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The Effect of Capital Taxes on Household's Portfolio Composition and Intertemporal Choice: Evidence from the Dutch 2001 Capital Income Tax Reform

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The Effect of Capital Taxes on Household's Portfolio Composition and Intertemporal Choice: Evidence from the Dutch 2001 Capital Income Tax Reform *

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Abstract

This paper estimates the effect of capital taxation on portfolio composition and savings using quasi-experimental variation generated by the Dutch 2001 capital tax reform. The reform drove a wedge between the taxation of housing and financial wealth and in addition affected the after-tax return on all assets. I use unique administrative household panel data with information on capital income, wealth and portfolio shares to exploit this variation. I derive and estimate a semi-structural model which directly relates the share invested in financial wealth to the after-tax return on financial and housing wealth. In addition, I link accumulated wealth in the reform-period to the change in the after-tax return on total wealth. Elasticities have the expected sign but are modest in size. I find some evidence for heterogeneity in the behavioral response. In particular, rich and single households seem to be more responsive in terms of both portfolio composition and wealth accumulation, than other households. The estimated elasticities can be used in capital tax models to calibrate the optimal tax rate.

Keywords: Tax Reform, Capital Taxation of Households, Portfolio Composition, Intertemporal Behavior
JEL-codes: H24, H31, G11, G18

1 Introduction

Capital taxation is a contentious issue in public economics. Seminal papers by Atkinson and Stiglitz (1976), Judd (1985) and Chamley (1986) suggest capital should not be taxed at all. However, recent literature suggests that this result only holds in a very specific setting and the optimal tax rate on capital tax is generally non-zero (see for an overview Conesa et al., 2009 and Diamond and Banks, 2010). In addition, many governments create tax incentives for households to hold specific assets, such as owner occupied housing and pension savings, but very little is known about the effectiveness of these subsidies.

In order to calculate the optimal capital tax rate on each asset it is of central concern to know if, and by how much, households respond to tax incentives when they choose their portfolio composition, and their level of savings. In this paper I answer this question by exploiting variation of the Dutch 2001 capital income tax reform.[1]

The reform was announced in 2000 and created enormous quasi-experimental variation in the after-tax return on assets. In particular, the reform drove a wedge between the taxation of owner-occupied housing, hereafter referred to as housing wealth, and the taxation of all other assets in household's portfolio, hereafter referred to as financial wealth.

Most households in the Netherlands owning both types of wealth have received a shock to their after-tax return on each of the two wealth types. At the household level, the two shocks are uncorrelated. In addition, the shock provides variation at each level of household income and all levels of (positive) wealth.

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[1] See Bovenberg and Cnossen (2001) for a comprehensive overview of the tax reform.

This allows me to isolate the effect of the tax reform from other changes in the dependent variable that are correlated with income, wealth and many other control variables.

In order to estimate the effect of the reform, I use a specifically designed unique panel dataset provided by Statistics Netherlands over the period 1995-2004. The dataset is based on the Income Panel Investigation (IPO) which keeps track of administrative records of 0.61 percent of the Dutch population, as well as their household members. The original IPO contains individual tax records on capital and labor income collected from both employers and employees for each household member, as well as a large set of control variables collected at both the national and the municipal level. For the purpose of this study the dataset is extended at the household level with administrative data on household portfolios.

The use of this data is one of the main innovations in this paper. In his Presidential Address to the members of the American Finance Association Campbell (2006) points out that to estimate a portfolio choice model the ideal dataset should have the following five characteristics: i.) it should cover a representative sample of the population, ii.) it should contain wealth and break down wealth into categories, iii.) the categories should be sufficiently disaggregated, iv.) the reported data should be sufficiently accurate and v.) households should be followed over time. The IPO dataset exhibits all of these characteristics, and of top of that the 2001 tax reform offers quasi-experimental variation in the return on assets. Such data is not available in the US and Canada and, as such, most previous studies had to rely on cross-sectional survey data.[2][3] Therefore, unlike most other studies in the literature, in this study I can control for unobserved household heterogeneity. This could be important, because unobserved heterogeneity, such as earnings ability, may be strongly correlated to the marginal tax rate of the household.

In addition, to my knowledge this is the first study to directly link portfolio choice to a tax-induced change in the after-tax return on assets. Unlike the Netherlands, most other tax systems in the world have some sort of capital gains tax. As a result, in other countries the capital tax affects both the expected return and the variance of the return, making it impossible to isolate the effect of taxation on the expected returns. Further, most other tax systems in the world tax all assets more or less synthetically. As such, it is impossible to separately identify asset-specific tax rates. In this respect the 2001 capital tax reform is an ideal experiment, because it drives a wedge between two asset types that were previously taxed synthetically. The estimates can therefore directly be used to predict the effect of the tax rate on a particular asset on the demand of the asset, and as such, they may be of large value to policy makers.

In order to aggregate the reform into economically meaningful statistics I impose some structure by developing a semi-structural model of the household's investment and savings decisions. In the spirit of the consumption-based capital asset pricing model (CCAPM)[4] I split the household decision in a first stage where the household chooses his level of savings and a second stage in which the household chooses its optimal portfolio composition. In the latter stage, I derive the optimal share invested in financial wealth and show that it should be a function of the gross expected after-tax return on financial and housing wealth, and the variance-covariance matrix of the returns. As such, the change in portfolio composition over the reform is a function of the change in each of these two components. I do not observe the after-tax return, since capital gains, and post-reform cash-returns are not recorded. In addition, I do not observe the variance-covariance matrix of the returns. However, by taking the assumption that the change in the expected before-tax returns and the change in the variance-covariance matrix are uncorrelated to the change in the capital-tax rate at the household level, it is still possible to identify the effect of a tax-induced change in the after-tax return on portfolio composition.

The validity of this assumption is discussed in detail in section 4 of this paper. However intuitively, the Netherlands is a small open economy. Therefore, the before-tax expected returns and variances in the capital market are unlikely to be correlated to the change in the tax rate. In addition, Domar and Musgrave (1944) already established that capital-income taxation may decrease the variance in after-tax returns, for given variance in the before-tax returns. However, the Dutch tax system only taxes cash returns. Since capital gains are much more volatile than cash returns[5] the impact of the Dutch capital tax system on the variance of after-tax returns is likely negligible.

Since Hall (1978) the empirical literature on the trade-off between savings and consumption has focused on estimating the Euler-equation. In particular, the fundamental parameter of interest since

[2]See e.g. Hubbard (1985), King and Leape (1998) and Poterba and Samwick, 2003 and Alan et al. (2010)

[3]A notable exception is the working paper Alan and Leth Petersen (2006) which uses administrative panel data around a capital-income tax reform in Denmark in the 80's.

[4]See e.g. Markowitz (1952) and Merton (1969, 1971, 1973).

[5]See e.g. LeRoy and Porter (1981) and Shiller (1981) who show that capital gains in the stock market are much more volatile than may be expected by changes in the interest rate and dividends.

Hansen and Singleton (1983) and Hall (1988) [6] has been the intertemporal elasticity of substitution. One of the difficulties in estimating a Euler equation is endogeneity. Proper instruments which are correlated to the rate of return but uncorrelated to the rate of consumption growth are difficult to find. However, the Dutch capital tax reform may provide just such an instrument. Unfortunately, the data do not allow me to uncover the consumption of households since I do not observe all objects in the budget constraint.[7] Instead I relate the change in total wealth accumulation to the change in the gross after-tax return on the portfolio. From this equation I retrieve the elasticity of the demand of total wealth with respect to a change in the return on total wealth. Although, the elasticity of intertemporal substitution cannot be retrieved from this equation, the sign of this elasticity equals the sign of the elasticity of intertemporal substitution. In addition, the estimated elasticity is interesting to policy makers in its own right, because it shows how capital taxation affects total accumulated wealth.

A particular concern in studies that use a tax-reform to identify the effect of taxation upon behavior is the endogeneity of the tax rate. In this case, the post-reform tax on housing and financial wealth may depend on the change in housing and financial wealth. For housing wealth this effect is likely small because housing is taxed together with labor income and labor income is orders of magnitude larger than housing income for most households. However, the marginal tax rate on financial wealth is crucially dependent on whether or not financial wealth exceeds a threshold. Therefore, I use the pre-reform data from 1995-1999 to construct a model to predict what financial wealth would have been without the reform. New tax rules are applied to predicted wealth levels to predict what the tax rate would have been without the reform. In the final regression I use the instrumented tax rates in order to determine the change in the after-tax return. This instrumentation strategy is standard in the estimation of the elasticity of taxable labor income (see e.g. Feldstein, 1995, Gruber and Saez, 2002 and Weber, 2013).

A second source of endogeneity may arise from the effect of wealth on portfolio composition. Empirical evidence shows a strong correlation between portfolio allocation and the level of wealth (see e.g. Mankiw and Zeldes, 1991, Poterba, 2002 and Campbell, 2006). Hence, a change in wealth may lead to a change the optimal portfolio allocation. Since, the portfolio return depends on the the portfolio allocation the change in wealth may indirectly affect the change in the portfolio return. However, an instrument is readily available. I estimate the change in portfolio allocation using the change in the after-tax return on each asset. The instrument is valid because the after-tax return on each asset is unlikely to be correlated with the change in wealth, except through the change in the return on the entire portfolio. As a result, the portfolio-allocation stage of the household decision process can be used to instrument for the stage where the household chooses between savings and consumption.

In the estimations I use 1999 as a base year since decisions in 2000 may already have been affected by announcement effects. I look at long-run effects up to 2004 and short-run effects up to 2001. In the long-run I find that a tax-induced change in the after-tax return on financial and housing wealth has statistically significant but modest effects on portfolio composition. The central estimate is that a one-percent increase in the tax on financial wealth decreases the share invested in financial wealth by only 0.033 percent. The elasticity with respect to the after-tax return on housing has the expected negative sign, but the effect is economically negligible.

Furthermore, I find that accumulated wealth in the period 1999-2004 is positive and significantly correlated to the change in the after-tax return on the portfolio. However, again effects are rather modest. A 1 percent increase in a hypothetical tax that covers all wealth would decrease accumulated wealth by only 0.036 percent. The short-run elasticities are only slightly lower than long-run elasticities. This indicates that households respond to the change instantaneously.

In the sensitivity analysis I split the sample, and estimate the elasticity of single households and households that had high levels of wealth. The elasticity for these groups is significantly larger. However, this result has to be interpreted with some caution because the sample of single households is rather small and the measurement error may be smaller for the rich households than the poor households. Therefore, it is difficult to separate real heterogeneity in the behavioral response from possible attrition through the measurement error.

Two potential caveats should be discussed. First, unlike other studies on the effect of taxation on portfolio allocation, such as King and Leape (1998) and Poterba and Samwick (2003), I only study the intensive margin of the portfolio choice. Since almost all households own at least a little bit of financial wealth through a savings or demand deposit, I exclude all households that do not own a house. Arguably, the fact that I have aggregated the portfolio to only two assets alleviates the severity of this omission. In addition, the decision of buying a house is fundamentally different from other investment decisions due

[6] See Attanasio and Weber (2010) for an overview of the literature.

[7] The most important missing variable are the capital gains.

to the fundamental indivisibility of buying a house (see also Cocco, 2005), complicating the introduction of an extensive margin in this study.

A second caveat is the fact that I do not observe the wealth employees have in their pension fund. Total savings of the pension funds amount to 138% of GDP in 2013 and are as such a significant portion of total savings for Dutch employees. Unfortunately, for the studied period, pension funds did not keep any records on payments by individual employees and as such there is no way to reconstruct pension savings for households. However, households cannot alter their pension savings on the basis of the tax reform because the level of contributions is set in negotiations between employers and unions. In addition, the reform has had no impact on pension savings, since pensions were untaxed both before and after the reform.

Most classical studies, relying on (repeated) cross-sectional survey data, find a strong effect of taxation on portfolio composition (see e.g. Hubbard, 1985, King and Leape, 1998 and Poterba and Samwick, 2003). However, in a recent article Alan et al. (2010) partially control for unobserved household heterogeneity by cleverly exploiting intra-household variation in the capital income tax rate in the Canadian tax system. They find a significant but relatively modest effect of taxation on portfolio composition.

A direct comparison between previous studies and this study is complicated by the fact that previous studies could not directly link portfolio composition to the after-tax return on assets. However, findings in this paper broadly correspond with the modest behavioral response found in Alan et al. (2010), suggesting that not controlling for unobserved household heterogeneity leads to an overestimation of the impact of taxation.

A large literature has been devoted on estimating the Euler equation using a variety of datasets and instruments. Estimates of the intertemporal rate of substitution vary between 0.65 and 1 (see e.g. Attanasio and Weber, 1989, Attanasio and Weber, 1993, Blundell et al., 1994, Banks et al., 1994 , Attanasio and Weber, 1995 and Engelhardt and Kumar, 2009). This paper adds to this literature by estimating the effect of taxation on intertemporal choice behavior. In particular, the 2001 tax reform provides a strong instrument for the change in the after-tax return on assets. Unfortunately, there is no direct relationship between the elasticity of the after-tax return on wealth estimated in this paper and the intertemporal elasticity of substitution. However, Attanasio and Wakefield (2010) simulate a life-cycle model where the net-after tax return on assets in the UK is increased from 2 to 2.5 percent. Their simulations show that such an increase in the return significantly increases accumulated wealth if the elasticity of substitution equals one. A similar policy analysis using estimates from this study shows only a modest affect on accumulated wealth. The large difference between the estimated effect in this paper and the simulation tentatively suggest that the estimated elasticity of intertemporal substitution in this study is smaller than in the base-line simulations of Attanasio and Wakefield (2010).

This paper is organized as follows. In the next section explains the 2001 tax reform in detail. In the third section discusses the IPO data. The fourth section introduces the econometric specification. The main results are presented in the fifth section. The sixth section presents some sensitivity analysis and the final section concludes.

2 The 2001 Tax Reform

The 2001 tax reform was officially announced by the Dutch government in mid-2000. Rates, bracket thresholds, income definitions and tax deductions all changed. Also, the new system introduced a wedge between the taxation financial and housing wealth. The reform drastically changed incentives to for portfolio composition and savings. In this section I will highlight how the tax reform has affected incentives through the households' intertemporal budget constraint.

In the Netherlands, household wealth has four components, each of which are taxed according to a different tax-regime: i.) financial wealth, ii.) housing wealth, iii.) tax-deferred wealth, iv.) ownership of small firms and closely-held corporations. Financial wealth is the difference between financial assets such as bank accounts, stocks, bonds and real estate, and loans. Housing wealth is the difference between the value of the owner-occupied house and the mortgage on the house.

The largest part of tax-deferred wealth are so-called second pillar pension savings. Collective labor agreements between employers and employees require firms to set up pension funds or join in sectoral pension funds. Total savings of the pension funds amount to 138% of GDP in 2013 and are as such a significant portion of total savings for Dutch employees. Unfortunately, for the studied period, pension funds did not keep any records on payments by individual employees and there is no reliable way to

reconstruct pension savings for households. As such, I have no choice but to ignore tax-deferred wealth in this study. Fortunately, the 2001 reform did not affect the taxation of these assets. Furthermore, behavioral responses in these savings at the household level are unlikely since the size of the contributions are set in negotiations between unions and employers. Up to 2003 there were no major changes in pension benefits, entitlements or contribution. In 2003 pension premiums did increase significantly due to the aftermath of burst of the dot-com bubble. However, the change in pension contributions was likely strongly correlated with household labor income and age, both of which I can control for in my estimation, and after controlling for those factors, only weakly correlated to the change in the capital tax rates.

In addition, this study ignores wealth stemming from small firms and closely-held corporations. The 2001 reform did change the taxation of wealth and income from closely-held corporation. However, households that own closely-held corporations likely have the possibility to shift income between various tax bases (see e.g. De Mooij and Nicodème, 2008). As such, I remedy this problem by simply excluding all households that owned close-held corporation, or small firms from my dataset. The focus of this study is therefore on housing and financial wealth.

In the remainder of this section I will explore the changes generated by the tax reform through the household's intertemporal budget constraint. The linearized intertemporal budget constraint of household i in period t is given by:

$$W_{i,t+1} + C_{it} = \left(1 - T_{it}^{L}\right) Y_{it} + V_{it} + R_{it}^{W} W_{it}, \tag{1}$$

where W_{it} denotes total household wealth of household i in time t, C_{it} consumption, T_{it} the marginal tax rate on labor income of the primary earner, Y_{it} gross labor income of the primary income earner, and R_{it}^{W} the gross-return rate on total wealth after capital taxes. The actual budget constraint is non-linear because the income is taxed progressively. However, linearizing the budget constraint simplifies the exposition considerably and is useful in deriving the relationship between behavior and the marginal tax rate (see also Saez, 2001, Gruber and Saez, 2002). The term V_{it} denotes virtual income, and contains a correction term for the fact that the actual budget constraint is non-linear, as well as net household income that does not pertain to labor of the primary earner.

The after-tax return on wealth is crucially dependent on the asset mix in the portfolio, since the different categories of wealth holdings face a different tax regime. Hence, it is useful to split up total wealth into financial and housing wealth:

$$W_{it} \equiv W_{it}^{F} + W_{it}^{H},$$

where, W_{it}^{F} is financial wealth, the difference between financial assets and loans, and W_{it}^{H} housing wealth, the difference between the value of the owner-occupied house and the mortgage resting on the house. Hence, the total gross after-tax return on wealth, R_{it}^{W} can be subdivided in the gross after-tax return on financial wealth and the gross after-tax return on housing wealth:

$$R_{it}^{W} = \alpha_{it}^{f} R_{it}^{F} + \left(1 - \alpha_{it}^{f}\right) R_{it}^{H},$$

where R_{it}^{j} is the after-tax return on wealth type j and α_{it}^{f} the share of financial wealth in the portfolio. The after-tax return on each asset can be characterized by the following equation:

$$R_{it}^{j} = 1 - \tau_{it}^{j} + \left(1 - T_{it}^{j}\right) R_{it}^{j} + R_{it}^{j*} \quad \forall \quad j \in \{F, H\},$$

where τ_{it}^{j} is the wealth-tax on wealth type j, R_{it}^{j} is the net taxable return on asset j and $T_{it}^{W^{j}}$ the marginal tax rate over return j. Finally, R_{it}^{j*} is the untaxed return.

Before the reform the wealth tax was levied on the part of total household wealth that exceeded some threshold. The threshold value in turn depended on household characteristics X_{ib}.. The threshold was larger for couples than for singles, but independent of portfolio composition:

$$\tau_{ib}^{j} = \tau_{ib}\left(W_{ib}, X_{ib}\right) \quad \forall \quad j \in \{F, H\},$$

where the subscript b denotes the base year and X_{ib} is the status of the household.

Cash returns were taxed synthetically with labor income of the primary earner according to a non-linear, progressive tax-system.[8] In addition, for real-estate the government taxes an imputed rent.

[8]The marginal tax rate I use for this study consists of two parts: general social insurance premiums and taxes. However, I will treat both as taxes since there is no relationship between the payment of social insurance premiums and benefits.

Capital gains were not taxed at all. Tax rates are age dependent since people over 65 do not have to pay the social premiums relating to the general pension. As such, their effective marginal tax rates are generally lower. In addition, there was a general tax deduction which depended on household status. Thus, the tax function could be expressed as follows :

$$T_{ib}^{j} = T_{ib}\left(Y_{ib} + \sum_{j\in\{A,H,M\}} r_{ib}^{W^j} W_{ib}^{j}, X_{ib}\right) \quad \forall \quad j \in \{F, H\}.$$

After the reform, the government introduced a tax-system based on imputed returns on financial wealth. Financial wealth above a threshold, which was again larger for couples than singles, are presumed to receive a return of 4 percent. The 4 percent in turn was subject to a tax rate of 30 percent. Effectively, the presumptive capital tax is equivalent to a wealth tax of $30\% \times 4\% = 1.2\%$. For future reference I will refer to this tax simply as a wealth tax. The new wealth tax does not pertain to wealth from housing. As such, the after-reform wealth-tax on assets is given by:

$$\tau_{ir}^{A} = \tau_{ir}\left(W_{ir}^{F}, X_{ir}\right),$$

where subscript r stands for all post-reform years. Housing wealth is no longer subject to the wealth tax:

$$\tau_{ir}^{W^H} = 0.$$

For financial wealth the capital-income tax is abolished such that:

$$T_{ir}^{W^F} = 0.$$

Capital-income pertaining from housing wealth is still taxed synthetically with labor income from the primary earner. However, the general tax deduction is abolished and replaced with a tax credit which depends on household type and employment status. In addition, the rates in the income tax have changed. The post-reform income tax can therefore be expressed as:

$$T_{ir}^{W^j} = T_{ir}\left(Y_{ir} + \sum_{j\in\{H,M\}} r_{ir}^{W^j} j_{ir}, X_{ir}\right) \quad \forall \quad j \in \{H, M\},$$

where $T_{ir}(.)$ is the post-reform income tax rate.

Table 1 gives an overview of the changes in deductions, tax credits, threshold levels and tax rates for a single household. All amounts are expressed in 1999 euros. As can be seen, the wealth tax has increased from 0.7 to 1.2 percent and the tax exempt threshold has been lowered drastically. This increase in wealth taxes is offset by the fact that housing is now wealth-tax exempt. The marginal income tax rate has decreased for households at the bottom and the top. However, the tax rate has increased for some households that used to be in the third bracket and are now in the fourth bracket. In addition, the income definition has changed since actual return of financial wealth is no longer taxed. However, this is unlikely to affect the marginal tax rate much since cash returns from financial wealth are generally much smaller than labor income for most households.

The tax-reform created a wedge between the taxation of housing wealth, and the taxation of other financial assets, by excluding the former from the new wealth tax and the latter from the income tax. The shock has not affected all households symmetrically. In particular, in the market for financial assets the abolishment of the capital-income tax has stronger effects for households with high synthetic income than for households with low synthetic income, due to tax progressivity. Additionally, because the tax rate on capital income is dependent on the earnings of the primary income earner, the size of the shock in the tax rate for given household income depends on the division of earnings within the household. Specifically, for a given household income, if the incomes of primary and secondary earners are relatively close, the tax rate on income earned by the primary earner is relatively low.[9] Also, the threshold of the wealth tax has shifted down affecting households that were previously below the threshold, but were not after the reform. Finally, the pre-reform tax on capital-income was only levied over cash returns. As such, households with relatively low cash returns and high capital gains paid a lower tax on their assets

[9]Note that this source of variation runs counter to the one exploited in Alan et al. (2010) in the Canadian tax system. In Canada, households can choose which partner pays capital income taxes. As such, households with a more unequal division of household income face a lower capital-income tax rate.

Table 1: Overview of the Tax System

	Pre-reform 1999			Post-reform 2001		
Wealth Tax						
Applies to	All Wealth			Financial Wealth		
General Tax Deduction	89,395			16,818		
Tax rate	0.70%			1.20%		
Income Tax						
Applies to	Full Synthetic Income			Labor and Housing Income		
General Tax Credit	0			3,284		
General Tax Deduction	3,993			0		
Tax Brackets	Starting	Up to	Percentage	Starting	Up to	Percentage
Bracket 1	0	6,807	35.75%	0	14,209	32.35%
Bracket 2	6,807	21,861	37.05%	14,209	25,808	37.60%
Bracket 3	21,861	48,080	50%	25,808	37,408	42%
Bracket 4	48,080	∞	60%	37,408	∞	52%

Note: The table gives an overview of the pre- and post-reform wealth and income tax. Deductions and credits apply to a single household without children. Tax rates apply to all income earners below 65. All monetary values are expressed in 1999 euros.

than households with high cash returns and low capital gains. This assymetric treatment of returns is now abolished since the post-reform tax rate is levied independent of the division of returns within the asset.

Furthermore, in the market for owner-occupied houseing the reform in the rates of the income tax have increased the tax rates for some households, but decreased the tax rates for other households, thereby providing a source of variation in the return on housing wealth. In addition, the abolishment of the wealth-tax on housing has affected those households above the wealth-tax threshold but has not affected those that were below the threshold.

As such, the reform offers a myriad of sources for identifying the effect of a change in the tax rate on portfolio composition and savings. The next section will present the data used to exploit the variation caused by the tax reform.

3 Data Description

The data used for the analysis is the Income Panel Investigation (IPO) provided by Statistics Netherlands. The IPO follows about 0.61 percent of individuals in the Dutch population in the period 1989-2010, and it follows all the household members of the original 0.61 percent. Individuals in the panel are unaware of their participation in the sample. In 1989 the dataset contained data on 210,000 individuals in 75,000 households. The size of the sample has steadily increased to correct for the increase in the population by adding newborns and immigrants such that the final sample size in 2010 consists of 270,000 individuals in 94,000 households. The sample is not entirely representative for the Dutch population because some groups were deliberately oversampled. However, sampling weights are provided.

For the purpose of this study, the IPO has been extended to contain administrative data on household wealth and portfolio composition. Data are collected at the household level through administrative tax records. The data contain financial wealth in three broad categories: financial wealth, housing wealth and closely-held corporations. All wealth is subdivided in assets and liabilities and for financial wealth they are further subdivided into saving accounts, stock, bonds, real estate and other assets. Loans, including mortgage loans, savings and checkings account are valued in their cash value. Stocks and bonds are valued at market prices. Dutch municipalities measure the value of all real estate in order to collect property taxes. These valuation have been used for real estate. Unfortunately, I have no data on the height of the property taxes themselves. However, there was no reform in the property taxes in the studied period. Therefore, this omission likely does not influence my results.

The dataset also contains some information on the taxable part of capital income. In particular, the data have some information on the cash returns. In the data, cash returns on financial wealth are measured as the sum of dividends, the difference between interest received and interest paid on all loans

except the mortgage, and imputed returns on all real estate except the owner-occupied house divided by total financial wealth. Cash returns on housing wealth are defined as the difference between the imputed return on the owner-occupied house and interest paid over the mortage divided by total housing wealth. In the pre-reform period cash returns on both financial wealth and housing wealth are available. In the post-reform period cash returns on housing are observed but there are no accurate observations on returns on financial wealth since the government did not need to collect this information anymore after abolishing the capital-income tax on these assets. Note that even in the pre-reform actual returns on assets may be significantly larger than the cash returns due to the fact that capital gains are not reported at all.

The dataset also contains additional information on households such as primary income from labor-, transfer- and subsidy-income, gross income, taxable income after deductions, net income and disposable income at the individual level as well as many other income-related variables. Demographic variables such as age, region and country of origin are also included.

I study the data of households in the period 1995-2004. By exploiting the pre-reform period of 1995-1999, I can control for portfolio dynamics. In 2000 the reform was announced. Announcement effects are likely to bias the estimates and as such I do not use data on wealth or capital income from 2000. The main estimation period runs from 1999-2004 and allows for estimation of the effects of the reform in both the short, 1999-2001, and long run, 1999-2004.

From the original data I select a balanced panel comprising the period 1999-2004. From these observations, I select the households whose structure has remained unchanged throughout the sample period. In particular, observations where households merged by marriage or cohabitation, or separated by divorce or death of one of the main partners were deleted from the sample. It is likely that the savings behavior of these households changed for reasons entirely unrelated to the tax reform. Observations where the size of the household increases through childbirth or decreases by one of the children leaving the house remain in the sample. In addition, I removed individuals that were in an institutional house during any of the years.

As mentioned in the previous section, I also filter out all households that own closely-held corporations, as well as self-employed individuals. In addition, I have filtered out all households that do not own positive financial and/or housing wealth. That is, I remove all non-home owners from the sample. Therefore, in this study I focus entirely on the intensive-margin portfolio choice. Finally, I remove outliers defined as households with reported cash returns lower than -20 percent or higher than 50 percent. The large returns for these households may stem from households that underreport their wealth. This is a particular concern for households with low wealth since they were not subject to the wealth tax and as such could not be penalized for underreporting their wealth. The summary statistics of the final sample for post- and pre-reform periods can be found in table 2. The appendix reports summary statistics for the unfiltered sample. All monetary values in the table are reported in 1999 euros. Pre-reform, net-return and after-tax returns on assets have been calculated by dividing cash and imputed income on wealth by wealth. In the post-reform period, returns are calculated under the assumption that before-tax returns were equal to returns in the pre-reform periods such that all the variation is driven by the change in the capital tax.

4 Methodology

It is clear that the tax reform provides many sources of variation in household's investment decisions. The upside of such a large reform is that the after-tax return on assets changed for almost all households. In addition, it has been shown in a large number of studies that portfolio choice and savings are strongly correlated to wealth and income (see e.g. Poterba, 2002, Campbell, 2006 and Attanasio and Weber, 2010). However, figures 1-6 show scatterplots of the relative change in the after-tax return on financial, housing and total wealth as a function of household pre-reform primary labor income and wealth under the assumption that the before-tax returns remain constant. As can be seen from the figures, there is very weak correlation between the change in the after-tax return and income and wealth. In addition, there is variation at all levels of wealth. It is therefore possible to control for these variables explicitly without soaking up any of the variation in the after-tax returns.

Note further that the variation in the return on housing and total wealth is very large for low levels of wealth. This may be due to the fact that homeowners with little housing wealth are highly leveraged. In that case, a small change in the tax rate induces a large change in the after-tax return on housing

Table 2: Summary Statistics for Main Estimation Panel

Variable	Pre-reform	(1995-1999)	Postreform	(2001-2004)
	Mean	Mean Std	Mean	Mean Std
Single	0.082	0.272	0.063	0.242
Couple	0.376	0.484	0.391	0.488
Single with child	0.010	0.098	0.007	0.081
Couple with child	0.532	0.499	0.540	0.498
Nr Children¡18	1.002	1.089	1.101	1.177
Nr Household Members	3.072	1.206	3.350	1.248
Age	41.117	9.339	45.797	9.435
Wealth	118,965	118,343	219,544	244,821
Share Financial Wealth	0.279	0.261	0.220	0.209
Primary Household Labor Income	49,143	23,935	58,093	31,817
Effective Wealth Tax Rate	0.005	0.003	0.007	0.006
Marginal Income Tax Rate	0.438	0.077	0.423	0.052
Net After-Tax Return Financial Wealth	0.007	0.203	0.006	0.034
Net After-Tax Return Housing Wealth	-0.087	0.313	-0.023	0.144
Net After-Tax Return Total Wealth	-0.029	0.132	-0.013	0.035
Nr of observations	12,831		12,831	

Note: Summary statistics of the filtered sample. Pre-reform nr of observations were taken in 1999. All monetary values are expressed in 1999 euros. Post-reform returns are calculated under the assumption that before-tax returns remained equal, such that only the tax rate changes. Mean std denotes the mean standard deviation over all years.

wealth. In my robustness analysis, I focus on a subsample with relatively high wealth-levels to see if excluding this group has a strong impact on my estimates.

In order to estimate the effect of the simultaneous change in the wealth and capital income tax on portfolio composition and savings it is necessary to take some structural assumptions in order to aggregate the reforms into a statistic. In addition, cash returns on wealth in the post-reform period are not accurately observed and capital gains are not observed at all. Finally, there may be multiple sources of endogeneity related to the non-linearity in the tax rate, and the relationship between wealth accumulation and portfolio composition. In this section I will first derive a semi-structural model for asset demand and a semi-structural model for wealth accumulation. Finally, a separate subsection explains the strategy to deal with potential endogeneity.

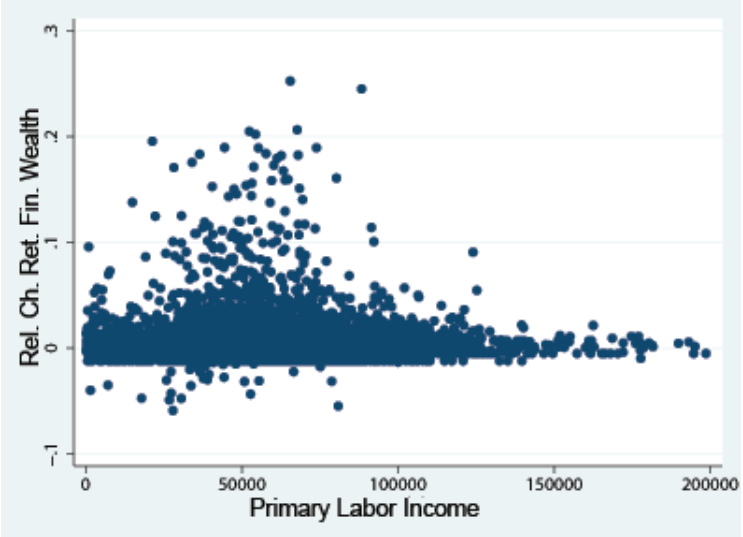
4.1 A Model of Asset Demand

In this paper I study two household decisions. I study the trade-off between consumption and savings, and I study the trade-off between the different assets in the portfolio. In CCAPM it is shown that you can split up this decision into two stages. In the first stage households choose how much to save and how much to consume. In the second stage they choose their optimal portfolio-composition by maximizing a mean-variance utility function. I follow this approach and split up my estimation in a first stage where the dependent variable is accumulated wealth, and a second stage where the dependent variable is the share of financial wealth in total wealth. By backward induction, I will first derive the estimating equation in the second stage where the household chooses its optimal portfolio composition. Assume the household chooses its portfolio shares in each period to maximize a mean-variance utility function of its portfolio returns:

$$f_i\left(E_t\left[R_{it}^W\right], E_t\left[\left(R_{it}^W - E_t\left(R_{it}^W\right)\right)^2\right]\right),$$

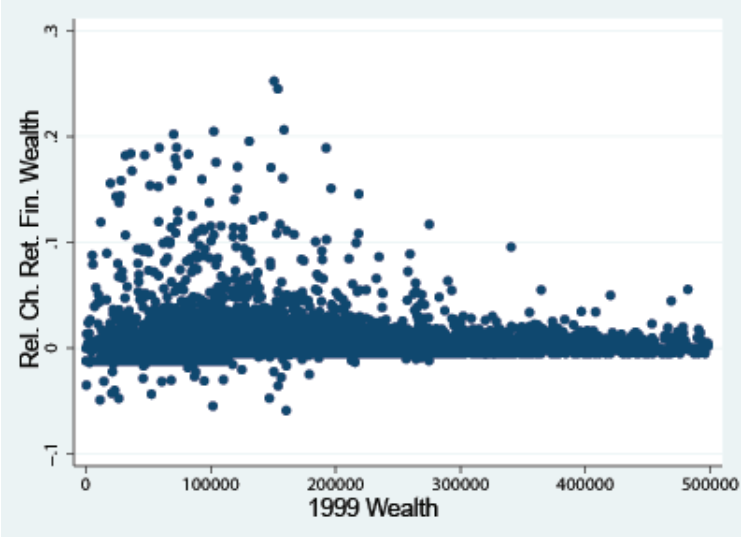
where E_t is the expectation operator in period t. It is well-known since Domar and Musgrave (1944) that capital-income taxation generally affects both the mean and the variance of the investment. A positive capital-income tax rate decreases the mean return on investment but at the same time it decreases the variance by letting the government share part of the losses. On the other hand, a wealth tax only affects the mean return since the size of the wealth tax is unrelated to the return obtained on the

Figure 1: The Change in Return on Financial Wealth Between 1999-2001 as Function of Base Year Income



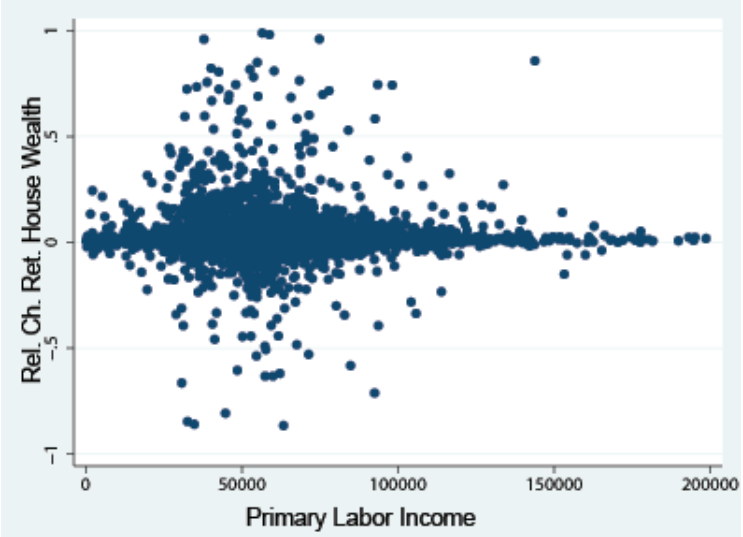
Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on financial wealth between 1999-2001 against base year primary labor income.

Figure 2: The Change in Return on Financial Wealth Between 1999-2001 as Function of Base Year Wealth



Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on financial wealth between 1999-2001 against base year total wealth.

Figure 3: The Change in Return on Housing Wealth Between 1999-2001 as Function of Base Year Income

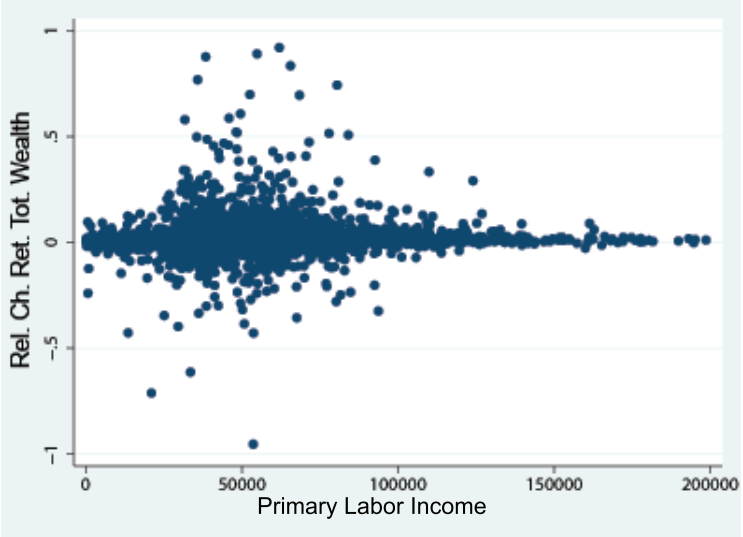


Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on housing wealth between 1999-2001 against base year primary labor income.

Figure 4: The Change in Return on Housing Wealth Between 1999-2001 as Function of Base Year Wealth

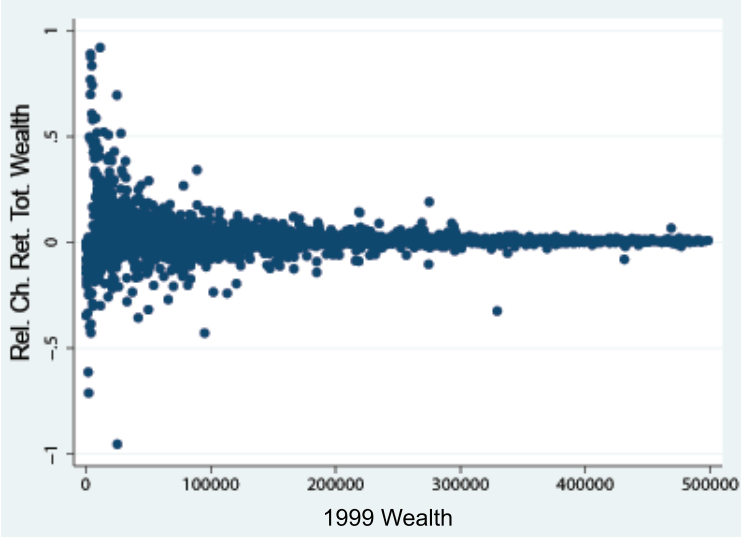
Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on housing wealth between 1999-2001 against base year total wealth.

Figure 5: The Change in Return on Total Wealth Between 1999-2001 as Function of Base Year Income



Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on total wealth between 1999-2001 against base year primary labor income.

Figure 6: The Change in Return on Total Wealth Between 1999-2001 as Function of Base Year Wealth



Note: Figure shows a scatterplot for all households of the relative change in the gross after-tax return on total wealth between 1999-2001 against base year total wealth.

asset. Therefore, it might be expected that abolishing the capital-income taxes on the cash-returns of financial wealth and the abolishment of wealth taxes on housing wealth affected both the mean return and the variance of the assets. In this case, identification becomes difficult because it is unclear whether the behavioral changes of the reform were caused by a change in the mean or in the variance of the return. Fortunately for the econometrician, the Dutch government only taxes cash returns. Of these, both imputed returns on real estate and interest payments on loans, savings accounts and government bonds are generally known before the household makes an investment decision. Dividend pay-outs are arguably somewhat more volatile, but are still far less volatile than capital gains (see e.g. Shiller, 1981 and LeRoy and Porter, 1981). Therefore, I take the strong assumption that the taxable part of returns, R_{it}^{j}, is non-random at period t. I assume that untaxed returns are random variables and the vector of untaxed returns on financial and housing wealth follows a normal distribution:

$$r_{it}^{*} \tilde{} \mathcal{N}\left(\mu_{it}, \Sigma_{it}\right).$$

where μ_{it} is a vector, $\left[\mu_{it}^{F}, \mu_{it}^{H}\right]$ of the mean returns on financial and housing wealth, and Σ_{it} the variance-covariance matrix of returns. The expected portfolio return can be written as:

$$E_t\left[R_{it}^{W}\right] = E_t\left[\alpha_{it}^{F} R_{it}^{F} + \left(1-\alpha_{it}^{F}\right) R_{it}^{H}\right]$$

The variance of the return is given by:

$$E_t\left[\left(R_{it}^{W} - E_t\left(R_{it}^{W}\right)\right)^2\right] = \left(\alpha_{it}^{F}\right)^2 \sigma_{it}^{FF} + 2\alpha_{it}^{F}\left(1-\alpha_{it}^{F}\right)\sigma_{it}^{FH} + \left(1-\alpha_{it}^{F}\right)^2 \sigma_{it}^{HH},$$

where σ^{jk} denotes the covariance of assets j and k. As can be seen, the variance of the portfolio is independent of the tax rate. From the first-order condition of the household one can derive the demand for the share of financial wealth in the portfolio as a function of the after-tax returns on financial wealth and housing wealth. Asset pricing theory predicts that the share increases in the return on financial wealth and the variance in housing wealth and decreases in the return on housing wealth and the variance in financial wealth. Assume, as is standard in the literature (see e.g. King and Leape, 1998), that the log share of assets is log-linear in each of the returns, and separable in all returns and the variance. In that case the log share of financial wealth can be written as:

$$\ln \alpha_{it}^{F} = \zeta_i + \eta_t + \sum_{j\in\{F,H\}} \varepsilon^{j} \ln E_t\left[R_{it}^{J}\right] + g_i\left(\Sigma_i\right) + \nu_{it},$$

where ζ_i, is a household-specific intercept, η_t a period-specifc effect, ε^{j} is the elasticity of the share with respect to return wealth type j, $g_i\left(.\right)$ is a general function of the variance-covariance matrix and ν_{it} is the error term. In order to estimate this model, using variation induced by the reform, I take first differences over the reform:

$$\Delta \ln \alpha_{ir}^{F} = \gamma + \sum_{j\in\{F,H\}} \varepsilon^{j} \Delta \ln E_r\left[R_{ir}^{j}\right] + \Delta\nu_{ir},$$

where Δx_{ir} denotes the difference of variable x between the post-reform period r and the base year b and $\gamma^{F} = \Delta\eta_t^{F}$. Further simplify the equation by writing out the expectations:

$$\begin{aligned}
\Delta \ln \alpha_{ir}^{F} &= \gamma + \sum_{j\in\{F,H\}} \varepsilon^{j}\left(\Delta r_{ir}^{j} - \Delta\left[T_{ir}^{j} r_{ir}^{j}\right] - \Delta\tau_{ir}^{j} + \Delta\mu_{ir}^{j}\right) + \Delta\nu_{ir}, \qquad (2)\\
&= \gamma + \varepsilon^{F}\left(\Delta r_{ir}^{F} + T_{ib}^{F} r_{ib}^{F} - \Delta\tau_{ir}^{F} + \Delta\mu_{ir}^{F}\right) + \varepsilon^{H}\left(\Delta r_{ir}^{H} - \Delta\left[T_{ir}^{H} r_{ir}^{H}\right] + \tau_{ib}^{H} + \Delta\mu_{ir}^{H}\right) + \Delta\nu_{ir},
\end{aligned}$$

where I have used the approximation $\ln\left(1+x\right) \approx x$ and the fact that $T_{ir}^{F} = \tau_{ir}^{H} = 0$. Clearly, direct estimation of (2) is problematic because we do not observe actual changes in the returns since returns are entirely unobserved after the reform. However, this omitted variable will not bias the final estimates as long as, after controlling for variables X_i, it is uncorrelated to the tax-induced change in the after-tax return on each asset. Control variables in X_i should obviously include variables that somehow influence household investment behavior and may be correlated to the change in the tax rate. I will first introduce the control variables that I will add to the model, before discussing the validity of this crucial assumption.

The first variable I include in X_i is the total sum of primary labor income the household earned during the reform period. Here primary labor income includes all taxes and employee and employer premiums. This variable is meant to capture the amount of disposable income a household had available

during the reform period. Clearly, households that had a lot of income during the reform period might save more than households that received less income. In addition, households with more income might use different investment instruments. Finally, primary income may be seen as a good control variable measuring ability of the household.

Furthermore, X_i contains base-year wealth and base-year savings to control for portfolio dynamics such as mean reversion and persistence. In addition, I have added wealth splines to X_i. The wealth splines are dummy variables indicating whether a household was in a specific decile of the wealth distribution in 1999. These spline terms control for possible exogenous dispersion in the wealth distribution, as in Gruber and Saez (2002).

In addition, I control for age of the primary income earner using age dummies. It is likely that households with old primary income earners invest less, and less risky, than households with younger income earners due to the fact that the probability of death increases with age. Finally, I control for household type and household composition.

As mentioned before, the question is whether conditional on the X_i just mentioned, the omitted variables are uncorrelated to the tax-induced changes in the after-tax return. This condition is very likely satisfied in the market for financial wealth. The Netherlands is a small open economy and it is unlikely that the Dutch tax reform affected world market returns in any significant way. On the other hand, returns in the much less international housing market might be affected by the tax reform. However, estimation results remain valid as long as the tax reform affected the housing market symmetrically or its effect was assymetric, but strongly correlated with control variables in X_i. Especially the latter scenario seems likely. Although households with different wealth or income levels may have faced different shocks in their before-tax housing return, it seems unlikely that within these wealth and income classes the change in housing returns was somehow directly related to the tax rate. The assumption allows me to make the following substitution:

$$\varepsilon^F \left(\Delta r_{ir}^F + \Delta \mu_{ir}^F\right) + \varepsilon^H \left(\left(1 - T_{ir}^H\right) \Delta r_{ir}^H + \Delta \mu_{ir}^H\right) + \Delta \nu_{ir} = X_i \beta + \xi_{ir}, \tag{3}$$

where ξ_{ir} the new error-term. Through the substitution all variables relating to the change in before-tax return drop out. Note again that X_i should absorb all variation in the after-tax return that is unobserved but possibly correlated to the change in the capital taxes. Inserting (3) into equation (2) we arrive at an estimation equation with only observable variables:

$$\Delta \ln \alpha_{ir}^F = \gamma + \varepsilon^F \left(T_{ib}^F r_{ib}^F - \Delta \tau_{ir}^F\right) + \varepsilon^H \left(\tau_{ib}^H - \Delta \left[T_{ir}^H\right] r_{ib}^H\right) + X_i \beta + \xi_{ir}. \tag{4}$$

Note that a similar equation could be set up for the change in the log share of housing wealth. However, since both shares add up to one, such an equation would give no additional information with respect to the information contained in equation (4). If an increase in the return on housing decreases the share of financial wealth, than by definition it must also increase the share of housing wealth by the same percentage. Hence, in order to estimate portfolio allocation in a model with two assets, one only needs to estimate one equation.

The elasticities in equation (4) directly relate the change in portfolio share to a tax-induced change in the after-tax return on the asset. This contrasts sharply with estimates in the US and Canada in e.g. King and Leape (1998), Poterba and Samwick (2003) and Alan et al. (2010), where portfolio allocation is related to an overall measure of the marginal tax rate on capital income. The results in these studies can inform policy makers whether an increase in the marginal tax rate shifts asset demand from less to more tax-favored assets, but are unable to inform the policy makers about the effect of increasing the tax-favored status of a particular asset by one percent. Such inference can only be made if different assets are taxed according to entirely different rules and effective marginal tax rate can be calculated independently for each type of asset. An even stronger inference can be made when a country reforms its tax system from a system where assets were taxed according to the same rules, to a system where taxes differ along the different type of assets. It is in that respect that the Dutch 2001 capital tax reform gives the econometrician a close to perfect natural experiment.

In addition, the tax systems in the US and Canada tax both cash and capital gains. As such, the capital income tax lowers both the return and the risk of the asset. Hence, in the aforementioned studies it is impossible to directly relate the change in the tax-rate to a change in the after-tax return, without also making strong structural assumptions about the effect of taxation on the variance-covariance structure of asset returns. By contrast the Dutch tax system affects the return but gives close to zero insurance against asset price volatility. As such, the change in investment decisions can be related directly to the change in the after-tax return, allowing for a more fundamental unraveling of the asset-demand equation.

4.2 A Model of Household Wealth Accumulation

In the first stage of the household optimization problem a household decides how much to consume and how much to save. The typical approach is to assume that it maximizes life-time utility with respect to the intertemporal budget constraint, yielding a consumption-Euler equation. A large literature starting with Hall (1978) has been devoted to estimating the Euler equation. Of particular interest is the intertemporal elasticity of substitution, the relative increase in the rate of consumption growth as a result of a relative increase in the return on the portfolio. In many models of capital taxation the intertemporal elasticity is a sufficient statistic for the distortion induced by capital taxation. However, directly estimating the Euler equation may be difficult due to endogeneity. Many factors such as business cycle fluctuation likely affect both the rate of consumption growth and portfolio returns. In addition, it is difficult to come up with instruments which are correlated to the interest rate but not directly correlated to the rate of consumption growth. As a result estimates of the intertemporal elasticity of substitution are sensitive to the instrument used.

The 2001 tax reform in the Netherlands is a strong candidate for an instrument, since it affected after-tax returns without additionally affecting consumption directly. Unfortunately, the IPO data cannot be used to deduce household consumption levels, because in the intertemporal budget constraint (1) a large part of the returns are unobserved. However, wealth accumulation can be observed. Although, the effect of taxation on wealth accumulation does not give exact information on the elasticity of intertemporal substitution, unless you are willing to take strong structural assumptions, it does give policy makers an indication of the intertemporal distortion created by capital taxation. In addition, what is lacking in terms of estimating the relevant preference parameter, is made up for in precision by using a particulary strong instrument.

To estimate the effect of the 2001 reform on capital accumulation I assume that the demand for log wealth is linear in the expected log return on wealth:

$$\log W_{it} = \zeta_i + \eta_t + \varepsilon \log E_r \left[R_{it}^W\right] + \nu_{ir}., \tag{5}$$

where γ is a constant, ε is the elasticity of wealth with respect to the after-tax return on wealth and ξ_{ir} is the error-term. Note that the sign of ε is not a-priori determined by economic theory. An increase in the after-tax return leads to a substitution effect where people consume more in the future and less now. As is noted in Summers (1981) the substitution effect is reinforced by a negative wealth effect. The increase in the financial discount rate decreases the discounted value of future labor income. This wealth effects decreases consumption in each period, and hence, increases savings. However, households with positive wealth holdings also experience a positive wealth effect since the discounted value of their financial wealth increases with the interest rate. As such, households are induced to consume more in each period. In order to achieve this they have to consume part of their current wealth holdings. If the substitution effect dominates ε is greater than zero and vice versa if the wealth effect dominates. Note that the sign of ε corresponds directly to the sign of the intertemporal elasticity of substitution.

Taking first differences over equation (5) we arrive at:

$$\Delta \log W_{ir} = \gamma + \delta \Delta \log E_r \left[R_{ir}\right] + \Delta \nu_{ir},$$

where $\gamma = \Delta \eta_t$. The equation can be further simplified by writing out expected portfolio returns and using $\log(1+x) \approx x$:

$$\begin{aligned}
\Delta \log W_{ir} &= \gamma + \varepsilon \sum_{j \in \{F,H\}} \Delta \left[\alpha_{ir}^j \left(r_{ir}^j - T_{ir}^j r_{ir}^j - \tau_{ir}^j + \mu_{ir}^j\right)\right] + \Delta \nu_{ir}, \\
&= \gamma + \varepsilon \sum_{j \in \{F,H\}} \Delta \alpha_{ir}^j \left(\left(1 - T_{ib}^j\right) r_{ib}^j - \tau_{ib}^j\right) + \\
&\quad \varepsilon \sum_{j \in \{F,H\}} \alpha_{ir}^j \left(\Delta r_{ir}^j - \Delta \left[T_{ir}^j r_{ir}^j\right] - \Delta \tau_{ir}^j\right) + \Delta \left[\alpha_{ir}^j \mu_{ir}^j\right] + \Delta \nu_{ir}
\end{aligned} \tag{6}$$

where $\alpha_{it}^h = 1 - \alpha_{it}^f$ is the share of housing wealth in total wealth. Note that the change in before-tax returns is not observed. However, I have already assumed that, conditional on X_i, the change in the unobserved variables is independent to the change in the tax-rate. Hence, also here I can make the following substitution:

$$\sum_{j \in \{F,H\}} \alpha_{ir}^j \left(1 - T_{ir}^j\right) \Delta r_{ir}^j + \Delta \left[\alpha_{ir}^j \mu_{ir}^j\right] + \Delta \nu_{ir} = X_i \beta + \xi_{ir}. \tag{7}$$

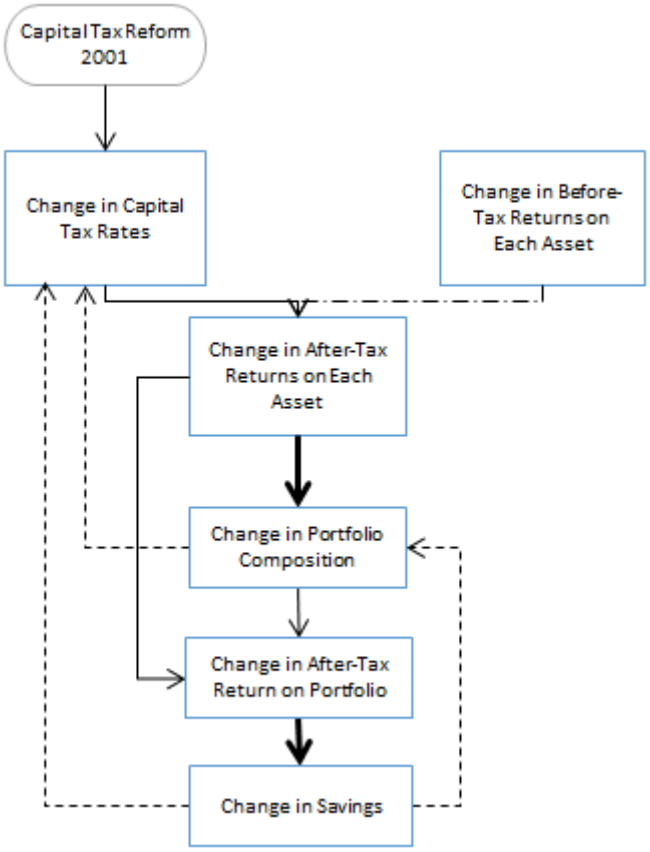
Substitute equation (7) into (6) to arrive at the final relationship:

$$\Delta \log W_{it} = \gamma + \varepsilon \left[\sum_{j \in \{F,H\}} \Delta \alpha_{ir}^{j} \left(r_{ib}^{j} - T_{ib}^{j} r_{ib}^{j} - \tau_{ib}^{j} \right) - \alpha_{ir}^{j} \left(\Delta T_{ir}^{j} r_{ib}^{j} + \Delta \tau_{ir}^{j} \right) \right] + X_i \beta + \xi_{ir}. \quad (8)$$

Equation (8) gives the relationship between wealth accumulation and a tax-induced change in the after-tax return, expressed entirely in observables.

4.3 Endogeneity

Figure 7: A Flow Chart of the Chain of Causality



Note: Figure depicts the chain of causality. Solid lines depict the main causal relationship this study tries to investigate, the two fat solid lines indicate the two main estimation equations, dashed lines indicate potential reverse causality and the dashed-dotted line indicates the unobserved channel.

The chain of causality is described in figure 7. In the flow chart solid arrows depict causal relations. The top fat solid arrow represents estimating equation (4) and the bottom arrow represents (8). Dashed arrows represent potential reversely causal links and the dashed-dotted arrow represents the omitted channel, the effect of the change in before-tax returns on after-tax returns. The flow chart starts at the 2001 reform which caused variation in the capital tax rates. In turn, the capital tax rate influenced the after-tax return on each of the two wealth types. Equation (4) has portfolio composition as a dependent variable and the after-tax return on each asset as the main independent variables. Both the change in portfolio composition and the change in the after-tax returns on each asset influence the return on the portfolio. Equation (4) has the change in wealth as a dependent variable and the change in the after-tax return on the portfolio as an independent variable.

As was argued in the previous subsection, the omitted change in before-tax returns might not be problematic as long as the change in those returns are, conditional on X_i, uncorrelated to the change

in the tax-rate. However, there are also three potential reverse causal links. First, the capital tax rate may depend on the change in asset composition in the portfolio. For example, the reform might have incentivized some households to shift their financial wealth to housing wealth in order to bring financial wealth below the taxable threshold. In addition, households might decide to reduce their total wealth in order to bring their financial wealth below the threshold.

The standard approach in empirical tax reform studies to remove this reverse causal link consists of two steps. First, use all available information to predict what the dependent variable would have been had there not been a tax reform. Subsequently, use the new tax system to calculate what the tax rate would have been under the predicted value of the dependent variable (see e.g. Feldstein, 1995, Gruber and Saez, 2002 and Kleven and Schultz, forthcoming).[10]

Since non-capital income and income from housing wealth are taxed synthetically, and non-capital income is orders of maginitude higher than housing income, the tax rate on housing wealth is close to independent of the amount of housing wealth a household owns. As such, there should not be a large endogeneity issue with the after-tax return on housing. However, in the market for financial wealth, the endogeneity problem might be larger. Households can directly affect their tax rate by saving above or below their threshold. Therefore, I estimate a simple savings model on pre-reform data reaching back to 1995 in order to estimate what total wealth would be, had there been no reform. The dependent variable in this equation is household savings as measured by the relative increase in wealth, $\Delta \ln W_{it}$. I subsequently use this model to predict what total wealth would have been without a reform. I then predict financial wealth by assuming that the share of financial wealth in the post-reform year is equal to the share of financial wealth in the base-year 1999, α^f_{ib}. The underlying assumption is that the share invested in financial wealth α^f_{it} is a stationary variable such that the base year share is a good predictor for what the share would have been in the post-reform year, had there been no reform.

The model used to predict savings is given by:

$$\Delta \ln W_{it} = X_{it}\beta + \gamma_i + \eta_t + \nu_{it}.$$

Independent variables in X_{it} are the lagged value of wealth and savings to control for possible mean reversion in portfolio dynamics. In addition, it contains the log of primary income from labor, the number of children, the number of household members, the type of household and age dummies for the age of the primary earner in the household. Since lagged savings can only be calculated from 1997 onwards the model is estimated in the period 1997-1999. Prediction takes place according to an iterative process. First, savings are predicted for 2000:

$$\Delta \ln \hat{W}_{i,2000} = X_{i,2000}\beta + \gamma_i + \eta_{2000}.$$

Obviously, η_{2000} does not follow directly from the model. However, I use the fact that in any model where η_{2000} would be estimated its value would be the difference between the cross-sectional mean of the dependent variable and the mean of its predicted value. That is,

$$\eta_{2000} = \overline{\Delta \ln W_{i,2000}} - \left(\overline{X_{i,2000}}\beta + \overline{\gamma_i}\right),$$

where a bar over a variable denotes its cross-sectional mean. Subsequently, I estimate wealth holdings in 2000 by using:

$$\ln \hat{W}_{i,2000} = \ln W_{i,1999} + \Delta \ln \hat{W}_{i,2000.} \tag{9}$$

I then update X_{i2001} by including predicted values of wealth and savings and again use the model to predict savings and wealth in 2001. The iterative process ends in the final period, 2004. In each post-reform year tax rules are applied to the predicted wealth level in order to estimate what the tax rate would have been if the tax reform had not affected household behavior. Finally, I use predicted instead of actual tax rates in the estimation of equation (4) and (8).

The second possible channel for reverse causality is the effect a change in wealth may have on the change in portfolio composition. Empirically portfolio composition is correlated with wealth (see e.g. Poterba, 2002, Campbell, 2006 and Attanasio and Weber, 2010). In addition, households may be limited in the amount of wealth they can invest in their house, in particular in the short run when they cannot change their mortgage. As such, a change in portfolio composition might be caused by a change of wealth. The econometric methodology in this paper allows for a straightforward approach to solve this issue. Equation (4) can be used to predict portfolio composition. Instruments are the change in the

[10] See Weber (2013) for a discussion of the validity of this approach.

after-tax returns on each asset. Instrument validity requires that the change in the after-tax return is strongly correlated with the change in portfolio-composition, and hence, with the change in the after-tax return on the portfolio. In the results section it is shown that this is indeed the case.

Second, the exclusion restriction requires that the change in the after-tax return can only be related to the change in wealth through the change in the after-tax return. Note that standard tests for the exclusion restriction such as the Sargan-Hansen test (see Sargan, 1958 and Hansen, 1982) cannot be used here because instrumentation is non-linear. That is, the effect of the change in the after-tax return on each asset on the change in portfolio composition is estimated using linear regression. However, the after-tax return additionally has a direct effect on the after-tax return of the portfolio as can be seen in figure 7 by the arrow going from the after-tax return on each asset to the after-tax return on the portfolio. Hence, in equation (8), if α_{it}^H is instrumented using r_{it}^j, equation (8) becomes non-linear in r_{it}^j. However, there is no reason to assume that the tax-rate on each asset has a direct effect on wealth accumulation, other than through its effect on the after-tax return on the portfolio. Hence, I simply assume that the exclusion restriction is satisfied.

Under the assumption that the relative change in after-tax return on each asset is a valid instrument, equation (8) can be estimated using portfolio shares predicted in (4). This second instrumentation step is not standard in the literature. Therefore, in the sensitivity analysis I also study this equation with actual instead of instrumented shares to see if it has a strong effect on the results.

5 Results

5.1 First Stage

Table 3: First-Stage Results

Variables	Change in Log Wealth
Log Wealth t-1	-1.322***
	(0.00649)
Change in Log Wealth t-1	0.133***
	(0.00415)
Log Prim. Labor Inc.	0.0331***
	(0.00796)
Log prim. Labor Inc. t-1	-0.00644
	(0.00781)
Observations	89113
R-squared	0.604

Note: Dependent variable is change in log wealth. The regression equation is estimated using individual- and year fixed effects. In addition, age and household controls have been included in the estimation. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 3 represents the first-stage estimates. Regression tables in this and the following section only show the main covariates. Coefficients for the full set of covariates for each table can be found in appendix B. As can be seen, there is strong mean reversion in wealth accumulation. Households with higher levels of wealth save less in the next period. However, additionally, there is some persistence in savings since households with higher lagged growth in their wealth seem to save more in the next period. As expected, households with higher labor income save more. Lagged income does not seem to be correlated with current savings. Results from these first-stage estimates are used to instrument the post-reform tax rate.

5.2 Long-Run Effects on Portfolio Composition

Table 4 presents the first set of main results. It considers the long-run effects of the reform on portfolio allocation. As can be seen, the change in the after-tax return is positively correlated with the share of financial wealth in the portfolio. Elasticities range from 2.606-4.159 depending on the control variables

Table 4: Long-Run Effects on Portfolio Composition

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
Rel. Ch. R^F	2.715***	2.606***	3.645***	2.696***	3.774***	4.159***
	(0.856)	(0.884)	(0.751)	(0.883)	(0.749)	(0.741)
Rel. Ch. R^H	-0.00622***	-0.0113***	-0.0174**	-0.0112***	-0.0174**	-0.0178**
	(0.00210)	(0.00245)	(0.00717)	(0.00242)	(0.00717)	(0.00743)
Log Savings 1999	-0.0944***	-0.0845***		-0.0830***		
	(0.0311)	(0.0314)		(0.0313)		
Log Wealth 1999	-0.0329	0.134***		0.139***		
	(0.0525)	(0.0185)		(0.0185)		
Control for:						
Splines	YES	NO	NO	NO	NO	NO
Prim. Labor Income	YES	YES	YES	NO	NO	NO
Hh/Age Effects	YES	YES	YES	YES	YES	NO
Observations	12261	12261	13885	12261	13885	13885
R-squared	0.036	0.022	0.018	0.021	0.017	0.006

Note: Dependent variable is relative change in the share of financial wealth between 1999-2004. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

included in the regression. The first column includes all control variables and it presents the preferred estimate of the elasticity at 2.715. This indicates that a one percent increase in the after-tax return increases the share of financial wealth in total wealth by 2.715 percent.

At first sight this effect seems rather large. However, recall that by the approximation $ln(1+x) \approx x$, a one percentage point increase in the wealth tax on financial assets decreases the gross return on financial assets by one percent. Since the current wealth tax rate is 1.2 percent, a one-percentage point increase in this tax rate corresponds to an $1/1.2 = 83$ percentage increase in the tax rate. Therefore, these results imply that a one percent increase in the wealth tax on financial assets decreases the share of financial assets in the portfolio by $2.715/83 = 0.033$ percentage. Hence, the effect of taxation on asset allocation is relatively modest. A close to doubling of the wealth tax decreases financial assets by only 0.033 percent.

This finding corresponds with recent findings in Alan et al. (2010) but are in stark contrast to earlier findings using cross-sectional data in e.g. Feldstein (1976), King and Leape (1998) and Poterba and Samwick (2003) who find strong effects of taxation on portfolio allocation. To my knowledge this study is the first to quantify the exact response of portfolio-allocation to a tax-induced change in the gross after-tax return on the asset.

The second row measures the effect of an increase in the return on housing wealth. As can be seen, an increase in the return on housing wealth slightly decreases the share invested in financial wealth, although the effect is much smaller. This asymmetric response could be explained by the fact that it is more costly for households to adjust their housing wealth. Households can increase their housing wealth by paying off their mortgage or by buying a new house. The former may be costly because households mortgage contracts usually fine households when they pay of more than the contracted amount. The latter is very costly due to moving cost and a 6 percent stamp duty that the government charges upon real estate transaction of owner-occupied houses.

Combining estimates from the first and second row of table 4 creates an interesting picture of household portfolio behavior. An increase in the return on financial wealth induces households to buy more financial wealth. Housing wealth remains remains unaffected due to high transaction costs, but since total wealth goes up, housing wealth as a percentage of total wealth goes down. On the other hand, an increase in the return on housing wealth does not induce households to buy more economically significantly more housing wealth, due to the transaction costs involved in buying housing wealth. Hence, there seems to be very little response to a change in the return on housing wealth.

With respect to the control variables, the change in the share invested in financial assets is decreasing in base-year savings, indicating that those individuals who have saved a lot in 1999 are less likely to save in financial assets in future periods. Wealth is uncorrelated to the change in the share invested in

financial assets except when I do not control for wealth splines.

The size of both elasticities is sensitive with respect to the control variables used. In particular, the elasticities get larger when I do not control for household and age effects and when I do not control for portfolio dynamics by including base-year savings and wealth. In addition, the elasticity of the housing return is rather sensitive with respect to the use of splines. This indicates a slight positive correlation between the (instrumented) change in the after-tax return on the wealth types and each of these variables. However, the elasticities remain significant and of expected sign in each specification. In addition as has been argued above, even when the elasticity is at its highest, the effect of taxation on portfolio composition is rather modest.

5.3 Long-Run Effects on Wealth Accumulation

Table 5: Long-Run Effects on Wealth Accumulation

	(1) IV-IV	(2) IV-IV	(3) IV-IV	(4) IV-IV	(5) IV-IV	(6) IV-IV
Rel. Ch. R^W	3.031***	2.775***	4.256***	2.808***	4.257***	4.318***
	(0.431)	(0.353)	(0.429)	(0.355)	(0.429)	(0.432)
Savings 1999	-0.0959***	-0.0957***		-0.0941***		
	(0.0121)	(0.0120)		(0.0121)		
Wealth 1999	-0.210***	-0.263***		-0.257***		
	(0.0273)	(0.00977)		(0.00971)		
Control for:						
Splines	YES	NO	NO	NO	NO	NO
Prim. Labor Income	YES	YES	YES	NO	NO	NO
Hh/Age Effects	YES	YES	YES	YES	YES	NO
Observations	12261	12261	12261	12261	12261	12261
R-squared	0.356	0.343	0.230	0.340	0.230	0.218

Note: Dependent variable is relative change in wealth between 1999-2004. IV-estimates using instrumented tax rates and portfolio shares. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

In table 5 I study the first stage of the household optimization problem, the trade-off between consumptions and savings. Results from the first column of table 4 were used to instrument for portfolio composition. My estimates show that a 1 percent increase in the after-tax return on the portfolio, reduces savings by somewhere between 2.775-4.318 percent. The preferred estimates are again shown in the first column where the elasticity equals 3.031. Under all specifications the elasticity is statistically significant at the one- percent level and positive. This indicates that the substitution effect dominates the income effect. This result indicates that the elasticity of intertemporal substitution is positive and this is in correspondence with all recent findings (see e.g. Attanasio and Weber, 1993, Blundell et al., 1994, Attanasio and Browning, 1995 and Engelhardt and Kumar, 2009).

By the same argument as in the previous subsection, the estimated elasticity indicates that a one percent increase in a hypothetical wealth tax over all wealth of 1.2 percent, decreases savings by 0.036 percent. Hence, also here, the distortinary effect of taxation on wealth accumulation is relatively modest.

Controls for portfolio dynamics show a strong indication for mean reversion. Wealth accumulated during the reform period is decreasing in base-year wealth and in base-year savings.

Results are sensitive to the use of control variables. In particular, the elasticity becomes somewhat larger when I do not control for portfolio dynamics and become smaller when I do not control for wealth splines.

5.4 Short-Run Effects on Portfolio Composition

Next, I study the short-run effect of the reform on portfolio composition in table 6 by taking the difference between the base year 1999 and the first post-reform year 2001. It is interesting to compare the short-run effects to the long-run effects since this may be indicative of how fast households can adjust their

Table 6: Short-Run Effects on Portfolio Composition

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
Rel. Ch. R^F	2.269***	3.368***	3.288***	2.235***	3.368***	3.882***
	(0.749)	(0.648)	(0.649)	(0.760)	(0.648)	(0.641)
Rel. Ch. R^H	-0.00366	-0.0146*	-0.0146*	-0.00837***	-0.0146*	-0.0147*
	(0.00241)	(0.00747)	(0.00746)	(0.00325)	(0.00747)	(0.00789)
Savings 1999	-0.0658**			-0.0521*		
	(0.0271)			(0.0273)		
Wealth 1999	-0.0146			0.121***		
	(0.0417)			(0.0157)		
Control for:						
Splines	YES	NO	NO	NO	NO	NO
Prim. Labor Income	YES	YES	YES	NO	NO	NO
Hh/Age Effects	YES	YES	YES	YES	YES	NO
Observations	15487	17570	17570	15487	17570	17570
R-squared	0.031	0.017	0.017	0.020	0.017	0.005

Note: Dependent variable is relative change in the share of financial wealth between 1999-2001. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2001. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

portfolio. In the preferred estimate, reported in the first column, the elasticity of the share invested in financial wealth with respect to the return on financial wealth equals 2.269. Surprisingly this elasticity is almost as high as the long-run elasticity, indicating that households reacted to the reform almost instantaneously.

The fast response may be explained by optimization frictions. The 2001 reform brought such a radical change in portfolio returns that households had to respond lest they would end up with highly inefficient portfolios. As a result, they responded right away. After the reform the returns did not fluctuate very much, and as a result, the households did not make anymore adjustments.

On the other hand, the elasticity with respect to the return on housing wealth is not significant. This again indicates that households react less strongly to changes in the return on housing wealth then to the return on financial assets.

Results are sensitive to the use of control variables where in some specifications the short-run elasticity exceeds the long-run elasticity. This could be seen as evidence for misspecification in those models since it seems unlikely that households overshoot their optimal portfolio allocation in the short run, especially if there are transaction costs.

Finally, note that there are slightly more observations in the short-run estimates than in the long-run estimates. This attrition is due to mortality and emigration, marriage and divorce, or missing variables somewhere in the period 2002-2004.

5.5 Short-Run Effects on Wealth Accumulation

In table 7 I present the short-run effects of the tax reform on wealth accumulation. One would expect that an increase in the after-tax return induces households to save more (or less if the income effect dominates) each period. Surprisingly, the preferred estimate the short-run elasticity of 2.739 is only slightly smaller than the long-run estimate. This indicates that households adjust their accumulated wealth immediately to the new after-tax return, but only slightly change their yearly savings in the periods afterward. This might again be the result of optimization frictions.

As mentioned before, it is not possible to directly compare estimates in this paper to estimates of the elasticity of intertemporal substitution. However, Attanasio and Wakefield (2010) perform a simulation for the UK where the after-tax net return is increased from 2 to 2.5 percent, using a life-cylce model. In their baseline simulation the elasticity of substitution equals 1. The simulations show that accumulated wealth may increase by as much as 18 percent at retirement age and by a very significant amount at all ages. On the other hand, estimates in this paper suggest that an increase in the net after-tax return

Table 7: Short-Run Effects on Wealth Accumulation

	(1) IV-IV	(2) IV-IV	(3) IV-IV	(4) IV-IV	(5) IV-IV	(6) IV-IV
Rel. Ch. R^W	2.739***	3.491***	3.491***	2.365***	3.491***	3.548***
	(0.407)	(0.366)	(0.366)	(0.305)	(0.366)	(0.368)
Savings 1999	-0.0917***			-0.0895***		
	(0.00996)			(0.00989)		
Wealth 1999	-0.187***			-0.239***		
	(0.0194)			(0.00854)		
Control for:						
Splines	YES	NO	NO	NO	NO	NO
Prim. Labor Income	YES	YES	YES	NO	NO	NO
Hh/Age Effects	YES	YES	YES	YES	YES	NO
Observations	15487	15487	15487	15487	15487	15487
R-squared	0.346	0.222	0.222	0.326	0.222	0.211

Note: Dependent variable is relative change in wealth between 1999-2001. IV-estimates using instrumented tax rates and portfolio shares. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2001. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

of 0.5 percentage point increases average wealth by approximately $0.5 \times 3.031 = 1.5155$ percent in the long-run. This is far less than the simulation would indicate. Obviously, these two results are not directly comparable since Attanasio and Wakefield (2010) study the steady-state effects in a life-cycle model, where attaining the steady state takes the life-time of an entire generation. However, the small effect that I find in this study coupled with the fact that short-run estimates are very close to long-run estimates gives some tentative evidence that the elasticity of substitution in the Netherlands is smaller than the baseline value in Attanasio and Wakefield (2010).

6 Sensitivity Analysis

6.1 Portfolio Composition

Table 8 shows a sensitivity analysis of the effects of the reform on portfolio allocation. The first column considers only those households where the age of the primary earner is below 65 in 2004. As can be seen, the elasticities are virtually identical to the elasticities in the initial sample.

The second column considers only those households that were above the wealth tax threshold in the base year 1999. This sensitivity analysis serves two purposes. First, households above the wealth tax threshold are relatively wealthy. Therefore, the analysis may help uncover potential heterogeneity in the behavioral response between wealthy and less wealthy households. Such heterogeneity in responses has been found in the literature in e.g. Alan et al. (2010) and might exist because wealthy households may be different in unobservable characteristics such as transaction costs. Moreover, wealthy households might be less liquidity constrained and therefore better able to optimally adjust their portfolio. Second, the measurement error may be less severe for wealthy households. If a low-wealth household misreports its wealth there is no sanction for it, as long as wealth is below the threshold. However, if households above the threshold under report their wealth the tax authorities may sanction them severely.

As can be seen, the elasticity with respect to the return on financial wealth for this group is almost twice as large. In addition, the elasticity with respect to the return on housing wealth increases with a factor larger than 100. This result gives some evidence for heterogeneity in the response rate, although the implied heterogeneity needs to be interpreted with some caution, because the lower estimate for the initial sample may have also been driven by measurement error.

The third group shows the result of single households without children. Their response with respect to the return on financial wealth is more than two times larger than it is for the initial sample. In addition, their response with respect to the return on housing wealth is more than 50 times larger. This again gives some indication of heterogeneity in the behavioral response where singles react much stronger

Table 8: Long-Run Effects on Portfolio Composition for Different Specifications and Subsamples

	(1) < 65	(2) Wealth Tax	(3) Singles	(4) Incl. outliers
Rel. Ch. R^F	2.786***	3.941***	6.438**	0.255***
	(0.865)	(1.102)	(3.168)	(0.0582)
Rel. Ch. R^H	-0.00621***	-7.343***	-2.843**	-0.00613***
	(0.00209)	(1.730)	(1.251)	(0.00157)
Log Savings 1999	-0.0964***	-0.187***	0.135	-0.0823**
	(0.0316)	(0.0452)	(0.116)	(0.0321)
Log Wealth 1999	-0.0304	-0.159***	0.0221	-0.0195
	(0.0584)	(0.0488)	(0.161)	(0.0538)
Control for:				
Splines	YES	YES	YES	YES
Prim. Labor Income	YES	YES	YES	YES
Hh/Age Effects	YES	YES	YES	YES
Observations	11903	8625	664	12510
R-squared	0.035	0.061	0.157	0.038

Note: Dependent variable is relative change in the share of financial wealth between 1999-2004. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

to the change in the capital tax than other households. However, the results have to interpreted with some caution, since the number of observations is relatively small.

The final robustness analysis includes outliers that were filtered out for all other estimates. As can be seen, the number of observations increases with only 240 households. However, the response with respect to the after-tax return on financial wealth decreases by a factor ten. This indicates that these outliers have a very strong effect on the results.

6.2 Wealth Accumulation

Table 9 presents the sensitivity analysis of the effects of the reform on wealth accumulation. The first column presents the results on the subsample that was younger than 65 in 2004. As can be seen, the elasticity is not significantly different for this subsample.

The second column shows the elasticity for the group that was subject to the wealth tax. As can be seen, the elasticity of this group is about three times larger than for the entire sample, indicating that the wealthy may perhaps react stronger to the change in the after-tax return than the poor. A larger response of the the wealthy may be indicative of the fact that liquidity constraints are binding for the households with lower wealth. If liquidity constraints are binding an increase in the return on the portfolio may relax the liquidity constraint, inducing poor households to consume more and save less. Liquidity constraints play a similar role if the household is not currently at the liquidity constraint but may, due to uncertainty, end up at the liquidity constraint in some state of the world (see e.g. Attanasio and Weber, 2010). Clearly, the poor are more likely to be liquidity constrained than the rich and as such, they are less likely to accumulate more wealth if the after-tax return on their assets goes up. The resulting outcome would be that wealthy households have a higher elasticity which is exactly what I find.

The third column displays the results for singles. Singles also have a higher elasticity although the number of observations is rather limited. The fourth column shows the result when outliers are included. This does not seem to effect the elasticity at all. The final column shows the elasticity when I do not instrument for the change in asset composition. The elasticity in this specification is still significantly positive but almost three times smaller. This may indicate that it is indeed necessary to instrument for reverse causality running from wealth to portfolio composition.

Table 9: Long-Run Effects on Wealth Accumulation for Different Specifications and Subsamples

	(1) < 65	(2) Wealth Tax	(3) Singles	(4) Incl. outliers	(5) IV-OLS
Rel. Ch. R^W	3.008***	9.915***	7.822***	3.031***	1.091***
	(0.430)	(0.471)	(1.012)	(0.431)	(0.257)
Savings 1999	-0.0967***	-0.136***	-0.0676	-0.0959***	-0.115***
	(0.0122)	(0.0204)	(0.0417)	(0.0121)	(0.0122)
Wealth 1999	-0.215***	-0.191***	-0.225***	-0.210***	-0.418***
	(0.0306)	(0.0304)	(0.0812)	(0.0273)	(0.0302)
Control for:					
Splines	YES	YES	YES	YES	YES
Prim. Labor Income	YES	YES	YES	YES	YES
Hh/Age Effects	YES	YES	YES	YES	YES
Observations	11903	8625	664	12261	12831
R-squared	0.356	0.250	0.558	0.356	0.613

Note: Dependent variable is relative change in wealth between 1999-2004. IV-estimates using instrumented tax rates and portfolio shares except in final column which only uses instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Household and age effects include household type dummies, number of children below 18 in the household, number of members in the household and age dummies for the primary income earner. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

7 Conclusion

In this paper I use the Dutch 2001 capital tax reform to estimate the effect of capital taxation on households' portfolio composition and intertemporal choice. To my knowledge this is the first study to directly link a tax-induced change on the after-tax return on assets to the portfolio and savings decisions of household. I find behavioral responses in the direction predicted by theory. However, in contrast to earlier findings in the literature, the estimated effect is modest. Therefore, the distortion caused by capital-income taxation is smaller than previously considered.

This finding is of direct impact to policy makers and researchers. A lower distortion of the capital-income tax on wealth accumulation implies a higher optimal capital tax rate. In addition, portfolio choice is not strongly affected by relative difference in the capital income tax rate on different assets. This indicates that nudges may perhaps be a more effective way to affect household's behavior (see e.g. Madrian and Shea, 2001).

In this study I investigate portfolio responses on the intensive margin. Future research should investigate whether Dutch households respond to tax incentives on the extensive margin, and what is the effect of pension savings on portfolio choice and wealth accumulation.

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A Summary Statistics for the Unfiltered Sample

Table 10: Summary statistics for the unfiltered sample

Variable	Pre-reform	(1995-1999)	Postreform	(2001-2004)
	Mean	Mean Std	Mean	Mean Std
Single	0.228	0.419	0.147	0.354
Couple	0.372	0.483	0.341	0.242
Single with child	0.041	0.198	0.040	0.488
Couple with child	0.359	0.479	0.472	0.081
Nr Children<18	0.743	1.066	1.016	1.190
Nr Household Members	2.567	1.336	3.142	1.423
Age	40.980	12.913	42.294	11.299
Wealth	81043.710	135244.035	136714.048	273311.630
Share Financial Wealth	0.566	0.422	0.421	0.362
Primary Household Labor Income	35518.320	27199.737	47129.161	35455.063
Effective Wealth Tax Rate	0.003	0.004	0.004	0.005
Marginal Income Tax Rate	0.416	0.112	0.361	0.064
Nr of observations	42,595		57,558	

Note: Summary statistics of the unfiltered sample. All monetary values are expressed in 1999 euros. Post-reform returns are calculated under the assumption that before-tax returns remained equal, such that only the tax rate changes. Pre-reform number of observations are taken in 1999, post-reform in 2004.

B Regression Tables with all Covariates

Table 11: Long-Run Effects on Portfolio Composition

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
Rel. Ch. R^F	2.715***	2.606***	3.645***	2.696***	3.774***	4.159***
	(0.856)	(0.884)	(0.751)	(0.883)	(0.749)	(0.741)
Rel. Ch. R^H	-0.00622***	-0.0113***	-0.0174**	-0.0112***	-0.0174**	-0.0178**
	(0.00210)	(0.00245)	(0.00717)	(0.00242)	(0.00717)	(0.00743)
Log Savings 1999	-0.0944***	-0.0845***		-0.0830***		
	(0.0311)	(0.0314)		(0.0313)		
Log Wealth 1999	-0.0329	0.134***		0.139***		
	(0.0525)	(0.0185)		(0.0185)		
Primary Labor Income	0.0131***	0.0120***	0.0121***			
	(0.00312)	(0.00315)	(0.00314)			
2nd Decile Wealth	-2.498***					
	(0.469)					
3rd Decile Wealth	-1.229***					
	(0.239)					
4th Decile Wealth	-0.490***					
	(0.152)					
5th Decile Wealth	-0.185*					
	(0.110)					
6th Decile Wealth	0.0365					
	(0.0838)					
7th Decile Wealth	0.0639					
	(0.0683)					
8th Decile Wealth	0.117**					
	(0.0548)					
9th Decile Wealth	0.122***					
	(0.0425)					
Couple	-0.0680	-0.0388	-0.0734	-0.00315	-0.0377	
	(0.0508)	(0.0511)	(0.0498)	(0.0503)	(0.0491)	
Single with Child	-0.0372	-0.0491	-0.147	-0.0750	-0.171	
	(0.219)	(0.215)	(0.216)	(0.214)	(0.215)	
Couple with Child	-0.156**	-0.131**	-0.193***	-0.0961	-0.159***	
	(0.0607)	(0.0610)	(0.0587)	(0.0605)	(0.0582)	
Nr Children< 18	-0.0855***	-0.0793***	-0.0810***	-0.0840***	-0.0854***	
	(0.0242)	(0.0244)	(0.0236)	(0.0243)	(0.0236)	
Nr Household Members	0.103***	0.0999***	0.111***	0.103***	0.115***	
	(0.0176)	(0.0178)	(0.0174)	(0.0177)	(0.0173)	
Constant	-0.854	-2.692***	-1.464***	-2.028***	-0.737*	-0.0559***
	(0.785)	(0.464)	(0.456)	(0.434)	(0.418)	(0.0133)
Observations	12261	12261	13885	12261	13885	13885
R-squared	0.036	0.022	0.018	0.021	0.017	0.006

Note: Dependent variable is relative change in the share of financial wealth between 1999-2004. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Age dummies for the primary earner were included in the regression $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 12: Long-Run Effects on Wealth Accumulation

	(1) IV-IV	(2) IV-IV	(3) IV-IV	(4) IV-IV	(5) IV-IV	(6) IV-IV
Rel. Ch. R	3.031***	2.775***	4.256***	2.808***	4.257***	4.318***
	(0.431)	(0.353)	(0.429)	(0.355)	(0.429)	(0.432)
Savings 1999	-0.0959***	-0.0957***		-0.0941***		
	(0.0121)	(0.0120)		(0.0121)		
Wealth 1999	-0.210***	-0.263***		-0.257***		
	(0.0273)	(0.00977)		(0.00971)		
Primary Labor Income	0.00845***	0.00898***	0.00240*			
	(0.00118)	(0.00120)	(0.00125)			
2nd Decile Wealth	-1.252**					
	(0.590)					
3rd Decile Wealth	0.122					
	(0.127)					
4th Decile Wealth	0.240***					
	(0.0739)					
5th Decile Wealth	0.0846*					
	(0.0505)					
6th Decile Wealth	0.0113					
	(0.0386)					
7th Decile Wealth	-0.0181					
	(0.0306)					
8th Decile Wealth	-0.0207					
	(0.0237)					
9th Decile Wealth	-0.00274					
	(0.0169)					
Couple	-0.0241	-0.0329*	0.00254	-0.00631	0.00956	
	(0.0181)	(0.0184)	(0.0200)	(0.0182)	(0.0199)	
Single with Child	0.0657	0.0676	0.0954*	0.0482	0.0900*	
	(0.0514)	(0.0521)	(0.0546)	(0.0512)	(0.0545)	
Couple with Child	-0.0362*	-0.0427*	0.0228	-0.0166	0.0295	
	(0.0218)	(0.0220)	(0.0241)	(0.0219)	(0.0240)	
Nr Children< 18	-0.0362***	-0.0389***	-0.0388***	-0.0424***	-0.0398***	
	(0.00842)	(0.00852)	(0.00898)	(0.00848)	(0.00893)	
Nr Household Members	0.0415***	0.0421***	0.0255***	0.0446***	0.0263***	
	(0.00621)	(0.00628)	(0.00662)	(0.00622)	(0.00657)	
Constant	2.255***	2.838***	0.271*	3.320***	0.416***	0.491***
	(0.388)	(0.203)	(0.158)	(0.200)	(0.142)	(0.00852)
Observations	12261	12261	12261	12261	12261	12261
R-squared	0.356	0.343	0.230	0.340	0.230	0.218

Note: Dependent variable is relative change in wealth between 1999-2004. IV-estimates using instrumented tax rates and portfolio shares. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Age dummies for the primary earner were included in the estimation. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 13: Short-Run Effects on Portfolio Composition

	(1)	(2)	(3)	(4)
	¡65	wtax	Singles	Incl. outliers
Rel. Ch. R	2.722***	11.51***	9.826***	2.739***
	(0.406)	(0.456)	(1.029)	(0.407)
Savings 1999	-0.0922***	-0.143***	-0.0723**	-0.0917***
	(0.0100)	(0.0161)	(0.0289)	(0.00996)
Wealth 1999	-0.199***	-0.161***	-0.224***	-0.187***
	(0.0216)	(0.0187)	(0.0713)	(0.0194)
Primary Labour Income	0.00941***	0.00416**	0.0133**	0.00901***
	(0.00218)	(0.00192)	(0.00636)	(0.00194)
1st Decile Wealth 1999	-3.806***		-19.24***	-3.776***
	(0.877)		(2.263)	(0.882)
2nd Decile Wealth	-1.135**		-4.360***	-1.098**
	(0.483)		(0.760)	(0.485)
3rd Decile Wealth	0.0498		-0.741**	0.0860
	(0.115)		(0.368)	(0.112)
4th Decile Wealth	0.193***		-0.00663	0.222***
	(0.0584)		(0.189)	(0.0547)
5th Decile Wealth	0.0770*		0.143	0.0979***
	(0.0398)		(0.142)	(0.0364)
6th Decile Wealth	-0.0186	-0.0744**	0.0246	-0.00346
	(0.0307)	(0.0305)	(0.107)	(0.0281)
7th Decile Wealth	-0.0541**	-0.0583***	-0.0269	-0.0426*
	(0.0243)	(0.0217)	(0.0874)	(0.0224)
8th Decile Wealth	-0.0399**	-0.0254	0.0167	-0.0299*
	(0.0193)	(0.0173)	(0.0727)	(0.0179)
9th Decile Wealth	-0.0201	-0.00846	-0.0148	-0.0171
	(0.0138)	(0.0124)	(0.0541)	(0.0131)
Couple	0.0183	0.0140		0.0147
	(0.0161)	(0.0157)		(0.0157)
Single with Child	0.0449	0.0332		0.0380
	(0.0392)	(0.0476)		(0.0389)
Couple with Child	-0.0336*	-0.0290		-0.0364*
	(0.0190)	(0.0185)		(0.0188)
Nr Children< 18	-0.0321***	-0.0283***		-0.0318***
	(0.00704)	(0.00698)		(0.00701)
Nr Household Members	0.0433***	0.0406***	0.169***	0.0431***
	(0.00544)	(0.00534)	(0.0237)	(0.00539)
Constant	2.250***	1.919***	1.990*	2.114***
	(0.309)	(0.270)	(1.020)	(0.283)
Observations	15144	10729	1001	15487
R-squared	0.347	0.270	0.593	0.346

Note: Dependent variable is relative change in the share of financial wealth between 1999-2001. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2001. Age dummies for the primary earner were included in the regression $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 14: Short-Run Effects on Wealth Accumulation

	(1) IV-IV	(2) IV-IV	(3) IV-IV	(4) IV-IV	(5) IV-IV	(6) IV-IV
Rel. Ch. R	2.739***	3.491***	3.491***	2.365***	3.491***	3.548***
	(0.407)	(0.366)	(0.366)	(0.305)	(0.366)	(0.368)
Savings 1999	-0.0917***			-0.0895***		
	(0.00996)			(0.00989)		
Wealth 1999	-0.187***			-0.239***		
	(0.0194)			(0.00854)		
Primary Labour Income	0.00901***		0.000427			
	(0.00194)		(0.00202)			
1st Decile Wealth 1999	-3.776***					
	(0.882)					
2nd Decile Wealth	-1.098**					
	(0.485)					
3rd Decile Wealth	0.0860					
	(0.112)					
4th Decile Wealth	0.222***					
	(0.0547)					
5th Decile Wealth	0.0979***					
	(0.0364)					
6th Decile Wealth	-0.00346					
	(0.0281)					
7th Decile Wealth	-0.0426*					
	(0.0224)					
8th Decile Wealth	-0.0299*					
	(0.0179)					
9th Decile Wealth	-0.0171					
	(0.0131)					
Couple	0.0147	0.0428**	0.0423**	0.0251	0.0428**	
	(0.0157)	(0.0178)	(0.0180)	(0.0162)	(0.0178)	
Single with Child	0.0380	0.0868**	0.0872**	0.0450	0.0868**	
	(0.0389)	(0.0431)	(0.0431)	(0.0396)	(0.0431)	
Couple with Child	-0.0364*	0.0126	0.0120	-0.0282	0.0126	
	(0.0188)	(0.0214)	(0.0215)	(0.0194)	(0.0214)	
Nr Children< 18	-0.0318***	-0.0266***	-0.0264***	-0.0372***	-0.0266***	
	(0.00701)	(0.00753)	(0.00757)	(0.00710)	(0.00753)	
Nr Household Members	0.0431***	0.0235***	0.0234***	0.0466***	0.0235***	
	(0.00539)	(0.00566)	(0.00573)	(0.00539)	(0.00566)	
Constant	2.114***	0.228*	0.215	2.980***	0.228*	0.326***
	(0.283)	(0.135)	(0.148)	(0.167)	(0.135)	(0.00705)
Observations	15487	15487	15487	15487	15487	15487
R-squared	0.346	0.222	0.222	0.326	0.222	0.211

Note: Dependent variable is relative change in wealth between 1999-2004. IV-estimates using instrumented tax rates and portfolio shares. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2001. Age dummies for the age of the primary earner were included in the estimation $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 15: Long-Run Effects on Portfolio Composition for Different Specifications and Subsamples

	(1) ¡65	(2) wtax	(3) Singles	(4) Incl. outliers
Rel. Ch. R^F	2.786***	3.941***	6.438**	0.255***
	(0.865)	(1.102)	(3.168)	(0.0582)
Rel. Ch. R^H	-0.00621***	-7.343***	-2.843**	-0.00613***
	(0.00209)	(1.730)	(1.251)	(0.00157)
Log Savings 1999	-0.0964***	-0.187***	0.135	-0.0823**
	(0.0316)	(0.0452)	(0.116)	(0.0321)
Log Wealth 1999	-0.0304	-0.159***	0.0221	-0.0195
	(0.0584)	(0.0488)	(0.161)	(0.0538)
Primary Labour Income	0.0124***	0.0172***	0.00885	0.0139***
	(0.00365)	(0.00325)	(0.00950)	(0.00315)
1st Decile Wealth 1999				
0				
2nd Decile Wealth	-2.494***			-2.157***
	(0.482)			(0.465)
3rd Decile Wealth	-1.228***		0.354	-1.192***
	(0.253)		(0.694)	(0.241)
4th Decile Wealth	-0.492***		0.428	-0.408***
	(0.165)		(0.476)	(0.155)
5th Decile Wealth	-0.188		0.274	-0.124
	(0.119)		(0.372)	(0.112)
6th Decile Wealth	0.0341	-0.0563	0.497*	0.0625
	(0.0911)	(0.0981)	(0.296)	(0.0852)
7th Decile Wealth	0.0623	-0.0338	0.335	0.0920
	(0.0739)	(0.0664)	(0.236)	(0.0694)
8th Decile Wealth	0.112*	0.0306	0.287	0.125**
	(0.0588)	(0.0532)	(0.200)	(0.0556)
9th Decile Wealth	0.117***	0.0561	0.415***	0.134***
	(0.0450)	(0.0418)	(0.158)	(0.0429)
Couple	-0.0857*	0.0137		-0.0640
	(0.0519)	(0.0527)		(0.0518)
Single with Child	-0.0527	-0.151		-0.0692
	(0.219)	(0.310)		(0.215)
Couple with Child	-0.170***	-0.0544		-0.146**
	(0.0614)	(0.0637)		(0.0620)
Nr Children< 18	-0.0881***	-0.0647**		-0.0813***
	(0.0244)	(0.0253)		(0.0245)
Nr Household Members	0.105***	0.0884***	0.0622	0.0984***
	(0.0178)	(0.0175)	(0.0773)	(0.0177)
Constant	-0.829	0.343	-3.569	-0.930
	(0.858)	(0.795)	(2.421)	(0.789)
Observations	11903	8625	664	12510
R-squared	0.035	0.061	0.157	0.038

Note: Dependent variable is relative change in the share of financial wealth between 1999-2004. IV-estimates using instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Age dummies for age of the primary earner were included in the estimation. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 16: Long-Run Effects on Wealth Accumulation for Different Specifications and Subsamples

	(1) ¡65	(2) wtax	(3) Singles	(4) Incl. outliers	(5) IV-OLS
Rel. Ch. R	3.008***	9.915***	7.822***	3.031***	1.091***
	(0.430)	(0.471)	(1.012)	(0.431)	(0.257)
Savings 1999	-0.0967***	-0.136***	-0.0676	-0.0959***	-0.115***
	(0.0122)	(0.0204)	(0.0417)	(0.0121)	(0.0122)
Wealth 1999	-0.215***	-0.191***	-0.225***	-0.210***	-0.418***
	(0.0306)	(0.0304)	(0.0812)	(0.0273)	(0.0302)
Primary Labour Income	0.00954***	0.00470***	0.0114***	0.00845***	0.0108***
	(0.00139)	(0.00119)	(0.00398)	(0.00118)	(0.00129)
1st Decile Wealth 1999					2.099***
					(0.227)
2nd Decile Wealth	-1.247**			-1.252**	1.299***
	(0.588)			(0.590)	(0.171)
3rd Decile Wealth	0.117		-0.282	0.122	0.435***
	(0.134)		(0.353)	(0.127)	(0.117)
4th Decile Wealth	0.235***		0.0739	0.240***	-0.0131
	(0.0803)		(0.211)	(0.0739)	(0.0800)
5th Decile Wealth	0.0806		0.0640	0.0846*	-0.238***
	(0.0559)		(0.153)	(0.0505)	(0.0566)
6th Decile Wealth	0.00800	-0.0899**	0.00524	0.0113	-0.262***
	(0.0427)	(0.0439)	(0.122)	(0.0386)	(0.0431)
7th Decile Wealth	-0.0214	-0.0451	-0.0149	-0.0181	-0.235***
	(0.0337)	(0.0337)	(0.0978)	(0.0306)	(0.0340)
8th Decile Wealth	-0.0224	-0.0234	0.0655	-0.0207	-0.186***
	(0.0259)	(0.0257)	(0.0813)	(0.0237)	(0.0263)
9th Decile Wealth	-0.00187	-0.00300	0.0153	-0.00274	-0.107***
	(0.0181)	(0.0177)	(0.0644)	(0.0169)	(0.0184)
Couple	-0.0256	-0.0167		-0.0241	-0.0695***
	(0.0188)	(0.0197)		(0.0181)	(0.0206)
Single with Child	0.0691	0.0611		0.0657	0.0224
	(0.0516)	(0.0659)		(0.0514)	(0.0614)
Couple with Child	-0.0390*	-0.0523**		-0.0362*	-0.0886***
	(0.0222)	(0.0238)		(0.0218)	(0.0242)
Nr Children< 18	-0.0359***	-0.0223**		-0.0362***	-0.0460***
	(0.00849)	(0.00895)		(0.00842)	(0.00925)
Nr Household Members	0.0416***	0.0410***	0.166***	0.0415***	0.0536***
	(0.00631)	(0.00652)	(0.0290)	(0.00621)	(0.00684)
Constant	2.241***	2.511***	1.700	2.255***	4.683***
	(0.428)	(0.423)	(1.076)	(0.388)	(0.437)
Observations	11903	8625	664	12261	12831
R-squared	0.356	0.250	0.558	0.356	0.613

Note: Dependent variable is relative change in wealth between 1999-2004. IV-estimates using instrumented tax rates and portfolio shares except in final column which only uses instrumented tax rates. Splines are linear decile spline terms over the wealth distribution. Primary labor income is a term containing the log of the sum of primary labor income earned between 1999-2004. Age dummies for the age of the primary earner were included in the estimation. Robust standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.