Down or Out: Assessing the Welfare Costs of Household Investment Mistakes

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This paper investigates the efficiency of household investment decisions using comprehensive disaggregated Swedish data. We consider two main sources of inefficiency: underdiversification ("down") and nonparticipation in risky asset markets ("out"). While a few households are very poorly diversified, most Swedish households outperform the Sharpe ratio of their domestic stock index through international diversification. Financially sophisticated households invest more efficiently but also more aggressively, and overall they incur higher return

losses from underdiversification. The return cost of nonparticipation is smaller by almost one-half when we take account of the fact that nonparticipants would likely be inefficient investors.

I.   Introduction

Modern financial markets offer a rich array of investment opportunities. Households in developed countries can accumulate liquid wealth in bank accounts, money market funds, bond funds, equity mutual funds, individual bonds and equities, financial products with insurance features such as annuities and capital insurance funds, and derivative securities. In addition, many households have significant wealth in less liquid forms such as real estate and private businesses.

How do households exploit these investment opportunities? Do they typically follow the precepts of standard financial theory such as participation (taking at least small amounts of compensated risk) and diversification (avoiding uncompensated risk)? To the extent that they deviate from these precepts, are the costs of such deviation modest and therefore explicable by relatively small frictions ignored in standard theory, or are they large and accordingly hard to rationalize? How heterogeneous are household investment strategies? Are cross-sectional differences in investment strategies correlated with observable household characteristics such as age, education, and wealth?

These questions are of central importance in economics and finance, but reliable answers are extremely hard to obtain because they require a high-quality data set on investment strategies. To study household portfolios, we would like to have data with at least four characteristics. First, the data should include a representative sample of the population. Second, for each household, the data should measure both total wealth and an exhaustive breakdown of wealth into relevant categories. Third, these categories should be detailed enough to distinguish between asset classes, and for some issues—notably the question of diversification—we would like to observe holdings of individual assets. Finally, the data must be accurately reported.

In this paper we use Swedish government records to construct a panel of wealth and income data covering all Swedish households over the period 1999–2002. These data are available because Sweden levies a wealth tax. In order to collect this tax, the government assembles records of financial assets, including mutual funds, that are held outside defined contribution pension accounts. The records go down to the individual security level and are based on statements from financial institutions that are verified by taxpayers. The data set also provides information on real estate holdings and the income, demographic composition, ed-

ucation, and location of all households. For nonretirement wealth, which accounts for 84 percent of aggregate household financial wealth in 2002, our data set meets the four criteria listed above, giving us the unique opportunity to analyze the financial behavior of the entire population of an industrialized country.

We study the stocks, mutual funds, and cash held by Swedish households outside defined contribution pension accounts. Using the return histories of these assets, we estimate the total risk and systematic risk of each household portfolio within a mean-variance framework. Our measure of systematic risk is covariance with a global equity index. To the extent that stock returns are well described by a global capital asset pricing model (CAPM), our risk estimates can be used to estimate the means of Swedish household portfolio returns. We obtain four main results.

First, the median household portfolio has a mean return close to the maximum that is achievable given its standard deviation. Equivalently, its Sharpe ratio, its mean excess return over cash divided by its standard deviation, is close to the maximum level attained by a global equity index; and its return loss, the difference between its mean return and the maximum consistent with its standard deviation, is small. Earlier researchers such as Blume and Friend (1975), Kelly (1995), and Goetzmann and Kumar (2004) have found that households own severely underdiversified portfolios of individual stocks; but we show that mutual funds and cash dominate direct stockholdings in many household portfolios, limiting the return losses from concentrated stock portfolios. A majority of participating households actually outperform the Sharpe ratio of their domestic market, which can be explained by the substantial share of international securities in popular mutual funds. This finding is robust to the use of alternative asset pricing models.

Second, there is significant cross-sectional variation in the efficiency of equity investment, as measured by the Sharpe ratios of household portfolios, and in the return losses from underdiversification. At the ninety-fifth percentile of the return loss distribution, losses are large whether they are measured relative to the size of the portfolio, in dollars, or as a fraction of disposable income. Thus a minority of Swedish households do appear to be severely underdiversified.

Third, households with greater financial sophistication, as measured for instance by wealth or education, tend to invest more efficiently but also more aggressively. Their portfolios have higher Sharpe ratios but also higher volatility. As a result, sophistication generally has an ambiguous effect on the average return loss. In Sweden, we find that the average return loss from underdiversification is larger for more sophisticated households.

Fourth, measures of financial sophistication also predict the proba-

bility that a household will participate in the equity market. Households with low education and wealth are less likely to participate and more likely to invest inefficiently if they do participate. This result suggests that nonparticipating households would likely invest poorly if they entered risky asset markets. We show that the welfare costs of nonparticipation are lower by almost one-half when underdiversification costs are taken into account. Agents who are "out" might well be "down" if they entered financial markets.

Some of our results confirm earlier empirical findings on individual portfolios. Consistent with the results of Heaton and Lucas (2000), we find that Swedish households exposed to more background risk, such as entrepreneurs or large families, tend to invest less aggressively and more efficiently. Similarly, our finding that richer households attain higher Sharpe ratios seems consistent with earlier research documenting a positive correlation between rationality and wealth (Vissing-Jorgensen 2004).

Our data set has significant advantages relative to previously available data. Most work on household portfolio choice relies on surveys, such as the widely used U.S. Survey of Consumer Finances (SCF).[1] The SCF is representative and measures all components of wealth, but it reports holdings of broad asset classes rather than specific financial assets, and it relies on the accuracy of voluntary household reporting. The Swedish data cover individual financial assets, reported by financial institutions and confirmed by taxpayers, who are subject to legal penalties for inaccurate reporting.

Following the pioneering work of Schlarbaum, Lewellen, and Lease (1978) and Odean (1998, 1999), a number of authors have looked at the account records of individual investors reported by a brokerage house.[2] These brokerage records are highly accurate reports of holdings and trades in individual stocks, but they sample customers of the brokerage house rather than the entire population and do not necessarily represent total wealth even of these customers, who may also have other

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[1] Recent studies that use the SCF include Heaton and Lucas (2000), Poterba and Samwick (2001), Tracy and Schneider (2001), Bertaut and Starr-McCluer (2002), Carroll (2002), and Bergstresser and Poterba (2004). Other surveys of wealth are the Wharton survey conducted in the 1970s (Blume and Friend 1978) and the UBS/Gallup survey (Vissing-Jorgensen 2004; Graham, Harvey, and Huang 2005), both of which rely on telephone interviews, and the Health and Retirement Survey (Juster, Smith, and Stafford 1999), which has high-quality data but only on older households.

[2] Recent papers using brokerage house data include Barber and Odean (2001), Zhu (2002), Goetzmann and Kumar (2004), Ivković and Weisbenner (2005), and Ivković, Sialm, and Weisbenner (2007).

accounts elsewhere. Similar difficulties afflict registries of ownership (e.g., Grinblatt and Keloharju 2000) and recent studies of asset allocation in 401(k) accounts and other tax-favored retirement accounts.[3]

Some other work has been done using government tax records. The U.S. tax system requires reporting of wealth only in connection with the estate tax, which is levied only on the holdings of the very rich at the date of death. Blume and Friend (1978) and Kopczuk and Saez (2004) have used U.S. estate tax records to study household asset allocation, but it is hard to know how to extrapolate from wealthy and elderly households to the broader population.

Massa and Simonov (2006) have also studied the portfolios of Swedish households. Massa and Simonov do not make direct use of Swedish government records. Instead, they begin with an income and wealth survey, Longitudinal Individual Data for Sweden (LINDA), which describes a representative sample of about 3 percent of the Swedish population. LINDA contains high-quality data on income, real estate, and overall taxable wealth but gives limited information about the components of financial wealth. Only the share of each household's wealth invested in risky assets and its bank account balance are available. Massa and Simonov merge LINDA with a data set on individual stock ownership of Swedish companies from 1995 to 2000. Stock ownership data were available in this period since Swedish companies were legally required to report the identity of most of their shareholders. These reporting requirements did not apply to mutual funds or to bond issuers, and thus Massa and Simonov cannot measure bond or mutual fund holdings. Their data set, like the brokerage records used by Odean (1998, 1999), can be used to measure biases in households' decisions with respect to individual stocks, but not the overall degree of diversification in household portfolios.

The article is organized as follows. Section II presents the data and describes asset allocation at the aggregate and household levels. Section III investigates the diversification of Swedish household portfolios, using a mean-variance framework. Section IV relates portfolio efficiency to household characteristics, Section V derives implications for the welfare cost of nonparticipation, and Section VI presents conclusions. The online Appendix describes our methods in greater detail.

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[3] Recent studies of such accounts include Benartzi and Thaler (2001), Madrian and Shea (2001), Choi et al. (2002, 2004), Agnew, Balduzzi, and Sundén (2003), and Ameriks and Zeldes (2004).

II.   Household Asset Allocation

A.   Data Summary

To understand our data set, it is helpful to begin with a brief description of the Swedish economy and tax system. Sweden is an industrialized nation with a population of almost 9 million. The GDP per capita in 2002 is estimated at $27,300 when currencies are converted at purchasing power parity; this is slightly higher than the EU average of $26,000. Sweden is characterized by a large middle class, lower inequality in disposable income, and a more progressive tax and transfer system than most other industrialized nations.[4]

Swedish households are subject to both a capital income tax and a wealth tax. Capital income (interest, dividends, and capital gains) is taxed at a flat rate of 30 percent, with deductions for interest paid and capital losses. The wealth tax is paid on all the assets of the household, including real estate and financial securities, with the important exception of private businesses and shares in small public businesses.[5] It is levied at a rate of 1.5 percent on taxable wealth above a threshold, which was equal to 2 million Swedish kronor (SEK) for married couples and 1.5 million SEK for single taxpayers in 2002. The Swedish krona traded at $0.1127 at the end of 2002, so these thresholds correspond to $225,000 for married couples and $170,000 for single taxpayers. In 2002, 263,000 individuals paid a total of $430 million in wealth tax.

Because of the existence of the wealth tax, the government's statistical agency, Statistics Sweden (also known by its Swedish acronym SCB), has a parliamentary mandate to collect household-level data on wealth. Statistics Sweden compiles information on household finances from a variety of sources, including the Swedish Tax Agency, welfare agencies, and the private sector. Financial institutions supply information to the tax agency on their customers' deposits, interest paid or received, security investments, and dividends. Importantly, nontaxable securities and securities owned by investors below the wealth tax threshold are included. Employers similarly supply statements of wages paid to their employees. In April, taxpayers receive a tax return on which all the data supplied by employers and financial institutions have already been en-

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[4] For 2002, we obtain a Gini coefficient of 35.0 percent for gross income (before taxes and transfers) and 27.1 percent for disposable income. These coefficients are low by international standards.

[5] More precisely, taxable wealth is calculated as 100 percent of the value of bank accounts paying interest above 100 SEK per year, bonds and fixed-income mutual funds, capital insurance products, residential real estate, and cars and boats exceeding 10,000 SEK in value, plus 80 percent of the value of "A-list" (generally large) Swedish stocks, comparable foreign stocks, and equity mutual funds. We refer the reader to Swedish Tax Agency (2004) for further details.

tered by the tax agency. The taxpayer checks the figures and, if necessary, corrects errors and adds information or claims for deductions.

We compiled the data supplied by Statistics Sweden into a panel covering four years (1999–2002) and the entire population of Sweden. The data set includes demographic information such as age, gender, marital status, immigration status, and education, as well as household composition and identification number. All tax returns are filed individually in Sweden since the tax code does not allow the possibility of joint filing. However, the household identification number allows us to group residents by living units and thus investigate finances at the family level. There are about 4.8 million households in Sweden during our sample period.

The panel contains highly disaggregated wealth information, which lists the worldwide assets owned by the resident at the end of a tax year. All financial assets must be reported, including bank accounts, mutual funds, and stocks. The information is provided for each individual account or each security referenced by its International Security Identification Number. The database also records contributions made during the year to private pension savings, as well as debt outstanding at year-end and interest paid during the year.

We also have disaggregated data on income. For labor income, the database reports gross labor income and business sector. For capital income, the database reports for each bank account or security the income (interest, dividends) that has been earned during the year. In this article we use disposable income, and private pension contributions as a fraction of income, as proxies for financial sophistication.

We believe our data to be of unusually high quality since the information comes directly from Swedish firms, financial institutions, and state agencies. The entire population is observed, so selection bias is not a problem. We acknowledge, however, four possible weaknesses in our data set. First, we do not observe the value of households' defined contribution pension savings. These include assets in private pension plans and in public defined contribution accounts that were established in a 1999 pension reform. According to official statistics, defined contribution pension savings had an aggregate value of $25.6 billion in Sweden at the end of 2002, whereas aggregate household financial wealth invested outside pension plans amounted to $131.3 billion. Our data set therefore contains 84 percent of household financial wealth. Furthermore, since pension savings are usually invested in mutual funds, their inclusion would likely strengthen our main finding that households are reasonably well diversified.

Second, we observe the total value of capital insurance products, a form of tax-favored saving, but we do not observe the allocation of these

assets.[6] We have made several alternative assumptions about asset allocation in capital insurance and find in the Appendix that our results are robust to any of these assumptions.

Third, bank accounts need not be reported to the Swedish Tax Agency unless they receive more than 100 SEK (or $11) in interest during the year. Missing bank account data can distort our estimates of the share held by a household in risky assets but do not affect our estimates of diversification of risky portfolios. As discussed in the Appendix, we have employed several imputation methods to address this problem.

Finally, there is the issue of tax evasion, the main form of which is probably the ownership of unreported international assets. We can cross-check the accuracy of foreign holdings in our data set by comparing the cumulative sum of aggregate investment flows over a long time period. Since 1979, Statistics Sweden has reported two different measures of aggregate household investment: (1) the difference between aggregate disposable income and aggregate consumption (imputed from payroll, sales, tax, and transfer data supplied by firms and government agencies) and (2) the aggregate investment of individuals (reported by financial institutions). The cumulated difference between the first and the second estimates over the 1979–2002 period represents about 6.2 percent of the aggregate assets owned by households at the end of 2002. The discrepancy is caused by a variety of items, including the consumption of Swedish travelers in foreign countries, capital gains, and unreported foreign investment. This analysis suggests that unreported foreign assets represent a modest fraction of household assets. More generally, illegal foreign investments involve fixed costs and are likely to be significant only for the very rich.

B.   Aggregate Asset Allocation

We report in table 1 the aggregate wealth of households in our data set and its breakdown into main asset categories at the end of 2002. Specifically, we compute gross wealth as the nominal value of financial and real estate assets held by the household. Aggregate gross wealth is ap-

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[6] Capital insurance is a form of investment subjected to a special tax treatment by the Swedish Tax Authority. It exists in two forms: unit link or traditional. Unit link savings are invested in mutual funds. Traditional insurance products guarantee a minimum fixed return, which between 1999 and 2002 could not exceed the 3 percent limit set by the Finance Inspection Board (*Finansinspektionen*). The taxation of capital insurance is based on the *Statslåneränta*, which is defined as the average market interest rate on Swedish government bonds with a remaining maturity of at least five years. Swedish authorities use the *Statslåneränta* as a proxy for the long-run nominal interest rate. Capital insurance accounts are subjected to a flat tax on their market value, whose rate is 27 percent of the *Statslåneränta*. In 2002, this corresponded to a tax on market value that was slightly higher than 1 percent.

TABLE 1
AGGREGATE WEALTH STATISTICS (December 31, 2002)

	AGGREGATE HOLDINGS (in Billion Dollars)		AGGREGATE ASSET ALLOCATION (from Micro Data)	
	Micro Data (1)	Official Statistics (2)	Wealth Share (3)	Financial Share (4)
Financial assets:				
Bank accounts	46.2	45.3	9.7%	35.1%
Money market funds	7.2	5.3	1.5%	5.5%
Mutual funds	29.4	30.8	6.1%	22.3%
Domestic stocks	27.5	29.3	5.7%	20.9%
International stocks	2.3	NA	.5%	1.8%
Capital insurance	12.1	12.1	2.5%	9.2%
Bonds and derivatives	6.9	8.6	1.4%	5.2%
Total financial assets	131.7	131.3	27.5%	100.0%
Real estate:				
Residential	304.8	284.3	63.7%	
Nonresidential	42.2	60.1	8.8%	
Total real estate	347.0	344.4	72.5%	
Total gross wealth	478.7	475.7	100.0%	
Total debt	147.8	149.1		
Total net wealth	331.0	326.6		
Number of households	4,869,448	4,869,448		
Gross wealth per household	$98,313	$97,692		
Net wealth per household	$67,966	$67,072		

NOTE.—The table reports aggregate wealth statistics for all resident Swedish households on December 31, 2002. We convert all financial variables into U.S. dollars using the exchange rate at the end of 2002 (1 SEK = $ 0.1127). In col. 1, we aggregate up the value of the asset holdings observed for each household in our micro data set. Column 2 reports the corresponding official statistic published by Statistics Sweden. We compute in col. 3 the asset allocation of the aggregate portfolio of financial and real estate assets in our data set, and in col. 4 the allocation of the financial portfolio alone.

proximately $480 billion for the households in our data set. On a per household basis, we estimate gross wealth at about $98,000, debt at $30,000, and therefore net wealth at $68,000.

Financial wealth represents 27.5 percent of gross wealth, or about $27,000 per household, and real estate accounts for the remaining 72.5 percent. Financial wealth is decomposed into its main components: bank accounts, money market funds, mutual funds, stocks, capital insurance, and other assets (bonds and derivatives).

Cash, which consists of holdings in bank accounts and money market funds, represents 41 percent of financial wealth. Mutual funds, including bond and equity funds, and direct stockholdings account for another 45 percent of financial wealth. The remainder is accounted for by capital insurance products (9 percent) and directly held bonds and derivatives (5 percent).

Direct stockholdings account for almost 23 percent of financial wealth. They have a market value of $29.8 billion in our data set and primarily consist of domestic equity ($27.5 billion). Since Swedish stock

markets had a market capitalization of $201.4 billion at the end of 2002, the domestic investors in our data set owned directly 13.7 percent of Swedish stocks, a figure consistent with the 14.4 percent estimate reported by the Swedish Central Bank.[7] Foreign stocks play a minor role, with direct holdings of about $2.3 billion. This finding is consistent with the relatively high cost of trading individual foreign stocks.

International diversification, however, is readily available to Swedish investors through mutual funds, which account for 22 percent of financial wealth. Swedish financial institutions have long recognized the importance of international diversification and routinely offer their customers a wide range of corresponding products. For instance, the most popular risky mutual fund in Sweden, Robur Bank's Kapitalinvest, holds half of its assets in foreign stocks. Other very popular funds, such as SHB's Sweden/World or SEB's Aktieparfond, also invest substantially in international equity. These funds make it straightforward for middle-class Swedish households to achieve a good level of international diversification. We investigate in Section III whether households take advantage of these opportunities.

Table 1 also includes the official wealth statistics computed by Statistics Sweden. Our data set matches these official statistics remarkably well. Statistics Sweden reports aggregate financial wealth equal to $131.3 billion, which is very close to our $131.7 billion estimate. The aggregate estimates are also quite close for each category of assets. The main differences occur for mutual funds and money market funds. We attribute this discrepancy to slightly different fund classifications.[8] The aggregated holdings in both types of funds are $36.1 billion with the SCB data and $36.6 billion with our data. Our data set thus has good aggregation properties, which confirms its reliability and accuracy.

C.   Asset Allocation in the Cross Section

Aggregate statistics tell us how the average dollar of wealth is allocated. This can be quite different from the asset allocation of the average household, however, because the wealthy invest differently than poorer

[7] In table 1, domestic equity consists of all the publicly traded companies that are registered in Sweden. This definition excludes transnational companies, such as ABB or Astra Zeneca, which have important operations in Sweden, are traded in Swedish stock markets, and are included in the domestic indexes. When these companies are included in the definition of domestic equity, household direct investments in domestic stocks have an aggregate value of $29.74 billion at the end of 2002, which represents 14.8 percent of Swedish stocks. The Central Bank estimate of direct domestic stockholdings (14.4 percent) is thus contained between the low (13.7 percent) and high (14.8 percent) estimates from our data set.

[8] We characterize a fund as a money market fund if the standard deviation of its returns is less than 0.35 percent per year. This cutoff corresponds to a substantial gap in the distribution of historical standard deviations and a shift in the names of the funds.
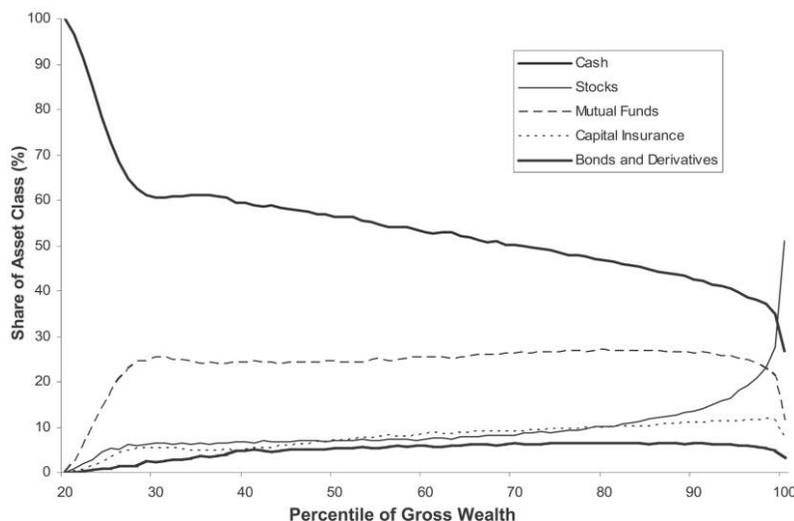
Fig. 1.—Composition of the financial portfolio. The figure represents the cross-sectional distribution of the asset allocation in the financial portfolio owned by Swedish households at the end of 2002. We subdivide households into gross wealth percentiles and report the average asset share within each wealth group. Households in the lowest two deciles are not shown in the figure because their total wealth is poorly measured and they hold almost nothing but cash.

households (Heaton and Lucas 2000; Tracy and Schneider 2001; Carroll 2002). A detailed microeconomic analysis is required to obtain a good picture of investment patterns at the household level.

Figure 1 illustrates how the composition of the financial portfolio varies with gross wealth. The horizontal axis shows percentiles of the distribution of gross wealth, starting at the twentieth percentile because the poorest 20 percent of Swedish households have almost no measurable wealth given the nonreporting of small bank accounts. The shares of all risky assets increase quickly between the twentieth and thirtieth percentiles and then become relatively stable until the ninetieth percentile. Mutual funds represent the largest fraction of risky assets held by households in this region of the wealth distribution. In the highest decile, however, direct stockholdings have a quickly increasing share and end up representing more than half of financial wealth for the richest Swedish households. Thus while stocks and mutual funds represent comparable fractions of aggregate wealth, figure 1 illustrates that mutual funds dominate stocks in most household portfolios. The wealth composition of Swedish households is consistent with results reported for other industrialized countries such as the United States (Bertaut and Starr-McCluer 2002).

Although our data can be used to examine many aspects of household finance, in this article we concentrate on diversification within portfolios of stocks, mutual funds (including both bond and equity funds), and cash (including both bank accounts and money market funds). We consider these portfolios in isolation and measure their risks using a mean-variance approach. We exclude capital insurance products because our database contains their total value but not their asset allocation. We have checked in the online Appendix that our diversification results are robust to including capital insurance products with a range of reasonable assumptions about their asset allocation.

Our data could also be used to study the risks of labor income, real estate, and directly held bonds and derivatives jointly with the risks we consider. However, this would pose significant measurement challenges because the capitalized value of labor income is not directly observed, the value of real estate is measured imperfectly and infrequently, and bonds and derivatives are numerous, sometimes short-lived, and frequently illiquid. Even excluding these other assets, we believe that mean-variance analysis is informative about diversification within households' equity and mutual fund portfolios. In principle, undiversified portfolios could be used to hedge specific risks in income or real estate, but previous research has found little evidence of this behavior. Notably, Massa and Simonov (2006) have investigated income hedging using data on direct stockholdings of Swedish households, and they find no evidence of hedging behavior except among the richest Swedish households. The main difference between their data set and ours is that we measure mutual fund holdings, which seem less suitable for income hedging than the direct stockholdings examined by Massa and Simonov.

In the remainder of the article we present a cross-sectional analysis for a random subsample that initially contains 100,000 households, or slightly more than 2 percent of the Swedish population, at the end of 2002. From the initial set of 100,000 households, we exclude those that have extremely low income or financial wealth (0.4 percent of the sample) or hold unusually short-lived assets whose risk properties are difficult to measure accurately (1.6 percent of the initial sample).[9] In the online Appendix we check that our results are robust to the inclusion of those investors.

For each household, we consider three types of portfolios: the *complete* portfolio, which contains all the stocks, mutual funds, and cash owned by the household; the *risky* portfolio, which contains stocks and risky mutual funds but excludes cash; and the *stock* portfolio, which contains

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[9] Specifically, we exclude those whose average reported disposable income over the past three years is less than 1,000 SEK ($113), whose reported financial wealth is less than 3,000 SEK ($339), or whose portfolios include assets for which we have fewer than 24 return observations through 2004.

direct stockholdings but excludes equity owned through mutual funds. The complete portfolio tells us the overall amount of risk taken by the household; the risky portfolio allows us to decompose the risk the household takes; and the stock portfolio allows us to compare our results with those of Goetzmann and Kumar (2004), who observe only directly held stocks and not mutual funds. We find that 87 percent of households that hold risky mutual funds or stocks own mutual funds, whereas 55 percent are direct stockholders. Furthermore, 76 percent of direct stockholders also own mutual funds. These facts imply that mutual funds play a key role in household diversification.

In table 2, we report summary statistics for these portfolios as well as other household characteristics in our subsample. A household is viewed as a participant in risky asset markets if its risky portfolio share is positive. A participating household takes financial risk and can make diversification mistakes. With this definition, 62 percent of Swedish households were participants at the end of 2002. Average financial wealth is substantially higher for participants ($41,000) than for nonparticipants ($8,000). We also observe that for participants, the average value of the complete portfolio we consider is about $35,000 as compared to $41,000 if we were to include capital insurance, directly held bonds, and derivatives.

III. Diversification of Household Portfolios

We now ask how households take risk within their portfolios. We begin by investigating portfolio variance, then assume an asset pricing model and use it to conduct a mean-variance analysis at the household level.

A. Idiosyncratic and Systematic Risk

We observe at the end of year t the portfolio of financial assets owned by household h. Let ω_h denote the corresponding vector of portfolio weights. The portfolio generates a random return between the end of year t and the next time the portfolio is rebalanced. Since we do not observe rebalancing within the year, we cannot directly compute household portfolio returns. For this reason, we investigate the properties of household portfolios by estimating the moments of asset returns and then inferring the household portfolio characteristics.

We begin by presenting results that impose no restriction on the mean returns of stocks and mutual funds. The risk-free rate in Sweden is proxied by the yield on the one-month Swedish Treasury bill. Excess returns are computed for all assets at a monthly frequency in local currency. We estimate the variance-covariance matrix Σ of the N assets and then impute the variance $\sigma_h^2 = \omega_h'\Sigma\omega_h$ of individual portfolios. Wer-

TABLE 2
SUMMARY STATISTICS

	All Households			Participants			Nonparticipants		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
Portfolio characteristics:									
Complete portfolio ($)	. . .	. . .	. . .	34,595	12,338	228,986	. . .	. . .	. . .
Risky portfolio ($)	. . .	. . .	. . .	18,694	4,295	174,997	. . .	. . .	. . .
Stock portfolio ($)	. . .	. . .	. . .	8,545	200	153,473	. . .	. . .	. . .
Financial characteristics:									
Disposable income ($ per year)	26,135	20,985	28,861	30,948	26,229	34,647	18,092	15,195	10,747
Private pension premia/income (%)	1.26	.00	6.15	1.70	.19	7.41	.52	.00	2.93
Financial wealth ($)	28,323	7,069	193,692	40,504	14,389	243,507	7,970	1,270	21,511
Log financial wealth	8.83	8.86	1.72	9.54	9.57	1.46	7.64	7.15	1.45
Real estate wealth ($)	75,357	26,710	208,228	102,983	59,809	253,053	29,194	0	73,507
Log real estate wealth	6.60	10.19	5.59	8.18	11.00	5.19	3.97	.00	5.23
Total liability ($)	32,156	9,222	123,177	40,625	16,608	98,274	18,004	2,876	155,139
Log total liability	6.74	9.13	4.75	7.33	9.72	4.71	5.75	7.96	4.67
Retirement dummy	.26	.00	.44	.23	.00	.42	.32	.00	.47
Unemployment dummy	.08	.00	.28	.07	.00	.25	.11	.00	.31
Entrepreneur dummy	.03	.00	.17	.04	.00	.19	.02	.00	.15
Student dummy	.04	.00	.20	.04	.00	.19	.05	.00	.22
Demographic characteristics:									
Age	52.19	51.00	18.50	51.16	50.00	17.24	53.92	52.00	20.33
Household size	1.94	1.00	1.24	2.17	2.00	1.29	1.55	1.00	1.05
High school summy	.64	1.00	.48	.71	1.00	.45	.52	1.00	.50
Post–high school dummy	.25	.00	.43	.31	.00	.46	.15	.00	.36
Dummy for unavailable education data	.17	.00	.37	.13	.00	.33	.24	.00	.43
Immigration dummy	.15	.00	.35	.11	.00	.31	.21	.00	.41

NOTE.—The table reports summary statistics of the main financial and demographic characteristics of Swedish households at the end of 2002. We convert all financial variables into U.S. dollars using the exchange rate at the end of 2002 (1 SEK = $ 0.1127). The computations are based on the random sample considered throughout the empirical analysis. Missing bank account balances are imputed using the methodology outlined in the online Appendix. All logarithms are computed in the natural base and winsorized at zero.

mers (2000) has used a similar method to evaluate the properties of stock portfolios held by mutual funds. Given a benchmark portfolio, the variance-covariance matrix Σ allows us to estimate the beta coefficients β of the assets and thus of the household: $\beta_h = \omega'_h \beta$.

We present in table 3, panel A, the characteristics of the risky portfolios owned by households at the end of 2002. The focus on risky portfolios allows us to investigate diversification choices while controlling for differences in cash holdings. The cross-sectional distribution of the risky portfolio standard deviation σ_h is reported in the first row. The total risk σ_h has a median value of 19.5 percent per year and a seventy-fifth percentile equal to 24.0 percent. Most households thus select risky portfolios with moderate standard deviations. A sizable fraction of households, however, select risky portfolios with high σ_h, such as 36.4 percent (ninetieth percentile) or 64.5 percent (ninety-ninth percentile).

We compare these results to a diversified equity benchmark. Because Sweden is a small and open economy, it is natural to consider a diversified portfolio of global stocks. We choose the All Country World Index (henceforth "world index") compiled by Morgan Stanley Capital International (MSCI) in U.S. dollars. From the perspective of a Swedish investor, the *domestic excess return* on an asset or benchmark is the difference between its return in Swedish kronor and the Swedish Treasury bill rate. Since we investigate the diversification of Swedish households, all our results are presented in terms of domestic excess returns.

A Swedish household that purchases the world index can adopt two alternative strategies. First, it can hold the index and bear the corresponding currency risk, earning the Swedish krona return on the index ("unhedged index"). Second, it can use currency forward or futures contracts to hedge currency fluctuations ("currency-hedged index"). Under covered interest parity, the corresponding domestic excess return in Swedish kronor equals the excess dollar return on the index over the U.S. Treasury bill rate.[10] Over the 1983–2004 period, the MSCI world index in U.S. dollars has a mean excess return of 6.7 percent and a mean standard deviation of 14.7 percent, that is, a Sharpe ratio of 45.2 percent.

Given a benchmark index B, we consider the regression

$$r^e_{h,t} = \alpha_h + \beta_h r^e_{B,t} + \varepsilon_{h,t}, \tag{1}$$

where $r^e_{h,t}$ and $r^e_{B,t}$ denote, respectively, the domestic excess returns on the household portfolio and on the benchmark. Note that this regres-

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[10] Solnik and McLeavey (2003) provide a textbook treatment of currency risk and hedging.

TABLE 3
DECOMPOSITION OF RISKY PORTFOLIO VOLATILITY

CROSS-SECTIONAL DISTRIBUTION

	Mean	1st Percentile	5th Percentile	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile	95th Percentile	99th Percentile
						A. Total Volatility				
Total risk σ_h (%)	22.2	4.7	7.5	11.3	16.0	19.5	24.0	36.4	49.1	64.5
Systematic risk $|\beta_h|\sigma_B$ (%)	12.8	.6	4.6	7.8	11.2	13.0	14.4	17.0	22.3	24.4
Idiosyncratic risk $\sigma_{i,h}$ (%)	17.6	4.6	5.9	8.2	11.4	14.4	18.9	31.9	43.5	62.9
Idiosyncratic share $(\sigma_{i,h}/\sigma_h)^2$ (%)	60.8	97.9	61.3	52.3	50.9	54.9	62.8	77.5	78.3	85.2
Beta coefficient β_h	.87	.04	.32	.53	.76	.89	.98	1.16	1.52	1.65
						B. Idiosyncratic Volatility				
Idiosyncratic risk $\sigma_{i,h}$ (%)	17.6	4.6	6.0	8.2	11.3	14.7	18.9	31.2	42.6	57.6
Asset volatility $\sigma_{a,h}$ (%)	21.1	5.4	8.3	8.6	14.6	18.5	26.6	35.5	48.8	70.2
Concentration $C_{a,h}$ (%)	.57	.82	.52	.91	.35	.46	.37	.72	.68	.67
Asset correlation $\rho_{a,h}$	.25	.04	.12	.14	.35	.29	.21	.14	.09	.13
Stock share D_h	.28	.01	.04	.01	.09	.16	.52	.90	.90	.82

NOTE.—The first column of each panel reports the sample mean of portfolio characteristics among participating households. In the next set of columns, households are sorted by their level of total risk (panel A) or idiosyncratic risk (panel B), and the mean of 500 households around the corresponding percentile is reported.

sion has a free intercept term and does not impose any asset pricing model. From this regression we obtain the variance decomposition

$$\sigma_h^2 = \beta_h^2 \sigma_B^2 + \sigma_{i,h}^2. \tag{2}$$

The household portfolio thus has *systematic risk* $|\beta_h|\sigma_B$ and *idiosyncratic risk* $\sigma_{i,h}$.[11]

We report in table 3, panel A, how the decomposition of a household's risky portfolio varies with its overall standard deviation σ_h. Specifically, we consider 500 households around each percentile of σ_h and compute the average risk characteristics of these households. For the median σ_h of 19.5 percent, systematic risk has a mean of 13.0 percent and idiosyncratic risk a mean of 14.4 percent. Idiosyncratic risk is thus a large determinant of the household risk exposure. The idiosyncratic variance share

$$\frac{\sigma_{i,h}^2}{\sigma_h^2} = \frac{\sigma_{i,h}^2}{\beta_h^2 \sigma_B^2 + \sigma_{i,h}^2} \tag{3}$$

has a mean value of 54.9 percent for households with median total risk. In other words, more than half the risk borne by a median household in its risky portfolio is uncorrelated with the benchmark.

Looking across the columns of table 3, panel A, we see a U-shaped pattern in the idiosyncratic variance share. This share is high for households with very low and very high total volatility. The high share for low-volatility households occurs because these households often hold bond funds, which do not move closely with the world equity index. The final row of panel A shows how the mean beta coefficient varies with total risk. The mean β_h grows monotonically with σ_h and equals 0.89 for households with median total risk.

B. Contributors to Idiosyncratic Risk

We next analyze the idiosyncratic volatility of a household risky portfolio. As in equation (1), let $\varepsilon_{h,t}$ denote the regression residual of the portfolio on the benchmark. We have $\varepsilon_{h,t} = \sum_{n=1}^{N} \omega_{n,h}\varepsilon_{n,t}$, where $\varepsilon_{n,t}$ is the residual in a regression of asset n on the benchmark. We consider a stylized symmetrical model in which the residuals of all assets in a household's portfolio have the same variance $\sigma_{a,h}^2$ and the same correlation $\rho_{a,h}$ with

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[11] Equation (2) imposes an adding-up constraint across estimates of systematic, idiosyncratic, and total variance. This constraint is automatically satisfied for sample variances if all assets in the household portfolio are observed over the same period of time, together with the benchmark portfolio. In practice, however, some assets are observed for shorter periods than others. In table 3, panel A, we present risk estimates that satisfy (2) by first calculating idiosyncratic and systematic variance and then adding the two to estimate total variance.

each other. The variance of the portfolio idiosyncratic component satisfies

$$\sigma_{i,h}^2 = \sigma_{a,h}^2 [C_{a,h} + (1 - C_{a,h})\rho_{a,h}], \tag{4}$$

where $C_{a,h} = \sum_{n=1}^{N} \omega_{n,h}^2$ is a measure of the concentration of the portfolio. Let $\bar{c}_a$ denote the average value of $\ln C_{a,h}$ in the population, and $\bar{C}_a = \exp(\bar{c}_a)$. A log linearization of (4) around $\rho = 0$ and $c = \bar{c}_a$ implies

$$\ln(\sigma_{i,h}) \approx \ln(\sigma_{a,h}) + \frac{1}{2}\ln(C_{a,h}) + \frac{1}{2}\left(\frac{1}{\bar{C}_a} - 1\right)\rho_{a,h}. \tag{5}$$

We can ask whether households that take a lot of idiosyncratic risk typically do so (*a*) by picking volatile assets, (*b*) by holding a concentrated portfolio, or (*c*) by picking correlated assets.

Panel B of table 3 presents a simple empirical analysis of this decomposition. The cross-sectional R^2 of the decomposition (5) is 98 percent. Portfolios are sorted by their idiosyncratic risk, and we calculate mean portfolio characteristics for 500 households around each percentile of the idiosyncratic risk distribution. The first row reports idiosyncratic risk, the second row reports the average idiosyncratic volatility of individual assets in the portfolio, the third row reports the concentration of the portfolio, and the fourth row reports the average correlation of assets in the portfolio.

The main influence on idiosyncratic risk is clearly the average idiosyncratic volatility of the assets in the portfolio, which increases monotonically with idiosyncratic risk. Concentration is U-shaped in idiosyncratic risk, whereas asset correlation is hump-shaped. Households with low idiosyncratic risk often hold concentrated portfolios of mutual funds, whereas households with high idiosyncratic risk hold concentrated portfolios of individual stocks. In the middle of the idiosyncratic risk distribution, households hold diversified portfolios of mutual funds and stocks that may tend to be more correlated with one another. In support of this interpretation, the last row of the table shows that the share of direct stockholdings in the risky portfolio increases strongly with the level of idiosyncratic risk.

These results show that in order to assess diversification at the household level, it is essential to observe holdings of mutual funds. The concentration of the stock portfolio, a statistic emphasized by Blume and Friend (1975) and Kelly (1995), is meaningless without a complete picture of the remaining constituents of the portfolio.

C.   Estimating the Mean Returns of Household Portfolios

Expected asset returns are notoriously difficult to estimate, and we have only short samples of data available for some of the stocks and mutual funds held by Swedish households. The median annual standard deviation for a single stock in our sample is 55 percent, and it is observed for 97 months or just over eight years. The standard error of a direct estimate of its mean return is therefore $0.55/\sqrt{(97/12)} = 19$ percent. Given the uncertainty in this direct estimate, we instead infer the mean return vector μ from an asset pricing model. Even if the asset pricing model is not exactly correct, it is likely to deliver better estimates of mean returns than the direct approach; this is an illustration of the general principle in econometrics that even false restrictions can reduce mean squared error if they reduce the variance of an estimate more than they increase its bias.

The global CAPM is a natural asset pricing framework for an analysis of diversification since it captures the expected excess return due to covariance with global equity markets. We therefore assume that assets are priced on world markets in an international currency, specifically, that the CAPM holds in dollar-denominated excess returns relative to the U.S. Treasury bill:

$$r_{j,t}^e = \beta_j r_{m,t}^e + \varepsilon_{j,t}. \tag{6}$$

The market return $r_{m,t}^e$ is measured as the U.S. dollar return of the world index in excess of the U.S. Treasury bill. As noted in subsection *A*, $r_{m,t}^e$ is also the domestic excess return of the currency-hedged world index under covered interest parity. Our use of the global CAPM therefore implies that the currency-hedged world index is mean-variance efficient from the perspective of a Swedish investor. In the online Appendix, we show that our results are robust to the use of a more general asset pricing model, the three-factor Fama-French model.

We estimate μ, given Σ, using standard procedures summarized in the online Appendix. Since the spread between the risk-free rate and the yield on bank deposits can be considered as a compensation for bank services, bank balances are assumed to earn the risk-free rate. We also assume that all money market funds earn this rate, an assumption that is consistent with the data we have on money market fund returns.

We report in figure 2 a scatter plot of household portfolios in the mean–standard deviation plane. In order to produce a clear picture, we plot a subsample of 10,000 randomly selected households. Figure 2*A* shows the risk characteristics of households' stock portfolios, which
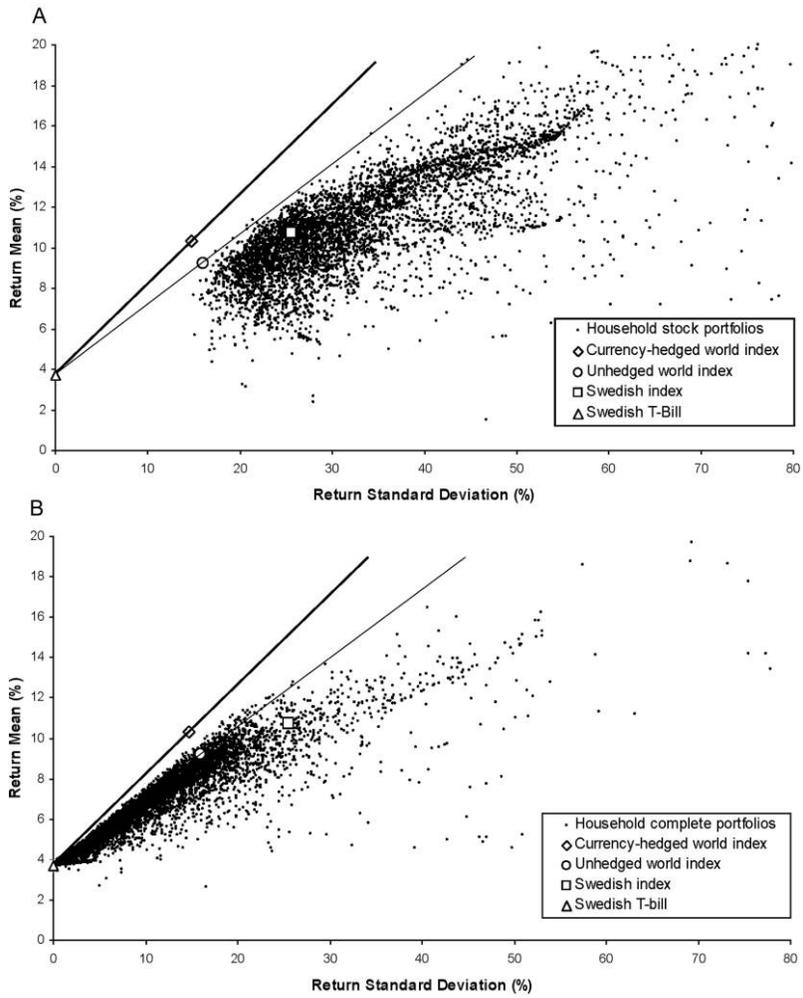
Fɪɢ. 2.—Scatter plots of household portfolios. *A*, Stock portfolios. The scatter plot illustrates the mean and standard deviation of household stock portfolio returns. *B*, Complete portfolios. The scatter plot illustrates the mean and volatility of household complete portfolios. The mean returns are inferred from the global CAPM, in which the currency-hedged world index (empty diamond) is mean-variant efficient. The graphs are based on a random sample of 10,000 households at the end of 2002.

appear quite inefficient as found by Goetzmann and Kumar (2004).[12] Figure 2*B* includes households' cash and mutual fund holdings and presents a more optimistic view of households' risk management. Households appear much better diversified when we include their holdings of mutual funds and scale their risky asset holdings by their total financial assets rather than merely their stockholdings.

In the online Appendix, we report the most widely held stocks and mutual funds in our entire database of all Swedish households. For individual stocks, we eliminate households that hold more than $5 million in a single stock. This procedure filters out large insider holdings and enables us to focus on "popular stocks." The telecommunications company Ericsson is the most widely held stock in Sweden. It is directly owned by almost half of direct investors, and its share of direct stockholdings (8.6 percent) is considerably larger than its value share of the Swedish index (5.2 percent). Other popular stocks include telecommunications companies (TeliaSonera), fashion companies (Hennes and Mauritz), paper manufacturers (Svenska Cellulosa), pharmaceuticals (Astra Zeneca and Pharmacia), and banks (SEB, SHB, and Förenings Savings Bank, or FSB). There is also a Finnish stock (Nokia). These stocks are well-known household names, but they have relatively low Sharpe ratios averaging 17 percent.

The 10 most popular funds are characterized by considerably higher Sharpe ratios, averaging 30 percent. They are sold by a few large banks: the aforementioned SEB, SHB, and FSB, along with Nordea. We note that most of them are internationally diversified. With the exception of SEB Sverige, each fund holds more than 25 percent of its assets in international securities. The most widely held fund (FSB/Robur Kapitalinvest) contains 54 percent of international stocks, and the second most popular fund (Nordea Futura) holds 17 percent in foreign stocks and 33 percent in foreign bonds. These numbers suggest that popular mutual funds enable Swedish households to achieve reasonable levels of international diversification. None of these funds, however, hedges for currency risk. It is thus considerably easier for Swedish households to hold portfolios with the efficiency of the unhedged world index than to hold portfolios that are comparable to the hedged world index.

D. Mean-Variance Measures of Diversification

We now provide a detailed quantitative assessment of the losses that households incur from suboptimal diversification. The moments of all

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[12] One popular combination of Swedish stocks is visible in this figure. Many Swedish investors directly hold both Ericsson and TeliaSonera, a telecommunications stock that was widely promoted in a privatization. The resulting two-stock portfolios form a hyperbola visible at the right of fig. 2*A*.

assets and portfolios are based on the global CAPM (6) described in the previous subsection.

Relative Sharpe ratio loss.—Diversification losses can be computed by comparing the Sharpe ratio of a household portfolio to the Sharpe ratio of a benchmark index, which need not necessarily be mean-variance efficient. For every household h, we denote by μ_h and σ_h the mean and standard deviation of the domestic excess return on the risky portfolio and by $S_h = \mu_h/\sigma_h$ the corresponding Sharpe ratio. Of course, the Sharpe ratio on the household's complete portfolio is also S_h. Similarly, we define the Sharpe ratio on the benchmark index as $S_B = \mu_B/\sigma_B$. The loss from imperfect diversification with respect to the benchmark can be quantified by the relative Sharpe ratio loss:

$$\mathrm{RSRL}_h = 1 - \frac{S_h}{S_B}. \tag{7}$$

The relative Sharpe ratio loss RSRL_h has several attractive features. First, it is independent of the aggregate equity premium, which is notoriously hard to measure. In fact, it is easy to show that $\mathrm{RSRL}_h = 1 - (\beta_h/\sigma_h)/(\beta_B/\sigma_B)$, so it depends only on the betas of the household portfolio and the benchmark with the mean-variance efficient index, together with their standard deviations.

Second, when the benchmark portfolio used to calculate the relative Sharpe ratio is itself mean-variance efficient—as will be the case when the dollar CAPM holds and we use the currency-hedged world index as the benchmark—the relative Sharpe ratio loss is a nonlinear transformation of the share of idiosyncratic variance we reported in table 3. The relation is

$$(1 - \mathrm{RSRL}_h)^2 = 1 - \frac{\sigma_{i,h}^2}{\sigma_h^2}. \tag{8}$$

Thus a high share of idiosyncratic variance, as found in table 3, implies a high relative Sharpe ratio loss with respect to the mean-variance efficient index.[13]

Finally, when the benchmark portfolio is mean-variance efficient, we

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[13] More generally, the relative Sharpe ratio loss with respect to an arbitrary benchmark B satisfies

$$(1 - \mathrm{RSRL}_h)^2 = \left(1 - \frac{\sigma_{i,h}^2}{\sigma_h^2}\right)\bigg/\left(1 - \frac{\sigma_{i,B}^2}{\sigma_B^2}\right),$$

where $\sigma_{i,h}$ and $\sigma_{i,B}$ denote idiosyncratic risk relative to the efficient index.

also have that RSRL_h equals one minus the correlation of the household portfolio with the benchmark:

$$\text{RSRL}_h = 1 - \text{Corr}(r^e_{ht},\ r^e_{mt}). \tag{9}$$

This property follows from the fact that the right-hand side of equation (8) is the R^2 statistic of the regression (1) or, equivalently, the square of the correlation of the dependent variable with the regressor.

Uncertainty about the relative Sharpe ratio loss arises from uncertainty about the correlation between a household's portfolio and the benchmark index. We know by (9) that the median correlation is 0.65, and we have 97 months of return data for an average asset in the household portfolio. The asymptotic formula for the standard error of a correlation, $(1 - \rho^2)/\sqrt{T}$, where ρ is the true correlation and T is the number of time-series observations (see, e.g., Johnson, Kotz, and Balakrishnan 1995, chap. 32), implies that the typical standard error for a household's relative Sharpe ratio loss is about 0.06. As we average across households, we shrink the uncertainty about the average relative Sharpe ratio loss, but the rate at which we do so depends on the correlation of idiosyncratic returns across households, that is, the extent to which different households follow similar undiversified investment strategies. We do not attempt to calculate standard errors for average relative Sharpe ratio losses in this article, but merely report point estimates.

In table 4, we consider three indexes for the benchmark Sharpe ratio S_B: (1) the currency-hedged world index, (2) the unhedged world index, and (3) an index of the domestic stock market (MSCI Sweden Equity). According to the global CAPM, the benchmark Sharpe ratio S_B is only 27.4 percent for the Swedish index, but 45.2 percent for the hedged world index, which is mean-variance efficient by construction. The unhedged index has an intermediate Sharpe ratio equal to 34.6 percent; this illustrates that the inefficiency of the Swedish index is due to both currency risk and suboptimal concentration in national stocks.

Table 4 reports the cross-sectional distribution of the relative Sharpe ratio loss on the complete portfolio in our sample of Swedish households. The first row uses the hedged world index as the benchmark, the next row uses the unhedged world index, and the third row uses the Swedish index. The median household has a relative Sharpe ratio loss of 35 percent with respect to the hedged world index under the assumption that the dollar CAPM holds. The relative Sharpe ratio loss is smaller at 14 percent with respect to the unhedged world index. Relative to the Swedish index, the median Swedish household actually has a negative relative Sharpe ratio loss of −8 percent, indicating that Swedish households are sufficiently diversified internationally to outperform their own domestic stock index. These results are consistent

TABLE 4
DIVERSIFICATION LOSSES

				CROSS-SECTIONAL DISTRIBUTION				
BENCHMARK	Mean	25th Percentile	50th Percentile	75th Percentile	90th Percentile	95th Percentile	99th Percentile
				A. Complete Portfolio Relative Sharpe Ratio Loss				
Currency-hedged world index	.38	.29	.35	.42	.55	.69	.89
Unhedged world index	.19	.07	.14	.24	.41	.60	.85
Sweden index	−.02	−.16	−.08	.04	.26	.49	.82
				B. Complete Portfolio Return Loss (%)				
Currency-hedged world index	1.68	.54	1.17	2.06	3.40	5.04	9.86
Unhedged world index	.66	.09	.30	.71	1.58	2.65	5.84
Sweden index	−.01	−.36	−.11	.05	.61	1.17	3.28

	C. Risky Portfolio Return Loss (%)						
Currency-hedged world index	4.14	2.01	2.92	4.21	8.51	12.16	17.91
Unhedged world index	1.75	.40	.87	1.73	4.61	7.07	11.25
Sweden index	.16	−.82	−.39	.22	1.93	3.20	7.52
	D. Return Loss in Dollars						
Currency-hedged world index	740	36	131	433	1,190	2,204	7,566
Unhedged world index	321	6	33	133	426	851	3,254
Sweden index	43	−55	−8	4	78	218	1,129
	E. Return Loss as a Fraction of Disposable Income (%)						
Currency-hedged world index	2.13	.14	.51	1.64	4.48	7.84	23.99
Unhedged world index	.86	.02	.13	.52	1.62	3.13	11.42
Sweden index	.02	−.20	−.03	.02	.32	.89	4.48

with the fact that the portfolios of many Swedish households contain a large fraction of international investments and mutual funds.

Finally, the table reveals large heterogeneity in the losses incurred by households. For example, 5 percent of households have Sharpe ratios below one-third the level of the hedged world index. While a large fraction of households seem to achieve a fairly reasonable level of performance, a nontrivial fraction of the population invests in a highly inefficient manner.

Return loss.—The relative Sharpe ratio loss quantifies the diversification level achieved by a risky portfolio. For complete portfolios, however, this statistic provides only limited information on overall efficiency. Consider for instance an investor who allocates a small fraction of her wealth to a single stock and invests the rest in the riskless asset. The relative Sharpe ratio loss reveals the inefficiency of the risky portfolio, but the investor might in fact be very close to the mean-variance frontier.

Accordingly we consider the following alternative measure. The *return loss* is the average return a household loses by choosing the household portfolio rather than a position combining the benchmark portfolio with cash to achieve the same risk level:

$$RL_h = w_h(S_B\sigma_h - \mu_h), \tag{10}$$

where w_h denotes the portfolio's weight in risky assets. In the mean–standard deviation plane, the return loss is the vertical distance between the household portfolio and the line connecting the riskless asset with the benchmark portfolio. When the benchmark is mean-variance efficient, this is the vertical distance between the household portfolio and the efficient frontier.

The return loss can be related to the relative Sharpe ratio loss in two different ways. First, we have

$$RL_h = S_B w_h \sigma_h \text{RSRL}_h. \tag{11}$$

The return loss is the product of the Sharpe ratio on the benchmark portfolio, which of course does not vary across households, the household's weight in risky assets, the standard deviation of the risky assets chosen by the household, and the household's relative Sharpe ratio loss. This "total risk decomposition" relates return loss to the total risk taken by the household and the portfolio inefficiency of the household.

Second, we have

$$RL_h = (Er_m^e)w_h\beta_h\left(\frac{\text{RSRL}_h}{1 - \text{RSRL}_h}\right). \tag{12}$$

The return loss is the product of the expected excess return on the mean-variance efficient market portfolio, which can but need not be

the same as the benchmark portfolio and of course does not vary across households, the household's weight in risky assets, the beta of the household's risky assets with the market portfolio, and a nonlinear increasing transformation of the household's relative Sharpe ratio loss. This "systematic risk decomposition" relates return loss to the systematic risk taken by the household—equivalently, the mean excess return that the household would earn if its portfolio were mean-variance efficient—and the portfolio inefficiency of the household relative to the benchmark.

Both decompositions show that the return loss, unlike the relative Sharpe ratio loss, depends on the expected excess return of the market portfolio.[14] In the results that follow, we assume that this equals the 1983–2004 average of 6.7 percent for the currency-hedged world index. It is straightforward to rescale the return loss to reflect alternative assumptions about the world equity premium.

An alternative measure of portfolio inefficiency is the excess standard deviation of the portfolio relative to an investment in the benchmark portfolio with the same mean return. This is the horizontal distance from the household's portfolio to the line connecting the riskless asset with the benchmark portfolio. The horizontal distance is just the vertical distance divided by the Sharpe ratio of the benchmark. When we divide (11) by S_B, the horizontal distance is $w_h\sigma_h\mathrm{RSRL}_h$, a quantity that does not depend on risk premia. Given the Sharpe ratios of the equity indexes, it is straightforward to obtain estimates of excess standard deviations from the return losses we report.

In table 4, we report return losses for households' complete portfolios (setting w_h equal to the share of the risky portfolio in the complete portfolio) and for their risky portfolios (setting w_h equal to one). The median return loss on the complete portfolio is 1.17 percent with respect to the hedged world index. The median return loss is smaller with respect to the unhedged world index at 0.30 percent and negative with respect to the Swedish index at -0.11 percent. Median losses are about three times larger, in absolute value, for risky portfolios than for complete portfolios. This is consistent with the large share of Swedish household wealth held in riskless assets.

As with Sharpe ratios, we observe considerable heterogeneity in return losses. The costs of underdiversification are modest for a majority of investors but are substantial for a sizable minority. For instance, 5 percent of investors have return losses on their complete portfolios of 5 percent per year or more.

One possible concern with these loss measures is that they measure underdiversification costs in return units; that is, they measure costs

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[14] This expected excess return determines the Sharpe ratio of the benchmark portfolio in (11), given the second moments of returns.

relative to the size of an investor's portfolio. If an investor has only a very small portfolio, the implied cost in dollars or as a fraction of income may be negligible. To address this concern, in table 4 we also report return losses in dollars per year and as a fraction of disposable income (measured as an average over three years to reduce the influence of temporary fluctuations). We see that the median cost of underdiversification is only $131 per year with respect to the hedged world index and $33 per year with respect to the unhedged world index. However, the distribution of dollar costs has a fat right tail. The ninetieth percentile is $1,190 with respect to the hedged world index, and there are some large dollar numbers in the top decile resulting from large undiversified Swedish portfolios. Similarly, when we scale by disposable income, we find that the median return loss is only 0.51 percent of disposable income, but the ninetieth percentile is 4.48 percent of disposable income. Some extremely high numbers in the far right tail of this distribution result from disposable income close to zero.

Connecting the dots.—We now summarize how the various results fit together. The risky portfolio of a participating household has a median value of $4,295 (table 2) and a median β_h with the hedged index equal to 0.89 (table 3). Since the risk premium on the hedged index is assumed to be 6.7 percent, the median participating household earns an excess payoff of $4,295 \times 0.89 \times 6.7\%$, or $256 per year compared to a pure cash investment.

In table 3, panel A, we observe that 54.9 percent of the risk borne by the median household is idiosyncratic and thus unrewarded in the global CAPM. The Sharpe ratio loss RSRL relative to the hedged index is therefore 0.33 by (8). Since the hedged and unhedged indexes have Sharpe ratios of 45.2 percent and 34.2 percent, respectively, the median Sharpe ratio loss is $1 - (45.2/34.2)(1 - 0.33) = 0.12$ relative to the unhedged index.[15] These estimates match quite closely the Sharpe ratio results of table 4.

The median volatility σ_h of the risky portfolio is 19.5 percent (table 3, panel A). Since the return loss is $RL_h = (S_m - S_h)\sigma_h = S_m\sigma_h\text{RSRL}_h$, we infer that the median return loss on the risky portfolio is $45.2\% \times 19.5\% \times 0.33 = 2.91\%$ relative to the hedged index and $34.2\% \times 19.5\% \times 0.12 = 0.80\%$ relative to the unhedged index, numbers that are consistent with table 4. The corresponding dollar losses from suboptimal diversification, $4,295 \times 2.91\% = 125 (hedged index) and

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[15] We note that

$$\text{RSRL}_h^B = 1 - \left(\frac{S_h}{S_m}\right)\left(\frac{S_m}{S_B}\right) = 1 - \left(\frac{S_m}{S_B}\right)(1 - \text{RSRL}_h^m),$$

where RSRL_h^B and RSRL_h^m denote, respectively, the Sharpe ratio loss relative to the benchmark B and efficient index m.

$4,295 × 0.80% = $34 (unhedged index), also closely match the $131 and $33 estimates reported in table 4.

Thus, by choosing an underdiversified portfolio, the median household earns a risk premium of less than $260 per year on its $4,300 risky portfolio instead of the $290 it could earn by investing in the unhedged index and cash, or the $380 that it could earn by picking an efficient portfolio with the same volatility. While this description characterizes a large fraction of the population, we also find that some investors make very poor choices and incur much larger losses.

IV. Who Is Underdiversified?

We have shown that many Swedish households choose reasonably efficient portfolios, but a few appear to be dramatically underdiversified. We now ask how the characteristics of households predict the characteristics of the portfolios they hold.

A. Decomposition of Return Loss

In order to investigate these issues, we decompose the return loss on the complete portfolio into components related to aggressiveness and portfolio inefficiency. We could do this using either (11) or (12), but we choose to use the latter. That is, we measure household aggressiveness using systematic risk rather than total risk. In the Appendix we show similar results based on (11).

Taking logs of (12) under the assumption that all terms are positive, we have that

$$\ln RL_{\text{complete},h} = \ln (Er_m^e) + \ln w_h + \ln \beta_h + \ln\left(\frac{\text{RSRL}_h}{1 - \text{RSRL}_h}\right), \quad (13)$$

where $\text{RSRL}_h = 1 - (S_h/S_B)$ is the relative Sharpe ratio loss on the household portfolio. This exact decomposition relates a household's complete return loss to the log equity premium, which is the same for all households, the household's portfolio share of risky assets, the beta of the household's risky portfolio with the currency-hedged world index, and a nonlinear transformation of the household's relative Sharpe ratio loss. Of the household-specific terms, the first two are related to aggressiveness, and the last measures portfolio inefficiency.

Next we ask how these determinants of return loss covary with observable household characteristics. In table 5, we regress return loss and each household-specific component of (13) onto demographic and financial variables. Demographic characteristics are measured for the

TABLE 5
Contributors to Complete Return Loss

	Return Loss $\ln(RL_{complete,h})$			Risky Share $\ln(w_h)$			Risky Portfolio Beta $\ln|\beta_h|$			Diversification Loss $\ln|RSRL_h/(1-RSRL_h)|$		
	Estimate (1)	t-Statistic (2)	Change (3)	Estimate (4)	t-Statistic (5)	Change (6)	Estimate (7)	t-Statistic (8)	Change (9)	Estimate (10)	t-Statistic (11)	Change (12)
Financial characteristics:												
Disposable income	.007	3.49	2.1%	−.007	−3.83	−2.1%	.009	9.12	2.7%	.005	4.79	1.5%
Private pension premia/income	.248	3.36	1.8%	.351	4.92	2.6%	−.016	−.44	−.1%	−.087	−2.17	−.6%
Log financial wealth	.090	20.20	14.1%	.137	31.90	22.3%	−.016	−6.93	−2.2%	−.032	−13.00	−4.5%
Log real estate wealth	.008	7.97	5.1%	.005	5.21	3.2%	.003	6.65	2.1%	.000	−.75	−.3%
Log total liability	.012	9.40	7.0%	.004	3.21	2.3%	.010	15.00	5.6%	−.002	−2.29	−.9%
Retirement dummy	−.043	−1.95	−4.2%	−.023	−1.10	−2.3%	−.050	−4.53	−4.9%	.031	2.53	3.1%
Unemployment dummy	−.086	−4.01	−8.2%	−.105	−5.06	−9.9%	−.001	−.11	−.1%	.020	1.72	2.0%
Entrepreneur dummy	−.115	−4.01	−10.8%	−.261	−9.40	−22.9%	.097	6.75	10.2%	.049	3.11	5.0%
Student dummy	.020	.65	2.0%	.069	2.32	7.1%	−.053	−3.44	−5.2%	.004	.24	.4%

Demographic characteristics:

Age	−.001	−1.97	−1.9%	−.001	−2.01	−1.9%	−.002	−7.56	−3.7%	.002	6.90	3.8%
Household size	−.143	−29.30	−16.9%	−.086	−18.20	−10.5%	−.010	−4.13	−1.3%	−.047	−17.60	−5.9%
High school dummy	.111	6.87	10.5%	.107	6.87	10.2%	.057	7.06	5.6%	−.053	−6.07	−5.5%
Post–high school dummy	.173	13.20	18.9%	.124	9.81	13.2%	.042	6.47	4.3%	.006	.89	.6%
Dummy for unavailable education data	.112	4.62	11.9%	.087	3.68	9.1%	−.037	−3.04	−3.7%	.063	4.74	6.5%
Immigration dummy	.043	2.53	4.4%	−.112	−6.76	−10.6%	.045	5.26	4.6%	.110	11.80	11.6%
Intercept	−1.093	−20.00	. . .	−2.751	−52.20	. . .	−.108	−3.95	. . .	−.127	−4.27	. . .
Adjusted R^2	.03			.04			.05			.03		

NOTE.—This table reports the OLS regression of the log complete return loss and its three components onto observable household characteristics. Losses are computed relative to the hedged world index. For each regression, we report the linear coefficient, standard deviation, and marginal effect of each predicting variable. The marginal effect is assessed by computing the impact on the dependent variable (in levels) of increasing a continuous regressor by one standard deviation, or of setting a dummy variable equal to one. Since

$$\ln(RL_{complete,h}) = \ln(E[r_m^e]) + \ln(w_h) + \ln|\beta_h| + \ln|RSRL_h/(1 - RSRL_h)|,$$

the coefficient estimate for the complete loss in each row is the sum of the other three coefficient estimates (with the exception of the intercepts in the last row). Financial variables are expressed in Swedish kronor, and disposable income is rescaled as a multiple of 100,000 SEK. All logarithms are computed in the natural base and winsorized at zero.
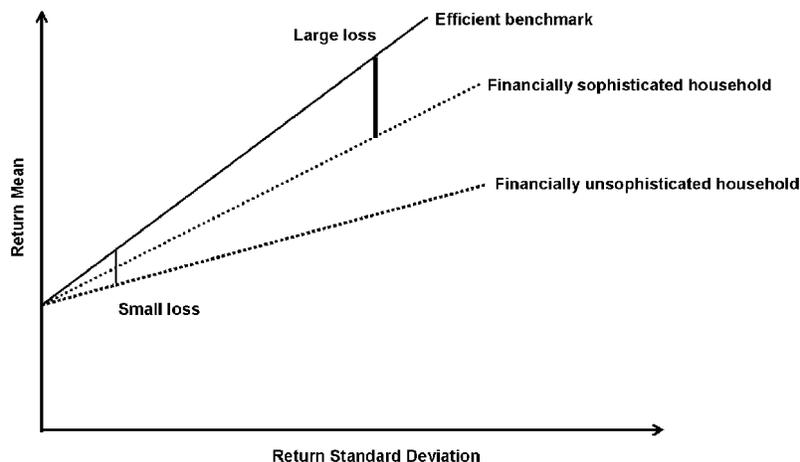
Fig. 3.—Impact of financial sophistication on the complete return loss. Rich and educated households select portfolios with a high Sharpe ratio but also a high risky share, resulting in a high complete return loss. Conversely, unsophisticated households allocate a small fraction of their financial wealth to an inefficient risk portfolio and overall incur low complete portfolio return losses.

household head, taken to be the household member with the largest disposable income.

Column 1 of the table shows that the return loss *increases* with measures of financial sophistication such as wealth, education, the ratio of private pension contributions to income, and liabilities. The remaining columns reveal that these characteristics are typically associated with more efficient investing (lower Sharpe ratio loss), but also considerably higher shares of risky assets and in some cases higher betas for the risky portfolio. Households with standard predictors of financial sophistication invest more in risky assets and choose more diversified portfolios, but overall they bear higher return losses than unsophisticated households. Conversely, the retired and unemployed dummies are associated with lower investment skills and lower risky shares, which overall result in lower return losses.

One interpretation of these patterns is that less sophisticated households are aware of their limited investment skills and invest cautiously because they do not feel sufficiently competent to achieve a high Sharpe ratio. In figure 3, we illustrate how the combination of lower efficiency and lower risk taking results in modest return losses for less sophisticated households.

Entrepreneurs, defined as household heads working at least part-time for their own businesses, tend to invest less in risky financial assets and as a result have lower return losses than the rest of the population.

These results are consistent with the findings of Heaton and Lucas (2000). The natural interpretation is that entrepreneurs bear idiosyncratic risk in their own private businesses, which discourages them from taking additional risk in public equity.

Finally, we acknowledge that the explanatory power of our regressions is quite low. There is considerable heterogeneity in investment strategies that is not captured by the demographic variables in our data set.

B.   Robustness Checks

The apparent inefficiency of some household portfolios might result from tax optimization strategies. The Swedish income tax code treats symmetrically the main types of capital income: interest, dividends, and capital gains are all taxed at a flat rate of 30 percent. Investors therefore have no tax incentive to purchase low-dividend-paying stocks. In addition, they can deduct 100 percent of capital losses against capital gains, which limits the negative skewness in after-tax returns.

The Swedish wealth tax, however, can cause distortions in portfolio choices because it is not levied on the stocks of certain companies (O shares). This exemption was initially designed to reduce the cost of capital for young innovative firms. In the online Appendix, we obtain very similar return losses when we rerun our analysis on households that do not pay the wealth tax, confirming that our basic results are robust to the different tax treatment of O shares. Our results thus seem robust to the relatively simple tax optimization strategies considered above. We acknowledge, however, that tax optimization can have more subtle effects, and we leave for further research the detailed analysis of its implications for household portfolios.

In the online Appendix, we have also verified the robustness of our results to alternative assumptions about the currency hedging of the benchmark index, the year of observation (1999–2002), the use of the Fama-French asset pricing model in place of the global CAPM, the availability of leverage, and the fees charged by mutual funds. The results presented so far ignore mutual fund fees, assuming that after-fee returns obey the global CAPM in the same way that individual stock returns do. Rough calculations measuring the fees on the 10 most widely held mutual funds (in the range 1.3–1.5 percent), and assuming equal fees of 1.4 percent on all other mutual funds and index fees of 0.4 percent on the benchmark, increase median return losses by about 30 basis points; in future work we hope to be able to measure more accurately fund-specific fees and the resulting drag on household investment performance.

The online Appendix also discusses the nature of the age effect on portfolio choice and calculates welfare costs of underdiversification un-

der the assumption that Swedish households have constant relative risk aversion. Finally, we discuss briefly the extent to which our results may be expected to apply to other countries besides Sweden.

V.   Down or Out?

We now turn our attention to the population of nonparticipants and use what we have learned about underdiversification to compute their welfare losses.

A.   *Who Participates in Risky Asset Markets?*

We first investigate the decision to participate in risky asset markets. As in earlier research (e.g., Vissing-Jorgensen 2002*a*, 2002*b*), the data set allows us to investigate the correlation between participation and other household characteristics. In columns 1–3 of table 6, we report the results of a probit regression. The estimates show that a household is more likely to participate if it has higher income, has higher financial or real estate wealth, has higher liabilities, or is more educated. Participation rates are also higher for retirees and investors with large contributions to a private pension plan relative to disposable income. Variables negatively related to participation include age, household size, unemployment, and immigration. Entrepreneurship has no significant effect. These findings are consistent with the assumption that risky investments require fixed learning and setup costs, which may be smaller for more educated and sophisticated households and are worth paying only if financial asset holdings are sufficiently large.

We determine the relative importance of these variables by considering a reference household that is assigned the average of all continuous characteristics and zero values for all dummy variables. We then examine one-by-one the marginal effect of each predicting variable. Column 3 of table 6 reports the impact of increasing a continuous regressor by one standard deviation or of setting a dummy variable to one. We observe that financial wealth has the strongest impact on participation: a one-standard-deviation increase in wealth increases the participation rate by more than 20 percentage points. Disposable income, age, education, immigration, and the share of private pensions also have substantial effects in excess of five percentage points.

We conclude that variables that predict underdiversification, such as low education and low wealth, also predict nonparticipation. It is possible that nonparticipating households are aware of their limited investment skills and prefer to stay out of risky asset markets rather than make poor investment choices. We next use this observation to ask what is the welfare cost of nonparticipation.

TABLE 6
Participation and Risky Asset Share

	Participation: Probit Regression			Complete Portfolio Risk: $w_h\sigma_h$			Sharpe Ratio: S_h		
	Estimate (1)	t-Statistic (2)	Change (3)	Estimate (4)	t-Statistic (5)	Change (6)	Estimate (7)	t-Statistic (8)	Change (9)
Financial characteristics:									
Disposable income	.106	15.30	8.8%	.096	7.38	3.1%	−.001	−5.24	−.6%
Private pension premia/income	3.053	14.00	6.1%	.533	1.08	.4%	.009	2.24	.2%
Financial wealth (in log)	.491	115.00	22.9%	.566	18.90	9.0%	.003	12.90	1.6%
Real estate wealth (in log)	.021	22.80	4.6%	.026	3.78	1.7%	.000	.75	.1%
Total liability (in log)	.017	13.50	3.3%	.117	13.50	7.1%	.000	1.92	.3%
Retired dummy	.137	6.04	4.6%	−.347	−2.33	−3.8%	−.003	−2.49	−1.0%
Unemployment dummy	−.065	−3.61	−2.3%	−.019	−.14	−.2%	−.002	−1.92	−.8%
Entrepreneur dummy	−.030	−.94	−1.0%	−.011	−.06	−.1%	−.005	−3.42	−1.8%
Student dummy	.028	1.08	1.0%	.079	.38	.9%	.000	−.08	.0%
Demographic characteristics:									
Age	−.014	−26.30	−9.8%	−.025	−6.38	−4.6%	.000	−6.78	−1.2%
Household size	−.009	−1.62	−.4%	−1.112	−34.00	−15.6%	.005	18.70	2.2%
High school dummy	.195	13.50	7.1%	.718	6.62	7.8%	.005	6.21	1.8%
Post–high school dummy	.130	9.12	4.3%	1.119	12.70	12.1%	−.001	−1.22	−.3%
Dummy for unavailable education data	−.066	−3.04	−2.3%	.731	4.47	7.9%	−.006	−4.47	−2.0%
Immigration dummy	−.384	−26.30	−14.4%	.873	7.59	9.5%	−.011	−12.60	−4.0%
Intercept	−4.852	−98.80	. . .	3.982	10.90	. . .	.244	85.10	. . .
Adjusted R^2	.04			.04			.03		

NOTE.—Columns 1–3 report a probit regression of the participation decision on financial and demographic household characteristics. Participation is defined as the ownership of at least one risky asset. Columns 4–6 report an OLS regression of the participants' risky share on the same set of observable characteristics. The risky share is defined as the weight of risky assets in the complete portfolio. For each regression, we report the linear coefficient, standard deviation, and marginal effect of each predicting variable. The marginal effect is assessed by computing the impact on the dependent variable of increasing a continuous regressor by one standard deviation, or of setting a dummy variable equal to one. The reported change is the absolute increase in the probability of participation for the probit and the percentage change in the dependent variable for the other two regressions. Financial variables are expressed in Swedish kronor, and disposable income is rescaled as a multiple of 100,000 SEK. All logarithms are computed in the natural base and winsorized at zero.

B.   The Welfare Cost of Nonparticipation

Economists often argue that nonparticipation in risky asset markets is a serious investment mistake. When one is calculating the return cost of nonparticipation, it is standard to assume that a participating household invests efficiently and therefore earns the equity premium. We have shown, however, that many households are underdiversified. We now take this phenomenon into account and present more realistic estimates of the return that a household loses by nonparticipation.

The return cost to a household of nonparticipation depends on the Sharpe ratio S_h^* and portfolio volatility $w_h^*\sigma_h^*$ that the household would select if it did participate in financial markets:

$$RC_{\text{complete},h} = S_h^* w_h^* \sigma_h^*. \tag{14}$$

We now investigate several scenarios for the total risk $w_h^*\sigma_h^*$ and the Sharpe ratio S_h^*.

First, we assume that if the household participated, it would obtain the Sharpe ratio of a diversified index and would choose the average total risk $w_h^*\sigma_h^* = 9.5$ percent in the complete portfolios of participants. The nonparticipation return cost RC_h is then 4.3 percent for a household that would invest in the hedged world index ($S_h^* = 45.2$ percent) and 3.3 percent for a household that would invest in the unhedged world index ($S_h^* = 34.6$ percent). Consistent with earlier research, we find that the return cost of nonparticipation is high if we assume an efficient risky investment strategy.

It may be more realistic to impute the levels of S_h^* and $w_h^*\sigma_h^*$ from the observable characteristics of nonparticipating households. As a second scenario, we regress the Sharpe ratios and volatilities of participants' complete portfolios on their observable characteristics and report the results in columns 7–9 and 4–6 of table 6. We then apply the results of these regressions to impute the likely portfolio properties of nonparticipants. This procedure suggests that the average nonparticipant would select a complete portfolio with Sharpe ratio $S_h^* = 27.7$ percent and volatility $w_h^*\sigma_h^* = 8.4$ percent. Both these numbers are slightly lower than the average among participants, because nonparticipating households are demographically similar to participating households that invest cautiously and inefficiently. With these numbers, the estimated return cost of nonparticipation is only 2.3 percent.

We can use a similar procedure to compute predicted return losses for specific households. Household A has dummy variables that are all equal to zero. That is, the head of household A is a native Swede who is employed, is not an entrepreneur, does not hold a high school diploma, and is not contributing to a private pension plan. The household's nondummy variables (size, income, log financial and real estate

wealth, log liabilities) are set equal to the average among nonpartici-
pants (table 2). We impute that $S_h^* = 28.0$ percent and $w_h^* \sigma_h^* = 7.6$
percent and infer that the nonparticipation return cost is then 2.1
percent.

Household B has the same characteristics as household A but is an
immigrant. The imputed values $S_h^* = 26.9$ percent and $w_h^* \sigma_h^* = 8.5$ per-
cent imply that the nonparticipation return cost is then 2.3 percent.
Similarly, household C has the same characteristics as household A but
is unemployed. The imputed values are $S_h^* = 27.8$ percent and
$w_h^* \sigma_h^* = 7.6$ percent, and the nonparticipation return cost is then 2.1
percent. These results suggest that nonparticipation return costs have
average values between 2.1 and 2.3 percent.

Overall, we see that the standard analysis considerably overestimates
the cost of nonparticipation by ignoring the inefficiency of household
portfolios. Households that stay out would likely be down if they entered
the market. Once we take account of this effect, nonparticipation ap-
pears to be a smaller mistake and may be easier to rationalize using
small frictions such as the participation costs postulated by Haliassos
and Bertaut (1995), Calvet, Gonzalez-Eiras, and Sodini (2004), and Viss-
ing-Jorgensen (2004).

VI.   Conclusion

In this article, we have used a unique Swedish data set to evaluate the
risk properties of household portfolios. We have found that the joint
observation of stocks and mutual funds is quantitatively extremely im-
portant for the assessment of household diversification. This should not
be surprising given that 76 percent of Swedish households that own
stocks directly also hold mutual funds.

We have considered financial portfolios in isolation, ignoring human
capital and real estate. We doubt that underdiversified financial port-
folios can be rationalized by offsetting risks in labor income or real
estate, and previous research by Massa and Simonov (2006) has found
no evidence that households pick their directly owned stocks to hedge
income risks. However, our data set does contain a great deal of infor-
mation on both income and real estate holdings, and we hope to exploit
this information in future research.

Almost two-thirds (62 percent) of households participated in risky
asset markets in Sweden at the end of 2002. Participating households
allocated on average 40 percent of their financial wealth to cash and
60 percent to risky assets. Mutual funds represent the largest share of
risky assets for most households, except for the very rich whose portfolios
are dominated by individual stocks. The data set permits us to compute
the risk characteristics of the portfolio of risky assets. The median vol-

atility is just under 20 percent, the median systematic exposure β_h is about 0.9, and the average excess return implied by a global version of the CAPM is 6 percent.

We have found that many Swedish households are well diversified. The median return loss implied by the global CAPM is 1.2 percent of financial wealth, or about $130 per year relative to the currency-hedged world index. This loss is modest even though it is very difficult for retail investors to achieve the efficiency of the hedged world index. The median loss relative to the unhedged world index is even smaller, only one-quarter the size, and a majority of Swedish households actually outperform the Sharpe ratio of their own domestic stock index. These encouraging results reflect substantial international diversification, which Swedish households achieve through the equity and balanced mutual funds sold by domestic banks. These numbers ignore the fees charged by mutual funds, but a rough calculation suggests that taking account of such fees increases the average return loss by only about 30 basis points.

While a large fraction of retail investors choose well-diversified portfolios, we also identify the unhappy few that select highly concentrated risky portfolios. For instance, 5 percent of the population incur return losses that exceed 5 percent of financial wealth, or $2,200 per year. For 1 percent of the population, the losses even reach 10 percent of financial wealth, or $7,500 per year.

We have shown that predictors of financial sophistication (such as wealth, income, and education) predict higher levels of participation, higher volatility in risky portfolios, and higher Sharpe ratios. Richer and more sophisticated households invest more efficiently; but they also take more risk, so they bear higher costs from portfolio inefficiency.

Finally, we have considered the 38 percent of households that do not participate in risky asset markets. We estimate the return loss from nonparticipation at 4.3 percent if we assume that such households would participate by earning the maximum available Sharpe ratio of the hedged global index. But this number overstates the cost of nonparticipation because nonparticipants might not diversify effectively if they did participate. The estimated return loss falls to 2.3 percent when we estimate the likely investment performance of nonparticipants.

The diversification achieved by many individual investors can have multiple causes, including not only their own financial skills but also the professional advice and diversified mutual funds provided by financial institutions. Such effects are difficult to disentangle in a cross section, but in Calvet, Campbell, and Sodini (2007), we use the panel structure of the data set to investigate household performance, including rebalancing and asset-specific trading decisions, through time.

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