Discussion Papers No. 395, November 2004
Statistics Norway, Research Department

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House ownership and taxes

Abstract:
The household portfolio is dominated by a small number of assets; primarily housing and mortgages. We compare data on actual portfolios of Norwegian households with estimated optimal portfolios, using traditional financial theory. We find actual portfolios to be close to the portfolio indicated by a mean-variance frontier, based on four assets and estimated under assumptions of short sale constraints. This result is sustained even in a no-tax regime. To induce a substantial change from housing to equity, taxation of the consumption stream from housing is needed. An alternative; taxation of capital gains from housing investment; could actually increase the relative holding of housing.

Keywords: Households, portfolio choice, consumption tax, capital gains tax.

JEL classification: G11, H2, H31

Acknowledgement: We are grateful for comments from Aadne Cappelen and Per Richard Johansen, and from participants at a seminar in Statistics Norway. The views expressed in this article do not necessarily reflect the views of Statistics Norway. All mistakes remain our own

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1 Introduction

Over the last two decades the structure of financial markets have changed. In a regime with credit rationing and high transaction costs, the households ability to diversify its portfolio was slight. The combination of deregulation, new information technology and new financial products have made financial markets accessible even to private investors with limited funds.

With the current range of investment opportunities, households should no longer be constrained with regard to portfolio allocation. This implies that the framework of financial economics, a literature that traditionally has focused primarily on the behavior of individuals that can allocate their money over a wide range of investment goods, to an increasing extent should apply to the household. As a result of this change one has seen an emerging interest in the behavior of the household portfolio (see e.g. Guiso, Haliassos and Jappeli, 2002, a book that sum up much of recent work in the area).

However, despite more investment opportunities, the household portfolio can still be described as rather one sided. The household portfolio tends to be dominated by two assets; housing and mortgages. In 2001 the average Norwegian household held 112 % of net wealth in housing assets. As a comparison, the same subject held only 10 % of net wealth in equity. Other interest rate bearing assets made up 16 %, while debt equaled 38 % of net wealth.[1] It seems to be a widely held assumption that this portfolio composition in part is due to a tax regime that favours housing over other capital

[1]That being said, the share of equity in the household portfolio has been rising in the later years, at least in % of household income. In Norway we have seen that the share of equity to gross income has almost tripled from 1996 to 2001.

assets, and in part due to constraints forcing households to make a discrete choice between owning a house—and therefore a large holding of housing assets—or renting a house.

In this paper we shed more light on why housing is so dominant as an investment asset. If equity is such a lucrative investment as is often claimed by financial experts, why do households not use the security of the house to borrow money for investing in equity? We give special attention to the role of taxes, and discuss how different forms of housing taxation will affect the household portfolio composition.

Our study of the implications of tax on housing should clarify the literature. Relatively few articles have been written on the topic of taxation of housing. Poterba (1984) discusses the effects of high inflation in a regime with tax preference on housing assets. His findings imply that higher inflation should lead to a higher share of house ownership, as the tax wedge increases when nominal return increases, while real returns remain unchanged. However, in a survey article, Poterba (2001) argues that there is still sparse empirical evidence on how taxes actually affect portfolio behaviour. In a recent work, Fuest, Huber and Nielsen (2003) present an OLG model to calculate the effects of introducing a capital gains tax on housing. They find that a capital gains tax could increase (before tax) price volatility in housing prices.

The method we use is the theory of the portfolio frontier. This is among the most established parts of financial theory, and the model is well known and widely applied (see e.g., Huang and Litzenberger, 1988). We apply the same methodology to understand the portfolio of the household as is applied to understand the portfolio of a professional investor. We construct a portfolio frontier for a household investing in four assets; housing, equity, bonds and mortgage; but apply short sale constraints as the household can not go short in housing, bonds or equity, and not long in mortgages.

We find that the portfolio frontier indicates the same type of portfolio composition—a high share of housing and a low share of equity—as we observe in the actual data. This is the case for all reasonable assumptions about risk aversion. Further, we show that this result also holds in a regime *with no taxes*; implying that the high share of housing in household portfolios is not primarily driven by the the low tax on housing assets. Rather, we find that what makes housing so attractive as an investment good is the implied rent from housing assets. Housing returns a high, stable stream of consumption services no other financial assets can match.

Last, we find that a higher tax on housing would not necessarily reduce the holding of housing assets. We discuss two kinds of taxes; a capital gains tax and a tax on implied rent. We find that introducing a capital gains tax on housing in line with the capital gains tax on equity can *increase the share of housing assets* in the portfolio of the average household. This result follows as a capital gains tax would reduce the risk of holding housing capital. However, if one introduces a tax on the implied rent from housing, e.g. in the form of wealth tax on housing assets, the average household can be expected to reallocate funds from housing to equity investments.

In section 2 we describe the calculation of the portfolio frontier. We also discuss how to calibrate the model. In section 3 we compare the calculated frontier with actual data. In the last section we discuss how shifts in expected returns, due to shifts between tax regimes, affect the portfolio for given levels of risk aversion.

2 Methodology and data

We build our analysis on standard financial theory. First we present the basic model. We then discuss some issues concerning calibration of the model.

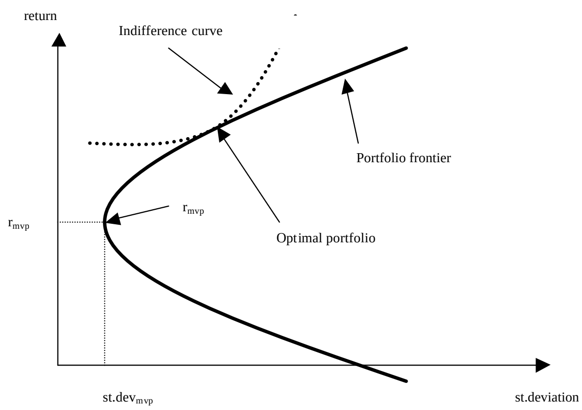
2.1 The mean-variance framework and the portfolio frontier

A standard assumption in finance is that an investor evaluates a portfolio based on two criteria; the expected return of the portfolio and the expected variance of this return. Technically this assumption is only valid under rather strict restrictions on the utility function. However, the mean-variance assumption makes it possible to obtain testable implications of theory that can not be obtained under more general forms of utility.

The mean-variance model has been a central piece of financial economics since it was presented by Markowitz (1952). An important implication of this model is the portfolio frontier. The mathematics of the portfolio frontier was first shown in Merton (1972), but has since become a central working tool in both theoretical and applied finance.

Strictly defined, the mean-variance frontier is the boundary of the set of means and variances of the returns on all portfolios of a given set of assets. This boundary can be found by minimizing the variance of return for given mean return. There exists a mean-variance frontier as long as there are two returns not perfectly correlated and yielding different means. A typical illustration of the mean-variance frontier is displayed in figure 1. The mean-variance frontier of all risky assets is graphed as the hyperbolic region.

Figure 1: Mean-variance frontier



If R is a vector of asset returns, E is the vector of mean returns, E=E(R), and Σ is the variance-covariance matrix, $\Sigma = E[(R-E)(R-E)']$, we can derive the mean-variance frontier using the Lagrangian approach. A portfolio is defined by its weights on the initial securities. Thus, $w'R$ is the portfolio return, where the weights sum to one. If I is a vector of ones, we have $w'I = 1$. The mean return on the portfolio is given by $w'E = \mu$. Minimizing variance for a given mean leads to the following minimizing problem:

$$minimise\ w'\Sigma w, \tag{1}$$

s.t.

$$w'E = \mu \;\; and \;\; w'I = 1. \tag{2}$$

For the given mean portfolio return, μ, the variance of the minimum variance portfolio is then

$$var(R) = \frac{C\mu^2 - 2B\mu + A}{AC - B^2}, \tag{3}$$

and the weights are given by

$$w = \Sigma^{-1}\frac{E(C\mu - B) + (A - B\mu)}{AC - B^2}, \tag{4}$$

where

$$A = E'\Sigma^{-1}E; \; B = E'\Sigma^{-1}I; \; C = I'\Sigma^{-1}I. \tag{5}$$

The marginal rate of transformation (between risk and return) is given by

$$MRT = \frac{D\sigma}{A\mu - B}, \tag{6}$$

where $D = BC - A^2$, and σ is the standard deviation of the portfolio.

The analytical solution for the mean-variance frontier is based on the assumption that there are no constraints on the possible position one can take in any asset. For practical applications this will be a problem. Most investors will be constrained in their ability to sell an object short. This is especially relevant for households. Imposing short sale constraints has the implications that no analytical solution for the mean-variance frontier can be derived. When we compute mean-variance frontiers below we use a programming sub-routine to calculate the optimal portfolios when the short sale constraints are binding.[2]

2.2 Risk aversion

In the mean-variance framework, optimal portfolio allocation is defined by tangency between the indifference curve and the efficient frontier, as shown in figure 1. The point of tangency is where the marginal rate of substitution equals the marginal rate of transformation between risk and return.

Under the assumptions of constant relative risk aversion[3], normally distributed portfolio returns with mean μ and variance σ and investors maximizing expected utility, it can be shown that the marginal rate of substitution is given by (see e.g. Flavin and Yamashita, 2002, for a reference)

$$MRS = \rho\sigma. \tag{7}$$

The risk aversion, ρ, in optimum is then given by

$$\rho = \frac{D}{A\mu - B}. \tag{8}$$

[2]The program is documented in Harding and Solheim (2004).
[3]We assume the a utility function on the form $U(W) = \frac{1}{1-\rho}W^{1-\rho}$, where W is wealth.

Solving for the return, μ, gives

$$\mu = \frac{1}{A}(\frac{D}{\rho} + B). \tag{9}$$

By making assumptions about the households utility function and the level of risk aversion, we can quantify the optimal portfolio, and thereby evaluate wether the household's actual portfolio is close to the optimal portfolio. Alternatively we can use the actual portfolios to calculate the level of risk aversion these imply.

2.3 Calibration

In practice households tend to invest in four objects: housing, interest rate bearing assets, equity and insurance claims. In addition the household can increase exposure by borrowing to invest. We chose to ignore insurance claims, as such claims are not very liquid.

As we compare with actual Norwegian portfolios, we use Norwegian data. One should expect that the relevant mean-variance frontier is based on a rational forecast of returns. However, it is not clear how to conduct a rational forecast of returns when making long term investments. Our data on actual portfolios cover the years 1998 to 2002. To match expectations formed in this period, we base our analysis on actual return for the period from 1993 to 2002. 1993 is a reasonable starting point, as Norway implemented a major tax reform in 1992. For equity we use the return on the Oslo Stock Exchange. For interest rates we use the average rate on debt and short term deposits respectively, collected from Norges Bank.

The pre tax return on housing consists of two components. These are the change in the housing price (capital gain) and the stream of service the house offers the owner (housing consumption). To measure capital gains we use the quarterly relative change in the housing price index for self owned houses. This measurement is imprecise, as we do not fully account for the fact that house investments are object specific, and that the risk of single investment is higher than the risk of investing in the general housing index.[4]

The consumption component is more problematic. Moum (1995) discusses four different approaches to calculate the stream of service received from a self owned house. The calculation can be based on: i) the costs of buying the service, ii) observed rental prices, iii) the costs a rental house owner is meeting or iv) the social costs of providing housing services. Under perfect competition and no public distortions the four methods should give the same results. Under a tax regime favoring self owned houses the methods may give different results. Moum concludes that the best solution is to calculate the income stream based on rental prices. One weakness with this approach is the likely lack of representativeness of renters for homeowners. The other methods are however seen as more problematic because they demand calculations of capital returns. [5]

To find consumption return we use estimations from the Norwegian Na-

[4]Englund, Hwang and Quigley (2002) find the object specific risk to be substantial. However, it is not clear how much of this variance is due to investments (or neglect of necessary maintenance) in the given object, and how much is due to factors outside the control of the owner (like changes in relative demand between different types of housing, different areas within the community et.c.). To the extent that the owner can control the relative value of a house, the index would be a relevant reference point.

[5]An approximation to using data on actual rental cost, is to assume that the stream of consumption services is a fixed percentage of the house value.

tional Accounts. These are calculated according to Moum's preferred approach. To find the rate of return, we divide the consumption stream on the total stock of housing capital.

Returns and a correlation matrix are given in table 1. To compare the model with actual data it is important to use post tax observations. All returns are therefore returns after tax, where taxes are based on the current (post 1992) tax regime. We focus on real returns, and use changes in the CPI as a measure of inflation.

Table 1: Real return after tax: four assets in the household portfolio

	Housing	**Interest**	**Equity**	**Debt**
Return	0.11	0.01	0.13	0.03
Standard deviation	0.11	0.01	0.31	0.01
Correlation				
Housing	1			
Interest	-0.19	1		
Equity	0.31	-0.09	1	
Debt	-0.05	0.93	0.04	1

Note: We assume that the household portfolio consists of housing, interest bearing assets, equity and debt. The table reports the expected return and standard deviation of each asset, and the correlation matrix. Expected returns are based on actual returns, after tax, quarterly observations, from Norwegian data over the period 1993:1-2002:2. All numbers in per cent. Real returns are calculated using realised inflation measured by the CPI. Sources: Norges Bank and Statistics Norway

Note that we ignore transaction costs. The transaction cost of a house is probably higher than the transaction cost in the other assets. This means that housing may have slightly too high return in our data. However, even transaction costs in financial markets are substantial for a non-professional investor.[6]

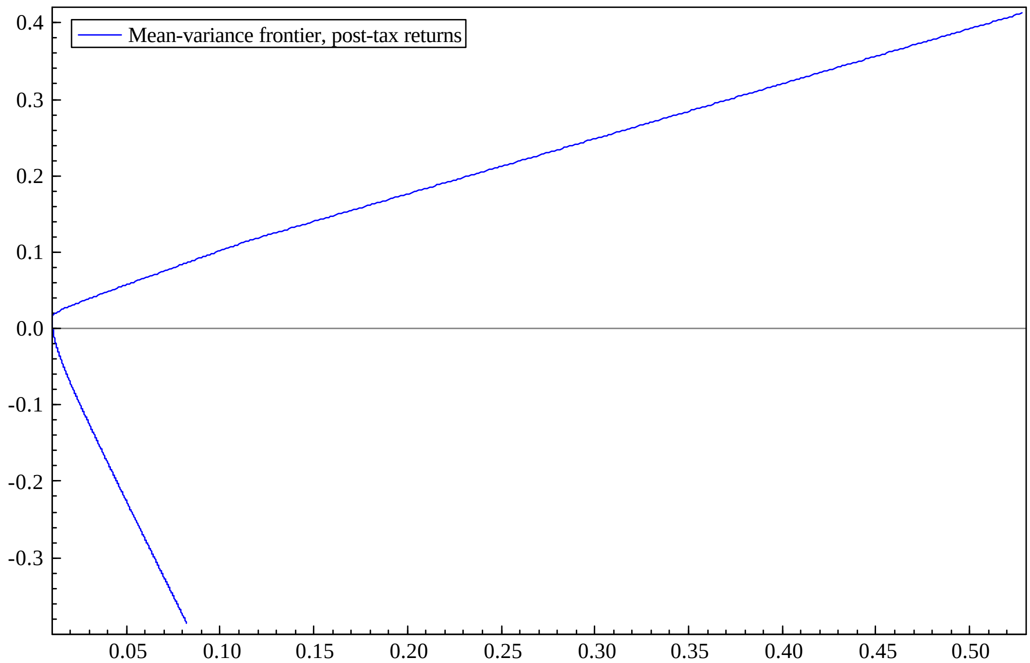
[6] Buying and selling a share in a mutual fund easily takes up more than 3 % of the investment. As a comparison, the same transaction in the housing market probably will cost between 3 and 10 % of the housing value. For housing assets, the share will be higher for low cost properties, as many of the costs incurred are independent of asset price.

3 Observed portfolios and optimal portfolios

In this section we first calculate a mean variance frontier for a given set of post-tax returns from the Norwegian market. We then present some data on actual portfolios of Norwegian households. We present both the average household over a number of years, but also a cross section of households based on the age of the oldest member of the household. In the last part of the section we compare the observed portfolios with the optimal portfolios.

3.1 The mean variance frontier

Figure 2: Mean variance frontier



Note: Each portfolio on the mean-variance frontier is associated with a given return and standard deviation. The figure is the real world representation of figure 1. The uneven steepness in the positive and negative parts of the curve is due to differences with regard to how the short sale constraints are binding.

Based on the return vector and covariance matrix presented in table 1, we calculate the mean-variance frontier using the theory presented in section 2. The frontier is presented in figure 2. As we can see, we replicate the form of figure 1. [7]

Table 2: Optimal portfolios - post tax returns

	Housing	**Interest**	**Equity**	**Debt**
ρ=**2**	2.95	0.00	0.19	-2.14
ρ=**4**	1.48	0.00	0.09	-0.58
ρ=**6**	0.99	0.00	0.06	-0.06
ρ=**8**	0.92	0.03	0.05	0.00
ρ=**10**	0.74	0.22	0.04	0.00

Note: We estimate the mean variance frontier under short sale constraints, based on the returns data presented in table 1. We report portfolio shares for each asset in the optimal portfolio for four different levels of risk aversion, ρ. The portfolio shares sum to 1. Negative numbers imply that the investor is borrowing the asset.

In table 2 we report the actual portfolio shares for five different levels of risk aversion. Notice that a low risk aversion (low ρ) implies a high willingness to take risk. We see that the degree of gearing—borrowing money to invest—is higher for individuals with a low risk aversion. For all levels of risk aversion it is optimal to hold a high share of housing in the portfolio.

Given the way we define the object vector, it should be no surprise that the investor either holds interest bearing assets or debt, but not both at the same time. There is no premium on liquidity here. In Norway, household debt tend to have a floating rate. There is a close correlation between the interest rate on debt and the interest rate on interest bearing assets.[8] As a result, there is no gain in holding interest rate bearing assets as long as one

[7]The curve seems to be much steeper for the part of the frontier below the minimum variance portfolio. This is due to the short sale constraints. The short sale constraints do not bind if one wants to minimise return—the best way to do so is to borrow money and place the proceeds in interest rate bearing assets.

[8]The correlation is not perfect, as the changes in the interest on debt tend to lag changes on interest bearing assets. This is due to regulations on notification.

holds debt.

3.2 The portfolio of the Norwegian household

Table 3: Actual portfolio shares—average Norwegian household

	Housing	**Interest**	**Equity**	**Debt**
1998	1.17	0.00	0.13	-0.30
1999	1.14	0.00	0.15	-0.28
2000	1.13	0.00	0.12	-0.25
2001	1.12	0.00	0.10	-0.22
2002	1.17	0.00	0.08	-0.25

Note: Table reports the portfolio shares of the average Norwegian household in 1998, 1999, 2000, 2001 and 2002. The data are calculated based on the household survey of Statistics Norway, and underlying data are collected from Norwegian tax returns.
Housing assets are estimated at market price. We report only net holdings of interest rate bearing assets, i.e. the sum of interest bearing assets and debt. Equity is holdings of Norwegian equity. Sources: Statistics Norway, own calculations.

Data on actual portfolios are collected from the household survey of Statistics Norway. Statistics Norway collects data from about 20 000 households every year, and compiles data on income and wealth based on filed tax returns of household members.

The survey includes holdings of real capital, financial capital and debt. We can distinguish real property from other real capital, but not general property from housing. From surveys on individual tax statements we do however know that housing makes up approximately 70 % of real property.[9] In the following we assume "real property" to be "housing". Housing value is estimated at market terms.[10]

[9] Data from the Norwegian tax return statistics, 2001.

[10] The numbers on housing reported in the survey are "taxable wealth". Statistics Norway has calculations on the relationship between taxable housing wealth and the housing wealth at market prices. It is found that the ratio of taxable value to market value was 0.31 in 1995, and 0.20 in 1999. Using 1995 as the base year, we find that the change from 1995 to 1999 can be explained if we assume that the tax assessment of housing wealth remained unchanged, while housing prices rose in line with the housing price index. To

For financial assets we distinguish between interest rate bearing assets and equity. Interest rate bearing assets is defined as holdings of bank deposits plus bonds. Equity include all holdings of Norwegian equity, including holdings of mutual funds. We do not distinguish registered from unregistered shares. For shares not registered on the Oslo Stock Exchange the stock value is calculated as 65 % of total sales of the company.

Table 3 reports asset holdings as share of net wealth for the average household for the years 1998-2002. We report only net holdings of debt and interest rate bearing assets. The table confirms the impression that the average household holds a high share of wealth in housing.

Table 4: Actual portfolio shares—age groups, 2001

	Housing	**Interest**	**Equity**	**Debt**
u25	2.64	0.00	0.30	-1.94
u35	2.28	0.00	0.19	-1.47
u45	1.45	0.00	0.11	-0.56
u55	1.10	0.00	0.14	-0.24
u67	0.94	0.00	0.09	-0.02
u80	0.81	0.15	0.05	0.00
o80	0.73	0.24	0.03	0.00

Note: Table reports the portfolio shares of the average household in seven age groups. 17-24, 25-34, 35-44, 45-54, 55-66, 67-80 and above 80. Age is based on the oldest person in the household. 67 is the official age of retirement in Norway. The data are calculated based on the household survey of Statistics Norway, and underlying data are collected from Norwegian tax returns.
Housing assets are estimated at market price. We report only net holdings of interest rate bearing assets, i.e. the sum of interest bearing assets and debt. Equity is holdings of Norwegian equity.

Statistics Norway also collects data on asset exposure where it differentiates between different age groups. There are seven groups; age 17-24 (u25), 25-34 (u35), 35-44 (u45), 45-54 (u55), 55-66 (u67), 67-80 (u80), and 80+

go from taxable wealth to market prices we therefore use the formula

$$Market\ value = \frac{taxable\ value * HPI}{0.31}, \tag{10}$$

where HPI is the housing price index, standardized to the value 1 in 1995.

(o80). The age of 67 is the official age for retirement in Norway.[11]

As we can see from table 4, both the share of housing, the share of debt and the share of equity tend to be age dependent. The young hold a high share of housing and a high share of debt; the old are net holders of interest bearing assets, and hold a lower share of total wealth in housing assets.

3.3 Optimal versus actual portfolios

Table 5: Actual shares versus optimal shares—root of summed squared differences

	1998	**1999**	**2000**	**2001**	**2002**
ρ=**4**	0.42	0.46	0.49	0.51	0.45
ρ=**4.5**	0.19	0.23	0.25	0.28	0.21
ρ=**5**	**0.07**	**0.09**	**0.08**	**0.09**	**0.02**
ρ=**5.5**	0.18	0.16	0.12	0.08	0.14
ρ=**6**	0.30	0.28	0.24	0.21	0.27

Note: To compare actual and optimal portfolios, we calculate the root of the sum of squared differences. The table reports these results for five different levels of risk aversion (ρ). For all five years, best fit is achieved at risk aversion equal to 5. A high ρ implies a high risk aversion.

In table 5 we compare actual and optimal portfolios. Of course, we do not know the risk aversion of the average household. So it is impossible to say how well the optimal portfolio really fits the actual data. Instead we compare the actual portfolios with optimal portfolios at different levels of risk aversion. We find that the average household portfolio seems to best match an optimal portfolio with risk aversion 5.[12]

Convex absolute risk tolerance should imply that the young, having more

[11] Like in most other countries actual average age of retirement is lower. Age is based on oldest household member.

[12] A risk aversion of 0 implies risk neutrality. Estimates of risk aversion often range from 2-4. Values above 10 is seen as implausible. However, according to Ljungqvist and Sargent (2000), p. 263, a risk aversion of 27 is necessary to justify the equity premium puzzle.

Table 6: Actual versus optimal, 2001

	u25	**u35**	**u45**	**u55**	**u67**	**u80**	**o80**
ρ=**2**	**0.38**	0.95	2.18	2.66	2.93	3.04	3.10
ρ=**2.5**	0.53	**0.10**	1.32	1.80	2.07	2.18	2.24
ρ=**4**	1.80	1.20	**0.04**	0.51	0.78	0.90	0.98
ρ=**5.5**	2.38	1.78	0.55	**0.11**	0.20	0.35	0.45
ρ=**6.5**	2.59	1.99	0.76	0.30	**0.04**	0.20	0.32
ρ=**9**	2.68	2.08	0.86	0.40	0.19	**0.02**	0.13
ρ=**10.5**	2.77	2.17	0.97	0.54	0.35	0.15	**0.03**

Note: To compare actual and optimal portfolios, we calculate the root of the sum of squared differences. The table reports these results for five different levels of risk aversion (ρ). As we can see, best fit will vary between age groups. As a rule, the older are more risk averse than the younger. A high ρ implies a high risk aversion.

periods to invest over, should be more willing to invest in risky assets. However, one can argue that the household looks not only at the risk of investing financial capital; it needs to take into account human capital as well. In general the household tends to transform human capital into financial capital over time. So financial capital should be expected to increase with age, while potential human capital diminish.

One might argue that holding most of ones wealth as human capital makes total capital stock more risky. If so, the young should be less willing to invest their financial assets in risky assets than the old. On the other hand, the ability to get a better paid job or a new job if the current job is lost will probably decrease with age. So risk related to human capital might actually increase with age. If this is the case, willingness to invest financial capital in risky assets should fall with age.

The data do however seem clear. As we can see in table 6, the portfolios of the young tend to fit optimal portfolios with a low risk aversion, while the portfolios of the old tend to look like optimal portfolios with a high risk aversion.

4 Tax and the optimal portfolio

It is often discussed how taxes affect the share of housing in the household portfolio. Many economists seem to believe that households hold a high share of housing due to the fact that housing assets tend to be less taxed than other investment assets. However, we do not find full support for this argument. Even in a regime with no taxes on any capital assets the household should hold a high share of net wealth in housing.

We also test explicitly for the effects of different tax regimes. We compare the effects of imposing a capital gains tax versus a wealth tax on housing. We begin the section with a more detailed discussion of return on housing.

4.1 The return to housing revisited

Table 7: Real pre tax return on housing

	Housing	**Capital gains**	**Consumption**
Return	0.12	0.06	0.04
Standard deviation	0.11	0.11	0.02
Correlation			
Interest	-0.23	-0.26	0.27
Equity	0.31	0.26	0.27
Debt	-0.07	-0.17	0.63

Note: The table reports real, pre tax return on housing, and the two components of real return, implicit consumption and capital gains. Note that as all numbers are real returns, the return from capital gains and consumption do not add up to pre tax total return on housing.

To understand the effect of taxes on the household portfolio we need to decompose housing returns into household consumption income and capital gains income, as discussed in the previous section. This is necessary, as these two returns are very different of nature.

In table 7 we report the two types of return on housing. As one can see, while the standard deviation of capital gains from housing is high, the standard deviation from housing consumption is low. Further, while capital gains are negatively correlated with the cost of debt, the consumption income from housing is strongly positively correlated with the cost of debt (0.63). This is due to a positive correlation between the cost of rental and the interest rate—as the cost of holding a home increases, the cost of renting the home will increase as well. A result is that the consumption return works as a hedge on borrowing costs. If the cost of borrowing rises, implicit return of holding a house, and thereby the consumption return, rises as well. As will be clear below, this distinction is important if we want to understand how taxes affect the household portfolio.

4.2 Tax shifts

We begin by comparing the optimal portfolio using pre and post tax returns. We then compare different types of tax on housing returns. We look at a capital gains tax and a wealth tax. A wealth tax would be a de facto tax on housing consumption.

4.2.1 Is the high share of housing in the household portfolio due to low tax on housing?

Table 8 reports the optimal portfolio for a fixed risk aversion, set at $\rho = 4$, under different assumptions of risk aversion. The first row reports the optimal portfolio under a no-tax regime, and the second row an optimal portfolio assuming 28 % tax on capital gains from equity investments and interest

Table 8: Optimal portfolio shares—different tax regimes

ρ=4	Housing	Interest	Equity	Debt
No tax	1.22	0.00	0.09	-0.31
Base	1.66	0.00	0.07	-0.73
Capital gains tax	2.30	0.00	0.06	-1.36
Consumption tax	1.33	0.00	0.12	-0.45

Note: Table reports optimal portfolio shares under short sale constraints. All portfolios reported are calculated for a risk aversion of ρ=4.
No tax: we use real, before tax returns on all assets.
Base: No tax on housing return, 28 % tax flat on all other capital return, full interest payment deduction.
Capital gains tax: 28 % tax on capital gains in housing, no tax on housing consumption. Other taxes as above.
Consumption tax: 28 % tax on housing consumption, no tax on capital gains from housing. Other taxes as above.

bearing assets, 28 % tax deduction on all debt payments, and no tax on housing.[13]

The share of housing, and the share of debt, are both lower in the no-tax regime. However, the share of housing is still very high. A shift to a no-tax regime only results in a small shift from housing to other investment assets. The primary effect is a reduction in gearing—a reduction in the willingness to borrow to invest in housing.

4.2.2 Capital gains tax on housing

To tax capital gains from housing would be to treat housing like an investment asset. Capital gain is in general taxed at date of realisation. Prior studies of capital gains taxes on housing include Fuest et al. (2003). They argue that such a tax might increase the pre-tax volatility of housing prices.

We impose a 28 % tax on capital gains—in line with tax on capital gains

[13] 28 % is the flat tax rate on capital income used in Norway.

on other assets.[14] The other objects are taxed as in the base-scenario. The optimal portfolio for a risk aversion of 4 is reported in table 8.

An interesting result emerges. In our estimations the share of housing in the optimal portfolio will *rise* following the imposition of capital gains tax on housing. A capital gains tax reduces the risk of a housing investment, while the return on housing investments remain high (as the consumption stream is not affected).

Important here is the relation between risk and return. A capital gains tax imply that the government takes on part of the risk of the investment. This makes it even more favorable to borrow money at a relatively low rate, and invest the money in housing assets. The main impact of a capital gains tax on housing in our estimations is therefore increased gearing.

How do this tax affect different groups? In calculations where we compare the impact on different levels of risk aversion (not reported), we find that the share of housing rises more in the high risk portfolio than in the low risk portfolio. Given that the young tend to be "high risk", this implies that a capital gains tax on housing could lead to an even higher exposure to housing among the young.

4.2.3 Wealth tax on housing

Next we impose a tax on the consumption income of housing. Again, the other objects are treated as in the base scenario. We implement this tax as

[14] Note that we here implement a capital gains tax as a "house index tax"—the tax applies to the increase in the housing price index from date of purchase to the date of a sale. This removes the problem of assessing "price gains" from "returns on investment" for the property.

a 28 % tax on the implied rent. The effects of a tax on housing consumption (but no capital gains tax on housing) are again presented in table 8. We find that such a tax would significantly reduce the share of housing in the optimal portfolio. Further, the share of other risky assets, i.e. equity, would rise.

An interesting question is how to implement a tax on housing consumption. In Norway the practice has been to add a share of housing value to income. This is not necessarily a good solution if income tax is progressive. Adding housing consumption to income will affect the marginal tax on income.

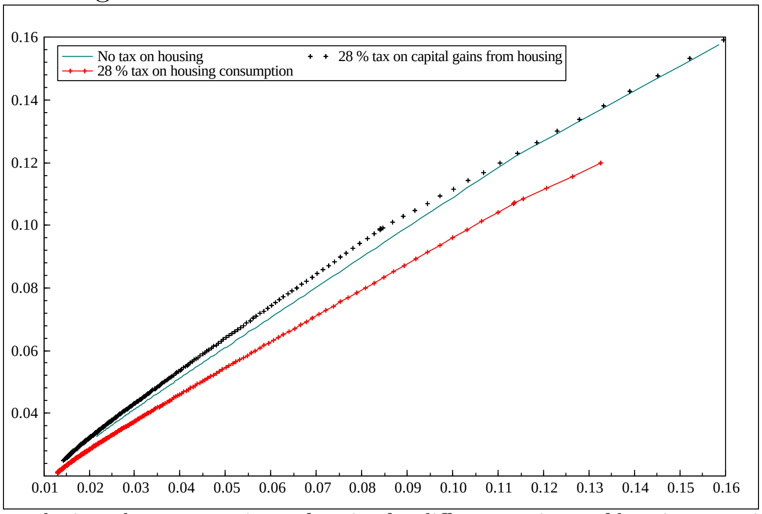
There is a possible alternative. As discussed above, the consumption level of housing can approximately be estimated as a share of housing value. A tax on housing wealth would therefore equal tax on housing consumption. As the value of housing can be distinguished from other types of wealth, one could even differentiate the wealth tax on housing assets and other capital assets. It is possible to think of a system with a wealth tax, but no capital gains tax on housing, and a capital gains tax, but no wealth tax on other capital assets. The tax proposed here; i.e. a 28 % tax on housing consumption, would approximate a 0.7 % wealth tax on housing wealth at market value.[15]

4.2.4 The mean-variance frontier

In figure 3 we plot the mean-variance frontier for the no-tax on housing regime, and the two regimes with tax on housing. The mean-variance frontier reports all optimal choices of return and variance for obtainable portfolios. We see that the mean-variance frontier with a capital gains tax on housing is

[15] This follows if one assumes the implied rent on housing to be 4 % of housing value.

Figure 3: Mean variance frontier: Three shifts



Note: The figure depicts the mean variance frontier for different regimes of housing taxation (equivalent to those reported in table 8):
No tax on housing: No tax on housing return, 28 % tax flat on all other capital return, full interest payment deduction.
28 % tax on capital gains from housing: 28 % tax on capital gains in housing, no tax on housing consumption. Other taxes as above.
28 % tax on housing consumption: 28 % tax on housing consumption, no tax on capital gains from housing. Other taxes as above.

to the left of the mean-variance frontier with no capital gains tax on housing. This implies that in our estimations the opportunity set of choices between risk and return is actually larger with a capital gains tax than without. Given our set of input, for a given standard deviation on the return, the household can obtain a higher expected return in a regime with a capital gains tax on housing. This result may of course not be general, but it illustrates that a positive tax can *increase* the expected return for a given variance.

5 Conclusion

Households tend to keep a substantial share of their capital in housing assets. In this article we have shown that given that households use historical returns to assess future returns, and that they use the mean-variance framework to find their optimal portfolios, this is a perfectly rational solution. Further, we have shown that the high share of housing is not a result of the low tax on housing (although it increases the share of housing somewhat)—households hold a large share of housing primarily because housing offers a steady and not very volatile source of return, in the form of housing consumption.

This finding gives the key to understand how taxes can be used to affect the housing market. If one wants to reduce the holding of housing, both relative to net wealth and relative to other assets, one needs to tax housing consumption, e.g. in the form of a wealth tax on housing. Such a tax would bring down demand for housing, and probably lead to a fall in housing prices. A capital gains tax on housing might actually make housing assets more lucrative, as such a tax would reduce the risk of investing in housing assets. Demand for housing will increase, and housing prices will probably rise.

Of course, it is important to be aware that there are considerable practical problems concerning taxation on housing. The most important is the question of valuation. As houses are individual objects, it is in general difficult to asses market value on a year-to-year basis. Such questions have not been discussed here—we assume that market value is measurable in the form of a housing price index. This assumption clearly needs more research. Further, there are other practical problems. E.g., for many house owners, a capital gains tax would imply that taxes are paid infrequently, but that the amounts paid might be substantial. This might cause some practical problems with regard to collecting this tax. Even more difficult may be to differentiate capital gains from return on investments (or lack of investments) that have taken place between date of purchase and date of sale. This might be an argument for a wealth tax instead of a capital gains tax, using market value assessed by a housing index.

Despite these problems, housing remains a taxed item in most countries. Given the current degree of capital flight, the importance of housing as a taxable asset may well increase in the years to come. However, very few articles have even attempted to spell out how taxes can be expected to affect the housing market. In this respect, this paper fills a hole. The simple model used here gives policymakers a powerful tool to apply in their analysis.

References

Englund, P., M. Hwang and J. M. Quigley (2002). "Hedging housing risk." *Journal of Real Estate Finance and Economics*, **24**, 167–200.

Flavin, M. and T. Yamashita (2002). "Owner-occupied housing and the composition of the household portfolio." *American Economic Review*, **92**(1), 345–362.

Fuest, C., B. Huber and S. B. Nielsen (2003). "Capital gains taxes on housing." mimeo, Copenhagen Business School.

Guiso, L., M. Haliassos and T. Jappeli (2002). *Household Portfolios.* MIT Press.

Harding, T. and H. O. A. Solheim (2004). "Documentaion of model on the household portfolio." mimeo, Statistics Norway.

Huang, C.-f. and R. H. Litzenberger (1988). *Foundations of Financial Economics*. Prentice Hall.

Ljungqvist, L. and T. J. Sargent (2000). *Recursive macroeconomic theory*. MIT Press.

Markowitz, H. (1952). "Portfolio selection." *Journal of Finance*, **7**, 77–91.

Merton, R. (1972). "An analytical derivation of the efficent portfolio frontier." *Journal of Financial and Qunatitiative Analysis*, **7**, 1851–1872.

Moum, K. (1995). "Beregning av bruttoproduksjon og eierinntekt i boligsektoren i nasjonalregnskapet - noen metodiske synspunkter." notat 95/47, Statistics Norway.

Poterba, J. M. (1984). "Tax subsidies to owner-occupied housing: an asset market approach." *Quarterly Journal of Economics*, **99**, 729–752.

Poterba, J. M. (2001). "Taxation and portfolio structure: issues and implications." Working paper 8223, NBER.

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