0 + \int_0^\infty d\hat{I}_{0t} e^{-\int_0^t r_\tau d\tau} dt$$

It follows that the price of the MacroShare should "track" the index so long as the index is approximated by a random walk, i. e., at least insofar as the expected future changes in the index are zero. This is a curious feature of this long-term asset: changes in the rate of discount should, by this simple model, have no effect on the price of the MacroShare, as they would on any other long-term securities. This makes it easier for the public to

understand the securities, makes them more user-friendly than either futures or index-linked notes, both of which have fair value that is affected by changing interest rates in a way that is puzzling to most investors.

Thus, for example, as this simple analysis illustrates, with the UCR MacroShares trading at a 15% premium above NAV, we can interpret this premium, at least approximately, as reflecting only long-term expectations about future oil prices, and not about interest rates. One might of course hope that investors would understand that time-varying interest rates would have a clear and calculable effect on asset values, but that hope would be wishful thinking. Most investors just do not grasp why futures prices do not just track spot prices, and why fair-value calculations involve interest rates. After experiencing the difficulties in explaining fair-value calculations to an attentive class of bright college students, it is painfully obvious that the general public will not comprehend futures prices. If we wish to have a product that investors might really use to hedge their asset risks, then this simplification would seem to be important.

One problem that the public suffers from, as noted above, is money illusion. When only nominal interest rates (and not real rates) are high, the public will likely think that index-linked notes should be reduced in price, following the errors outlined by Modigliani and Cohn, described above. This might lead to massive mispricing of index-linked bonds, which would not tend to happen with the MacroShares.

Conclusion

Some of the most important achievable advances in human welfare could come about by financial innovation related to household risk management. I have reviewed

here some of the issues that come up when we consider the possibility of such major financial innovations. The underlying utility maximization problem that households face is extraordinarily complex, and involves risks that evolve over long distances into the future, routinely decades or even a century or more into the future. Research in behavioral finance has brought forth many anomalies of human behavior that need to be engineered-around.

The examples considered here of actual attempts at financial innovation to benefit the risk management of households have illustrated the inventive process, not unlike that of mechanical engineering. There are many details of construction that have to be worked out, and the process of adapting a core concept into a device that will be used by millions of people is slow and arduous.

I have concentrated here especially on a couple innovations that I have been involved with, derivative markets for single-family home prices and the MacroShares applied to oil price risk. Our experience with these shows that, as regards financial innovation, the process is at times painfully slow, but the details are eventually gotten right, because each experiment suggests another, improved, design. Innovation can be meandering; yet again, progress appears to be relentless.

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