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# Counterintuitive response to tax incentives?

## Mortgage interest deductions and the demand for debt

**Abstract:**
A number of European countries changed their tax system in the early 1990s along the lines of the US tax reform act of 1986. After the reforms marginal tax rates were generally lower, and mortgage interest deductions less generous. At the same time a long period of house appreciation started in most countries. This paper considers this puzzle empirically using a rich data base of Norwegian tax records from 1986 to 2000. We use nonparametric, difference in difference and tobit approaches in attempt to control for a wide array of factors that may offset, or mask, response to changed incentives. Of special concern is possible credit constrains as implied by credit score models routinely applied by credit institutions. We find a surprisingly static relationship between the probability of debt across age groups, and a strikingly linear and unchanged relationship between debt and gross income for young households. After the reform house prices doubled and tripled. The wealth effect may spur consumption. We find no sign of consumption smoothing by using self-owned housing as debt collateral, not even for older households. On the contrary, older households did react to the reform by reducing real debt.

**Keywords:** Tax incentives; credit rationing; mortgage market, household debt

**JEL classification:** D91, H20

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# 1. Introduction

The US tax reform act (TRA) of 1986 has served as a model for tax reforms world wide. Though the reforms varied across countries, tax payers in general faced lower marginal taxes and weaker incentives for acquiring debt after the reform. This was expected to have an adverse effect on housing markets. Looking back at the first decade of the post reform era, house prices have soared in most OECD-countries. Clearly, the effect of a tax reform can be offset by other factors in the economy. We ask what other factors are likely to affect households in a strong and direct way masking tax reform response? Moreover, does heterogeneity in the tax record data allow us to get at least some crude estimates of the isolated effects of the tax reform? We attempt to answer both questions affirmatively.

The 1986 tax reform may be viewed as one of the largest natural experiments concerning households responses to changes in taxation. Auerbach and Slemrod (1997) illuminate the difficulties in evaluating real responses, in opposition to financial, accounting and timing responses. The case of mortgage debt is an illustrative example, the TRAs asymmetric treatment of consumer and mortgage debt, which after the reform gave a swift shift to mortgage debt (Maki, 2001). In other words, households' tenure decision was most probably affected in two ways: First by changing the relative price between owner occupied and rented housing, and second by creating a loop hole for accounting other debt as mortgage debt.

Mortgage demand is intimately linked to a household's tenure decision. Tax distortions may occur if rental income is more heavily taxed than self-owned housing consumption (Henderson and Ioannides,1983). A house, an asset on the housing market, is sticky since transaction costs are considerable. Furthermore, indivisibility (in most cases) makes a house investment sluggish, and responses to tax incentives slow, since observed household portfolios may reflect adjustment to prior tax regimes. Shares, bonds and deposits, however, are highly liquid and households may respond quickly to changed tax incentives regarding these assets. Scholz (1990) studied the impact of the TRA on household portfolios, and found that high income households did hold disproportionately many tax favored shares.

A household's tenure decision is for most households linked to the possibility of mortgage financing. Brueckner (1994) analyzes the households mortgage size decision in a two-period framework. He gives explicit conditions for when credit constraints are binding, in other words, when a household seek the highest possible mortgage. Potential credit constraints may seriously affect households'

portfolio choices in two ways. First by direct favoring the housing market, since a house or dwelling also offers a solution to the housing consumption need, and as such a tax favored one, both prior to and after the reform. The second way is more important from a portfolio point of view: A house serve as a debt collateral. Credit institutions tend to be reluctant to supply credit for investment in asset markets, and view dwellings as more secure collaterals for debt. Phrased differently, a household actively seeking risk diversification by investing in various markets, may find credit financing hard with the exception of mortgage financing. An alternative is to achieve diversification over time; first enter the housing market, and second over time use the house as debt collateral to finance other investments.

If true, that is if credit constraints are present, then observed household behavior is not a result of changed tax incentives alone. This is our point of departure. A household's demand for debt is the result of considerations largely concealed to us. The credit supply side on the other hand is more transparent. In fact, credit institutions tend to rely on credit score models, which contrary to household decision rules, are both formalized and routinely applied. Credit score models are discussed in Section 2. Their structure offers insight, when and to whom constraints are likely to be binding. In this respect our approach ties in with contributions of Chiuri and Jappelli (2003) and Ortalo-Magné and Rady (1999) by putting an emphasis on the role of credit supply.

Section 3 gives a brief description of the Norwegian tax reform and macroeconomic factors in the time period from 1986 to 2000 that may have influenced household behavior. In particular, after tax mortgage costs and house prices have varied considerably both prior to and after the reform of 1992. Most likely, this affected intertemporal debt considerations as present capital costs and expected future rewards changed over time.

In Section 4 we consider cross sectional tax data gathered every year from 1986 to 2000. By using nonparametric techniques, we discover several intriguing regularities. One serious problem with reforms in general, is the dynamic nature of adaptation. This is particularly true for housing market investments, due to considerable transaction costs. Moreover, an adjustment on the margin in response to a tax reform may prove difficult. Young households may be argued to face a tenure and mortgage decision less tainted by past debt history. However, we find a striking static regularity between real debt and real gross income over time for this cohort. Likewise, equally puzzling, the ratio of households with debt as a function of age is virtually unchanged by the reform.

These observations may be taken as an indication of a weak response to changes in tax incentives. This is in agreement with the findings of Jappelli and Pistaferri (2006) concerning the Italian tax reform, which coincided in time with the Norwegian tax reform, and cancelled the link between marginal tax and mortgage deductions. They conclude that borrowing constraints and lack of financial information are the two plausible explanations for their findings.

In the case of Norway we find empirical regularities consistent with both credit constraints as well as response to changed tax incentives. Older households with gross income above a certain level reduced debt, whereas older low income households increased debt. If credit constraints are most likely to be binding for low income households, increased debt after the reform is consistent with changes in credit constraints implied by credit score models. High income households, on the other hand, may have been less constrained both prior to and after the reform, and thus are in the position to react adequately to weakened incentives.

A shortcoming of the reasoning above, is that the intertemporal nature of housing investments only enter through the house as a mortgage collateral. Most likely, there is heterogeneity across households regarding present-cost/future-gains considerations. In other words mortgage demand, and not only supply can be conditional on housing return forecasts. If true, borrowing behavior will reflect this.

In the last two sections we attempt to estimate the effect of changes in debt interest deductions, though only the mixed effect of changes in demand and supply is observed. The key insight is the following. Observed debt for constrained households will reflect credit constraints, whereas for largely unconstrained households observed debt will reflect sensitivity to after tax cost of debt. In Section 5 we present a two-period credit demand model based on a model of Dunsky and Follain (1997). Our version of the Dunsky-Follain-model may be viewed as an analogue of the credit score model for credit institutions, in the sense that debt is conditional on future gains, as well as immediate costs.

In Section 6 we estimate a tobit regression model for debt demand. The analysis supports the hypothesis of procyclic credit demand. Furthermore, unconstrained households responded to less generous interest deductions by reducing debt.

A tax reform may be viewed as a natural experiment. In Section 7 we apply a difference-in-difference approach. We find a substantial response to the tax reform. However, the result is largely driven by increase in real debt for the control group, which may be at least partly attributed to weakened

constraints. The final section gives a brief discussion of the combined findings of the different approaches.

## 2. Mortgage supply

In this section we will briefly describe the mortgage supply side. A household's demand for debt is a result of potentially complex intertemporal considerations. Unobserved idiosyncratic factors as well as time and consumption preferences can be argued to make the intertemporal decision problem opaque to the analyst. The supply side is more transparent, since granting a mortgage relies on a risk analysis which is ideally objective in the sense that the mortgage decision relies on company rules. In practice these rules tend to be formulated as a credit score model.

A credit score model can be represented by two equations. The first is investment evaluation as the house serves as a mortgage collateral. The present value (following Kiyotaki and Moore (1997)) limits the mortgage size. By assuming adaptive expectation a two-period market evaluation may give rise to the following constraint:

(1) Present value constraint (PVC): $M \le P_h^e \, h / (1+r) + E$,

where $M$ is the mortgage, $P_h^e$ is the expected value of one unit of housing the next period, $h$ is the number of housing units, $r$ is the money marked interest rate and $E$ is the households net equity.

The PVC-constraint is a risk neutral constraint, since it relies on the present value of expected future return only, and not on its (expected) variance. The second constraint is linked to cash flow:

(2) Cash flow constraint (CFC): $M \le a\, I$,

where $M$ is the mortgage, $I$ is gross income and $a$ is a positive number.

This condition relates the mortgage size to the gross income of the household, and is routinely posted on credit institutions in the form of a mortgage calculator for potential borrowers.[1]

[1] Several web based calculators and costumer aids exist, see for example http://www.dnbnor.no (webpage of Norway's largest bank with a mortgage market share of 40 percent), or http://www.min-okonomi.no/Laan/laanekalkulator.

A possible explanation for this rule of thumb is the following. Credit institutions realize that forecasts may prove wrong. Furthermore, they assume that house owners will hesitate to sell if the transaction price does not meet their mortgage obligations. In other words, credit institutions rely on the house owner's incentive to avoid personal bankruptcy. A manageable mortgage-to-income ratio increases the probability of weathering the storm in times of depreciation.

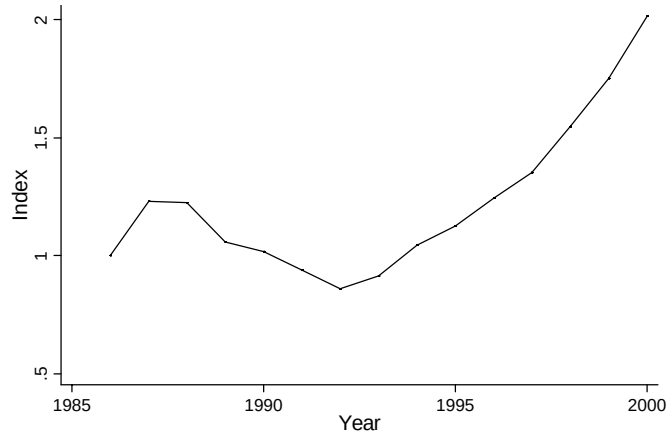
Additional market and agent characteristics may play a role in the credit supply decision. Equations (1) and (2) may then be viewed as expected mortgage constraints or approximations to real life constraints. The main insight relevant from evaluation of response to tax reforms is that (1) and (2) pinpoint when and to whom credit rationing is likely to occur. Moreover, (1) is procyclic and may at times dominate (2); (2) on the other hand may be a binding constraint for low income households irrespective of housing market movements.

# 3. Norwegian tax reform of 1992, mortgage interest rates and the housing market

Norway experienced a bank crisis[2] in the late 1980s and a sharp market decline in the housing market. The tax reform passed the Norwegian Parliament April 1991 and was put in to effect in 1992. The reform coincided with the end of a long period of considerable inflation. One year after the reform housing markets started to recover and mortgage interest rates were gradually lower as figures 3.1 and 3.2 illustrate.

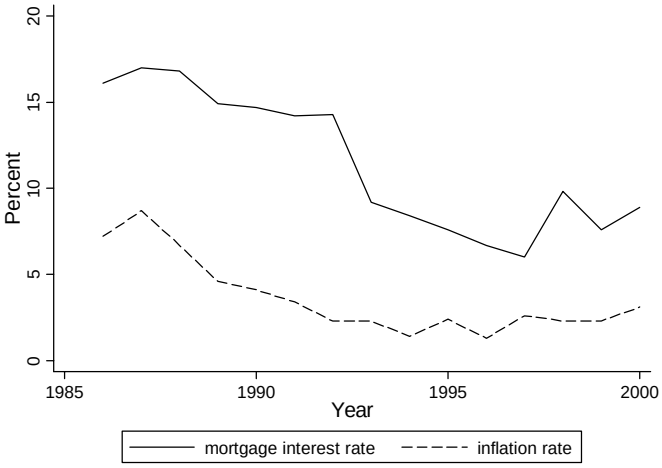
[2] Credit markets had prior to the early 1980s been subject to regulations. After the deregulation a period of credit growth started. In the late 1980s the real interest rate was record high, and many failed to meet their debt obligations. This lead to bankruptcy of several of Norway's largest banks, as well as a substantial fall in house prices.

**Figure 3.1. Norwegian house price index, 1985-2000**




Source: Statistics Norway.

**Figure 3.2. Mortgage interest rate and inflation rate**




Source: Statistics Norway.

The Norwegian tax reform of 1992 removed the coupling between marginal tax and mortgage interest deductions. Prior to the reform mortgage interest were fully deductible from gross income, giving a tax subsidy of up to 70 percent for some households. After the reform mortgage interest remained fully deductible, but with a flat 28 percent irrespective of marginal tax bracket.[3]

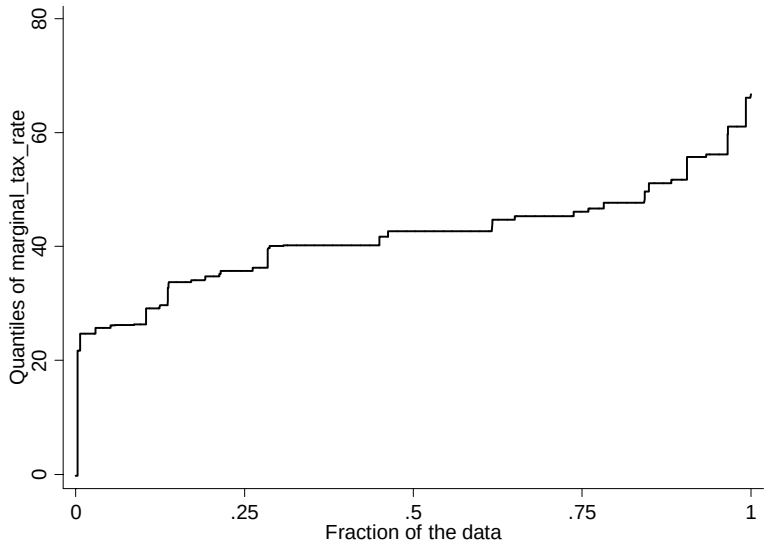
[3] Further details concerning the Norwegian tax reform can be found in Fjærli (2004) (Section 2. The previous Tax System and the Key Elements of the 1992 Tax reform, page 437)

Figure 3.3 displays the after tax nominal mortgage cost rate prior and after the 1992 reform. One striking feature is the bump in present costs for high marginal tax (high income) households in the early 90s, and the slow movement back towards prereform driven by lowering of mortgage interest rates. Low income households on the other hand, have faced a steady reduction of present after tax mortgage cost from a staggering above 12 percent in the late 1980s to below 4.5 percent in 1996. The reduction of after tax cost is largely driven by lower interest rates, but not solely. Low income households have low marginal tax and 20 percent of households had a marginal tax lower than 28 percent (Figure 3.4). For these households the reform represented higher interest deductions. Figure 3.3 and Figure 3.4 show a striking heterogeneity with respect to after tax mortgage cost prior to the reform, and generally lower (for most households) after tax mortgage cost in the aftermath of the reform.

**Figure 3.3 After tax mortgage interest for high and low marginal tax groups.**
High marginal tax = 60 percent. Low marginal tax = 24 percent. After tax mortgage intereste rate $=(1-\tau_{mt})\, r_{nt}$, where $\tau_{mt}$ is the mortgage interest deduction rate and $r_{nt}$ is the nominal mortgage interest rate in percent.


Source: Statistics Norway.

**Figure 3.4. Marginal tax distribution prior to reform**




Source: Survey of income and wealth, Statistics Norway

# 4. Norwegian Tax records; signs of credit rationing

## 4.1 Data description

The data source is the Survey of Income and Wealth (Statistics Norway), which is based on individual tax returns. The data contain information about debt, income, demographic variables for each year from 1986 to 2000. The data set includes over 100 000 observations. We restrict the analysis to non-retired and non-self-employed. The reason for excluding the latter is a potential mix between business related and personal debt. Furthermore, the debt exposure of retired persons may reflect intertemporal considerations exclusive to that group, transfers to heirs, or adaptation specific to that cohort like war pensions and sailor pensions. Excluding these two group leaves a sample of 63 302 observations. Mortgage incentives are linked to the marginal tax rate before the reform, and for each household this tax rate is imputed as the marginal tax rate given no deductions.

## 4.2 Signs of credit rationing

Households' response to a tax reform is in its nature dynamic. Housing investments tend to be sticky, unforeseen changes in after tax costs of self-owned housing consumption and investment is not expected to have an immediate effect on household portfolios. It may deter further exposure in housing markets or it may stimulate a faster rate of payments on the principal. Such effects may take years to unfold, and as behavior tend to be conditional on macro economic as well as demographic

factors a cautious analysis of cross sectional data is required. In the following we use nonparametric methodology to present summary statistics that shed some light on potential credit constraints and responses to changed tax incentives.

From a dynamic point of view we would expect young households to serve as markers for the impact of the reform in the short run, since paying back mortgage takes time, whereas deciding upon a new mortgage allows an instantaneous reaction to changes in tax incentives. Figure 4.1 displays real debt as a function of real gross income[5] for the home owner cohort of people of age[6] between 20 and 30. The two curves show a strikingly linear relationship between gross income and debt. Furthermore, this relationship is virtually unchanged by the reform expect for a divergence for high income households, which increases debt to gross income ratio in the aftermath of the reform. Figure 4.2 highlights another static relationship: The fraction of households with debt as a function of age is virtually unchanged.

Figure 4.1 and Figure 4.3 are consistent with credit rationing driven by Eq. (2) of the credit score model. However, this also implies that the income to mortgage factor, *a*, is unchanged. It may be argued that going from a high inflation scenario to a low inflation scenario, is likely to change the gross income to mortgage ratio, since nominal interest payments become lower. If income to mortgage ratios stayed fixed and this was a result of rationing, it means that in the post reform years credit institutions did not respond to the new low inflation scenario, and handed out credit conservatively. On the other hand, both prior to and after the reform, there were times of appreciation as well as depreciation. This may mask the importance of Eq. (1) of the credit score model in times of depreciation.

The same kind of comparison for the cohort 40 to 60 years old tells a different story. Figure 4.3 relates debt and gross income prior to and after the reform. The post-reform curve is tilted down in comparison with the pre-reform curve, indicating that low income households increased their debt and high income reduced their debt. This tilt is consistent with rationing implied credit score models; low income households experience a binding constraint that is weakened as the house market turned, hence increase debt, whereas high income households adjust to lessened tax incentives. However, as Figure 3.3 displays, low income households faced falling after tax mortgage costs, though deductions were lower in contrast to high income households to whom falling nominal interest rates, has been partly

[5] Real gross income is defined to be nominal gross income deflated with the consumer price index. (Consumer price index =1 in 1986)

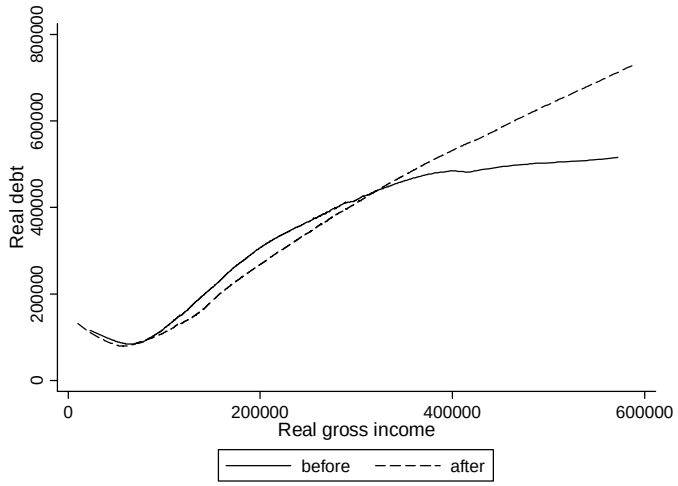
[6] Household age defined to be the age of the family member with highest gross income.

offset by less generous tax deductions. Our nonparametric analysis does not allow us to capture the isolated effect of the changed after tax cost of debt. We will attempt to do this by using regression techniques in Section 6.

Households in the 40-60 cohort have high house ownership percentages (above 80 percent) for the period in question. This implies that the lion's share of households are house owners both prior to and after the reform. For these households reduction of debt is likely to be increased payments on the principal. Another mechanism is up trading. In times of appreciation, which dominated the post reform years, starter homes tend to appreciate more (Røed Larsen and Sommervoll (2004)), which means that climbing up the housing ladder may require less mortgage financing, absolutely and relative to households purchasing starter homes.

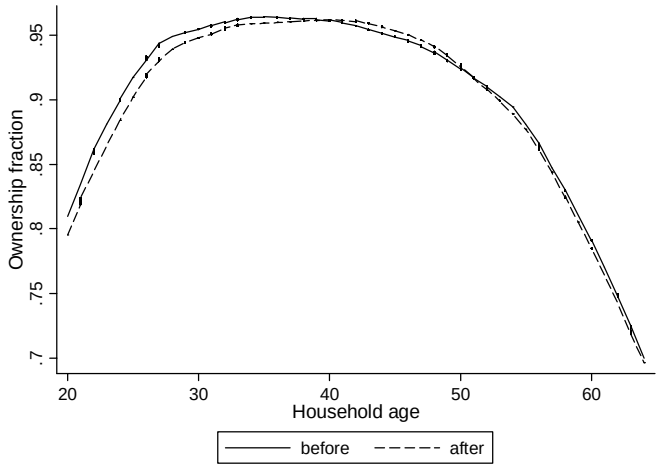
Figure 4.4 is consistent with this line of reasoning: The young borrow more as a reaction to less severe constraints or to increased investment eager. Older households, on the other hand, reduce debt. For ages above 28 years there is a surprisingly regular shift towards lower debt.

**Figure 4.1 Real debt versus real gross income. Age cohort 20 to 30. Number of observations: 9 496. Debt and gross income given in Norwegian 1986-kroner. Tricube smoothing. Bandwidth 0.4**



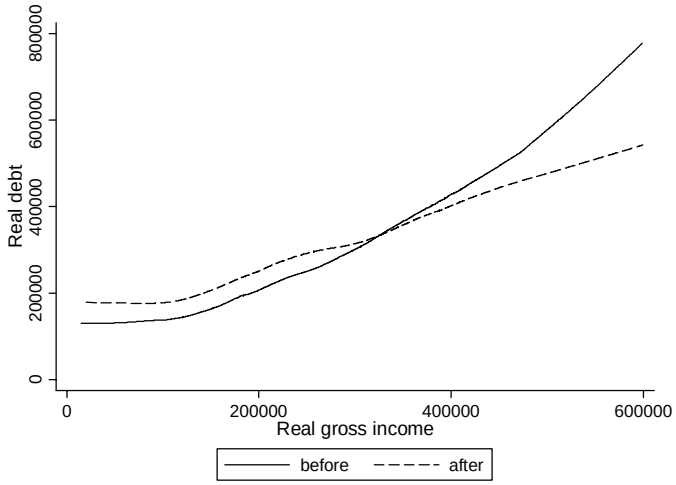

Source: Survey of income and wealth, Statistics Norway.

**Figure 4.2 Fraction of households with debt as a function of household age. Number of observations: 63 302. Debt given in Norwegian 1986-kroner. Tricube smooting. Bandwidth 0.4**



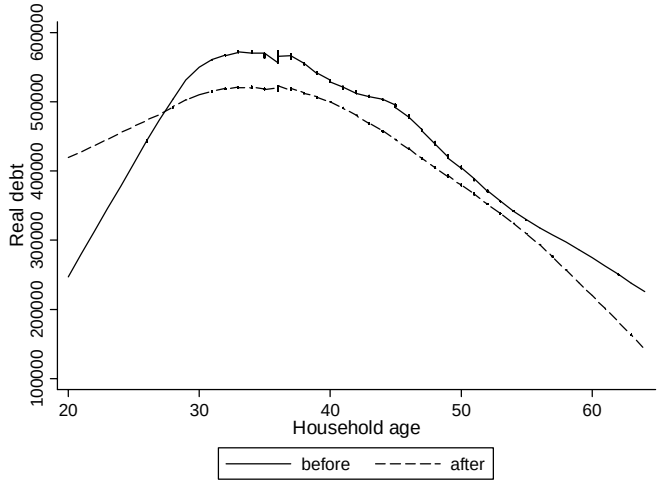

Source: Survey of income and wealth, Statistics Norway.

**Figure 4.3 Real debt versus real gross income. Age cohort 40 to 60. Number of observations: 29 703. Debt given in Norwegian 1986-kroner. Tricube smoothing. Bandwidth 0.4**




Source: Survey of income and wealth, Statistics Norway.

**Figure 4.4 Real debt versus household age upper 4 deciles of the gross income distribution. Number of observations: 24 892. Debt and gross income given in Norwegian 1986-kroner. Tricube smoothing. Bandwidth 0.4**




Source: Survey of income and wealth, Statistics Norway.

# 5. Mortgage Demand

Mortgage demand is intimately linked to tenure choice. Though both rental and self owned housing are solutions to the basic need of shelter, they constitute two distinct bundles of services. The tenure choice is not merely a consideration of after tax user costs. We do not attempt to model the tenure choice decision, but assume that a household has decided upon self owned housing consumption, and need to determine the mortgage size. Our point of the departure is the model of Dunsky and Follain (1987). A household attempts to maximize expected utility in a two-period setting. That is, households maximize:

(3) $$E(U) = U(c,h) + F\left(E(W), \sigma^2(W)\right),$$

where *E(U)* is the expected utility, *U(c,h)* is the first period utility function of housing consumption *h*, and other consumption *c*, and *F* is a function of the first two moments of the second period wealth *W*.

The maximation is subject to the following constraint:

(4) $$W_0 + I = P_c c + P_h h - M + B_e,$$

where $W_0$ is wealth in the first period, $I$ is income, $P_c$ ($P_h$) is the price of consumer goods (unit price of self owned housing[7]), $M$ is the mortgage and $B_e$ is risky financial asset.

The expected wealth $E(W)$ is given by:

$$
\begin{aligned}
(5) \qquad & E(W) = \left(1 + E\left(r_p\right) - \tau_p - \delta\right) P_h h \\
& - \left(\left(1 + r_m\right) M + \left(1 + E\left(r_e\right)\right) B_e + \left(1 + E\left(r_I\right)\right) I - \tau_y \left(I + E\left(r_e\right) B_e\right) + \tau_m \left(r_m + \tau_p P_h h\right)\right),
\end{aligned}
$$

where $E(r_p)$ is the expected appreciation rate of housing, $\tau_p$ the property tax rate, $\delta$ the depreciation rate of housing, $P_h$ the unit price of housing, $h$ units of housing, $r_m$ the mortgage interest rate, $E(r_e)$ the expected rate of risky asset return, $B_e$ the risky assets, $E(r_I)$ the expected salary increase rate, $I$ the income, $\tau_y$ the marginal income tax rate, and $\tau_m$ the mortgage deduction tax rate.

The Dunsky-Follain model makes an explicit link between future rewards and debt demand. Household expectations may be formed in many ways. We assume adaptive expectations[8] of the following nature: Agents observe a variable $X_t$ and its one period (yearly change) $\Delta X_t = X_t - X_{t-1}$ and extrapolate to the next period by $X^e_{t+1} = X_t + \Delta X_t$. With these assumptions (5) can be rewritten as

(6)

$$
\begin{aligned}
E(W) = & \left(1 + r_{pt} + \Delta r_{pt} - \tau_p - \delta\right) P_h h \\
& - \left(\left(1 + r_m\right) M + \left(1 + \left(r_{et} + \Delta r_{et}\right)\right) B_e + \left(1 + r_{It} + \Delta r_{It}\right) I - \tau_y \left(I + \left(r_{et} + \Delta r_{et}\right) B_e\right) + \tau_m \left(r_m M + \tau_p P_h h\right)\right).
\end{aligned}
$$

This model captures one essential part of (housing) investment, the intertemporal weighing of present cost versus future gain. Present after tax cost of consumption and investment is:

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[7] $P_h h$ is the purchase price, and not an imputed price of self-owned housing consumption.

[8] After the seminal paper by Muth (1960), adaptive expectations have been widely used in macroeconomic inflation models (Rudebusch and Svensson, 1999), and several extensions to the optimality of adaptive expectations under various assumptions of the underlying data generation process have been proven (Satchell and Timmermann, 1995). Adaptive expectations are susceptible to the Lucas Critique, and may be far from optimal when negative serial correlation is likely. However, adaptive expectations and positive serial correlation can be linked as adaptive expectation may spur positive serial correlation, and a tendency of persistent price patterns may rarely punish adaptive rules of action. In the case of housing markets, empirical work (Case and Schiller, 1989) indicates price movement persistence, possibly in violation of a market efficiency hypothesis. Cho (1996) surveys the literature on housing market efficiency, and concludes that markets tend not to be informationally efficient. Furthermore, both house prices and excess returns exhibit short run serial correlation. However, if central banks are worried about asset inflation and target house prices negative serial correlation can be the result. Furthermore, lags in housing supply can also challenge the near-rationality assumption of adaptive expectations, if increased supply is not met by increased demand.

(7) Present after tax costs: $P_c c + (1-\tau_m) r_m P_h h$.

The model is not directly applicable empirically. The investment horizon may be unknown at the time of purchase. In fact, the agents may view the endogeneity of reselling time as a way to avoid selling at an unfortunate time. Households may wrongly assess the probability of self-determined selling time, but their conjectures about future behavior, wrong or not, will affect their present demand for debt.

One way to address the problem of a blurry investment horizon is to interpret the two periods as "present" and "future". Present after tax cost are given by $(100- \tau_{mt}) r_{nt}$, where $\tau_{mt}$ and $r_{nt}$ is mortgage interest deduction rate and mortgage interest rate, respectively, at time *t*. Expected future returns for a given household are problematic empirically. A household may have a definite investment horizon, or at least a vague feeling of likely time for moving to another dwelling. Fortunately, there is some empiric evidence for a correlation between present price patterns observed by households and their present conjectures of housing market appreciation (Case and Shiller, 1989 and Shiller, 1990) irrespective of investment horizon. If true, then the adaptive expectation framework of the two-period model above may serve as an approximation for self-perceived future housing returns.

Present-future considerations are likely to vary with age. This calls for a model specification which is flexible across age groups. One empiric regression set up that meets these requirements is the following:

(8) $$D_j = a + \Sigma_k \left[ \beta_k \left(100 - \tau_{mtj}\right) r_{ntj} + \theta_k \right] E_{kj} + \varsigma \Delta P_{ht} + \Sigma_j \eta_j X_j + \varepsilon_j ,$$

where *k* ranges over age cohorts, $D_j$ is inflation adjusted debt for household *j*, $\alpha$ is a constant term, $(100- \tau_{mtj}) r_{ntj}$ is inflation adjusted capital cost in time period *t* for household *j*, $E_{kj}$ is a dummy equal to *1* if household *j* belongs to age group *k* and zero otherwise, $P_{ht}$ is housing price index change, and $X_j$ is household specific dummies, see Table 6.1 for details.

A few comments are in order. This model is a stylized way to represent a present cost and future reward with respect to mortgage based housing investment. The model is partial in the sense that expected house appreciation represents future investment return[10] in general.

[10] Including the change in Norwegian Stock market index on the right hand side is an option. However, there is no credit market serving non-self-employed households with credit for asset market speculation. So a potential link between debt and asset markets is dubious or at least indirect by using a housing market portfolio as a debt collateral. Including the share in the stock market index and running a regression show no positive relation between debt and stock appreciation.

# 6. Regression Analysis

The first column (Reg.1) of Table 6.1 displays the coefficient estimates of the regression model (8) of the preceding section used on the full sample. The after tax current cost impact coefficient (ATCCI) estimate is negative for all age cohorts. The second column (Reg. 2 of Table 6.2) gives estimates of the model excluding the lowest decile of the gross income distribution and the 20-30 age cohort, which can be argued to be most affected by credit constraints.

The estimates on these two samples display the same kind of regularities, expected negative sign of the ATCCI-coefficients as well as strikingly regular relation between debt and household size. The house appreciation coefficient is estimated with expected sign and high t-value. Though expected signs and high t-values are encouraging, our model is susceptible to the critique that applies to all parametric econometrics; omitted variables and the choice of functional form may seriously bias the estimates. Likewise, significance of the macro variable, housing appreciation, does not imply causality. The relevance of the expected sign and t-value is conditional on the premise that households follow housing market movements when deciding upon debt. Furthermore, as discussed in Section 2, credit institutions may rely on the same forecasts; hence both debt demand and credit constraints move in the same direction. Interestingly in this respect, is to note that the expected house appreciation coefficient is estimated to be higher (52.4 versus 40.7) in Reg. 1 than in Reg. 2, which may be read as a stronger link to the credit bounds when not excluding households most likely to be constrained. At the same time the impact of the tax parameter (ATCCI) goes down and fail to be significantly different from zero for the 30-40 cohort.[11]

The estimates may understate the long term adjustment to reduced interest deductions, as households need time to adjust. Furthermore, cross sectional data only contain the indirect trace of tenure change and debt reconsiderations. One way to capture some of the dynamics is to exclude some time interval just after the reform. Estimation excluding the first two years after the reform gives after tax cost coefficients estimates that are considerably higher (Table 6.1, Reg. 3). This may be taken as sign of gradual adaptation to the post reform era. However, excluding one post year after another does not give a steady progression towards higher long term effect. This may be due to a weakness in the model, that already was present in the Dunsky-Follain model: In a two-period framework, a household invest in the first period and sell in the second and last. Persistent house appreciation has a

[11] The estimates are robust in the sense that resampling and reestimation does not change the sign nor significance of the estimates. Rerunning the model using debt to income ratios as dependent variable gives qualitatively the same picture with respect to sign and significance of the after tax cost variable.

considerable wealth effect on home owners. Using the house as debt collateral, facilitates consumption smoothing. The age cohorts 50 to 60 and 60 and above may be argued to have strong incentives for consumption smoothing either by trading down or increasing debt. Intriguingly, as Figure 4.5 clearly shows, the shift in real debt as a function of age gives no indication whatsoever, that this is the case.

**Table 6.1 Regression results**

| | Reg. 1[a] Real debt | Reg. 2[b] Real debt | Reg. 3[c] Real debt |
|---|---|---|---|
| Age cohort 20-30 | -73.863 | | |
| | (5.31)** | | |
| Age cohort 30-40 | 20.225 | 19.318 | 11.72 |
| | (-1.69) | (-1.33) | (-0.72) |
| Age cohort 50-60 | -87.67 | -112.774 | -112.468 |
| | (6.13)** | (6.69)** | (5.94)** |
| Age cohort 60- | -238.944 | -277.688 | -287.313 |
| | (12.28)** | (11.77)** | (11.06)** |
| After tax current mortgage cost impact Age cohort 20-30 (ATCCI) | -3.318 | | |
| | (2.13)* | | |
| ATCCI, age cohort 30-40 | -4.057 | 0.327 | -0.798 |
| | (3.23)** | (-0.2) | (-0.44) |
| ATCCI, age cohort 40-50 | -8.237 | -5.687 | -8.274 |
| | (6.53)** | (3.73)** | (4.75)** |
| ATCCI, age cohort 50-60 | -7.59 | -3.678 | -6.382 |
| | (4.42)** | (-1.78) | (2.70)** |
| ATCCI, age cohort 60- | -6.521 | -2.232 | -3.077 |
| | (2.62)** | (-0.72) | (-0.88) |
| Expected house appreciation[e] | 52.429 | 40.725 | 51.572 |
| | (4.24)** | (2.64)** | (3.23)** |
| Single | -139.662 | -100.181 | -102.611 |
| | (35.07)** | (15.36)** | (15.17)** |
| Couple with one child[f] | 80.96 | 62.56 | 61.037 |
| | (18.89)** | (11.67)** | (10.91)** |
| Couple with two children | 93.27 | 65.757 | 65.918 |
| | (24.92)** | (14.48)** | (13.95)** |
| Couple with three children | 115.383 | 88.934 | 89.261 |
| | (24.95)** | (16.55)** | (15.93)** |
| Couple with four children | 131.012 | 114.441 | 113.704 |
| | (16.58)** | (12.86)** | (12.16)** |
| Constant | 356.835 | 368.479 | 382.741 |
| | (37.48)** | (32.13)** | (30.76)** |
| No. of observations | 63 302 | 46 318 | 42 619 |

[a] Full sample of non-self-employed and non-retired. [b] Excluding the lowest decile of the gross income distribution and the age cohort 20-30. [c] In addition to the ex-clusions of Reg. 2, the observations from the two first years after the reform is dropped. [d] Age cohort 40-50 is the reference for age cohort dummies [e] Represented by observed change in housing price index. [f] Couple without children is the reference for household composition dummies t-values are given in parentheses. One and two stars indicate that the coefficient is statistically different from zero at the 5% and the 1% level, respectively.

# 7. Difference in difference approach

A tax reform may be viewed as a natural experiment, and as such be argued well suited for a difference in difference approach. In this section we adopt the same approach as used in Jappeli and Pistaferri (2006). Let the control group be defined by households that had marginal tax rate between 27 and 29 percent. These households had roughly the same mortgage deduction rate both prior to and after the tax reform. We define the treatment group to be households with marginal tax higher than 34 percent.[12] A marginal tax rate of 27 percent is low by Scandinavian standards; thus a treatment group of households that faced more lenient tax deductions after the reform cannot readily be constructed.

Denote $D_{ijt}$ the amount of debt for household $j$ in group $i$ ($i=0$, control group; $i=1$, treatment group) at time $t$ ($t=0$, before reform; $t=1$ after reform). We assume that demand for debt is:

$$D_{ijt} = \beta_t + f_j + \delta \times 1\{j=1, t=1\} + \upsilon_{ijt}. \tag{9}$$

For $j$ in {0,1}, $t$ in {0,1}, and where 1{.} is an Boolean function that equals *1* if the statement in the bracket is true and zero otherwise. We assume that $\upsilon_{ijt}$ is an i.i.d. error term. Both groups are subject to an aggregate shock $\beta_t$ and $f_j$ captures long term differences between the groups. We can identify the effect of the reform using the following difference-in-difference of expectation values:

$$E\left(D_{1j1} - D_{1j0}\right) - E\left(D_{0j1} - D_{0j0}\right). \tag{10}$$

The difference-in-difference estimate is given in Table 7.1. We see that the treatment group does not significantly change debt, whereas the control group nearly double real debt. The validity of a difference-in-difference approach relies on three assumptions: (1) The reform is exogenous with respect to debt; (2) It is exogenous with respect to sample composition; (3) No other events affect the groups asymmetrically.

Endogeneity of the reform (1) may be argued highly unlikely. Assumption (2) may be harder to justify, since movements across tax brackets need not be independent of borrowing decisions. The Achilles heel of this approach is (3). As the control group has low marginal taxes (by Scandinavian

[12] We leave out households with marginal tax between 29 and 34 percent, to separate the control group from the treatment group. Including these households in the treatment group gives result qualitatively equal, but (as expected) give a difference-in-difference estimate with lower absolute value.

standards), they are likely to be susceptible to credit constraints. Furthermore, constraints vary with the housing market, since houses serve as mortgage collaterals. This implies that the profound change of the control group towards higher debt may be driven by weakened constraints; constraints that can be argued less severe for the treatment group. As discussed in the previous section, housing market turns influences both on the debt demand and supply, thus house appreciation may have boosted credit demand.

**Table 7.1 Difference in difference estimates for real debt. Control group: Marginal tax rate prior to deductions equal to 0.27-0.29.Treatment group: Marginal tax rate prior to deductions equal to 0.34**

| | Treatment group | Control group | Between-group difference |
|---|---|---|---|
| After the reform | 2.72 | 3.31 | -0.59 |
| | (0.11) | (0.01) | (0.11) |
| Before the reform | 3.33 | 1.81 | 1.52 |
| | (0.03) | (0.05) | (0.06) |
| Within group difference | -0.61 | 1.50 | |
| | (0.11) | (0.05) | |
| | | Difference in difference | |
| | | -2.11 | |
| | | (0.12) | |

# 8. Conclusion

The Norwegian government implemented a tax reform which ultimate effect was to eliminate the link between the marginal tax rate and mortgage deductions. After the reform the deduction rate was at 28 percent for all households. This implied less generous deductions for most households and was expected to have an adverse effect on mortgage demand.

We find evidence of such an effect, but our analysis reveals a much more complex empirical picture. In particular, the effect of the tax reform may have been offset by three different factors:

A. The tax reform coincided with a shift from high to low inflation (Figure 3.2). This reduced the nominal after tax cost of mortgage for most households. As noted by Schwab (1982) reduced

inflation tilts the stream of real payments towards the future; thus making the present burden of mortgage financing lower.

B. Credit constraints may have been binding for some households at some points in time. If true, they may mask household adaptation to the tax reform.

C. Mortgage demand is likely to be linked to conjectures of future housing returns, and as these may vary over time, so will expected after tax returns on investment.

These factors leave different empiric imprints. Credit constraints, as implied by credit score models are likely to be binding for young and low income households. Both the nonparametric analysis of Section 4 and the regression analysis of Section 6, may be interpreted as smoking guns for presence of rationing. From a tax reform point of view, the tax records of these households offer little insight to adaptation to the tax reform of 1992. Largely unconstrained households, on the other hand, may respond to changes in incentives. The analysis of Section 4 shows that older and high income households did reduce real debt. To what extent this reduction was distorted by (A) and (C) is a difficult empiric question. Our regression analysis incorporating both present after tax costs and future returns approximated by recent changes in the house price index, seems to indicate sensitivity to present after tax costs as well as future returns. Though we single out a wide set of variables affecting mortgage, and perform various sensitivity tests, the results may be challenged. In addition to a non-canonical choice of functional form, potential endogeneity and omitted variable problems may weaken the analysis. Furthermore, portfolio adjustments in the aftermath of a tax change may take years to unfold, and an analysis may at best underestimate the long term adaptation to the tax reform. Despite these weaknesses the regression may be argued to capture some regularity in tax records, and combined with the nonparametric analysis in Section 3 it offers insight to household behavior.

Older and high income households did reduce real debt, in contrast to young and low income households. This paves the way of another puzzle. With house prices on a steady rise, households already owning a house, which is true for most older households, got wealthier. Increased wealth may spur consumption, if households have preferences for consumption smoothing. However, we find no trace of increased borrowing using the house as a debt collateral. On the contrary, both the parametric and nonparametric analysis shows exactly the opposite. This can be viewed as a surprising variant of present biased preferences, a keen eye on *present* after tax debt costs, and a blind spot for the *present* wealth. If true, households may be overly sensitive to changes in present after tax cost of housing

investment. This is in contrast to the findings of Jappelli and Pistaferri (2006). They did not find evidence for a link between tax considerations and the demand for debt in the case of the Italian tax reform. They question whether lack of financial information about after tax interest rates plays a vital role in the Italian case. Norway may be more informationally efficient, though there are no surveys to reject or strengthen such a hypothesis.[13]

The difference-in-difference estimate may also be interpreted as support for an adequate response to changed incentives. However, households in the control group all face low marginal tax rates (by Scandinavian standards), which may imply that they are susceptible to credit constraints. Their near doubling in mean debt may at least partly be a response to less severe credit rationing. If true, the difference-in-difference estimate may overstate the effect of the tax reform.

In sum, our three approaches give a strong indication of debt reduction for unconstrained households. This may be viewed as encouraging from a policy point of view, since the success of a reform tends to rely on informed households taking adequate actions. Why doubled and tripled house prices did not spur consumption smoothing remains a puzzle, and may be hard to reconcile with the type of preferences over time which we normally assume. This may imply that there is a considerable inertia in household adaptations, at least when it comes to wealth changes.

[13] A weak support for informational efficiency regarding after tax costs, is persistent coverage of interest rates and after tax mortgage cost of housing in mass media. A weaker form of efficiency may be sufficient: Those who faced the stiffest after tax cost increase knew it, and reacted accordingly. As income correlates with education and economic literacy, this may have been the case.

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