Intertemporal Consumption and Credit Constraints:

Does Consumption Respond to An Exogenous Shock to Credit?

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Abstract

Past research has shown that it is very difficult to identify the effect of credit constraints on intertemporal consumption allocation because the key variable, the marginal utility of money, is unobserved. In this paper the question is asked if consumption is affected by an exogenous increase in the access to credit provided by a credit market reform that gave access for house owners to use housing equity as collateral for consumption. If this is the case it is taken as evidence that some households have been credit constrained prior to the reform. The reform provides an exogenous increase in access to credit comparable to one year of disposable income or more for a considerable fraction of the households in the sample analysed. The analysis is based on Danish panel data with information on income and wealth that facilitates imputing total expenditure at the household level for years around the reform. It is found that some households, particularly among the 30-50 year olds have been constrained, and the analysis provides an estimate of the expected change in the marginal utility of money from lifting the constraint.

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1. Introduction

The standard model of consumption where consumers maximize expected utility subject to expected life time resources predicts in its simplest version with certainty equivalence that consumption is constant across time, Hall (1978), and that the marginal propensity to consume out of extra credit that does not increase life time wealth is zero. This prediction has been massively refuted. The most popular alternative hypothesis that researchers have turned to is that consumers are credit constrained. In this case consumption is no longer constant, and the marginal propensity to consume out of extra liquidity for constant wealth should be positive. Credit constraints have implications for welfare. If households are credit constrained a credit market reform giving access to additional credit is welfare improving for these households.

The literature on tests for credit constraints on micro data is comprehensive. For a survey, see Browning and Lusardi (1996). The main problem with testing for liquidity constraints is that the key variable in the credit constraints model, the marginal utility of money, is unobserved. Therefore indirect measures are used in testing for liquidity constrained behaviour. The dominant source of changes in liquidity for constrained consumers is variations in income. This has lead several researchers to suggest that consumption should track income when households are constrained, Hall and Mishkin (1982). This is known as the test for excess sensitivity. Hall and Mishkin find evidence for a fraction of consumers being constrained, but the evidence from using this test in a number of follow-up studies, for example Altonji and Siow (1987), is mixed.

The mixed evidence in the early literature is likely to be due to the excess sensitivity test being a weak test of credit constrained behaviour. Excess sensitivity is consistent with a range of other behavioural patterns. For example, it could appear that consumption is tracking income if income is persistent or if the consumer is guided by rule of thumb behaviour where he either does not save at all or saves a constant fraction of his income. Moreover, Carroll (1997) shows that if consumers are

impatient and have a precautionary motive for saving then average consumption growth equals average labour income growth. This behaviour arises because the consumer is precautionary and faces a risk that income will be zero at some point in the future. He therefore saves more than what is perhaps needed ex post in order to insure himself against zero consumption events. Also, the expectation of a possible future binding constraint can make the consumer behave as if the constraint is already binding thereby depressing consumption and making consumption changes correlated with income, Deaton (1991). The power of many empirical tests of the liquidity constraints hypothesis is also limited by the use of data on food consumption, because food consumption is not very income responsive.

An important step forward in attempting to increase the power of tests for liquidity constraints was to split the available sample of households according to liquid assets, Zeldes (1989) and Runkle (1991). Sample splitting according to liquid assets improves the power of the test, because it puts focus on a group that is more likely to be constrained. The evidence is however still mixed. Zeldes finds significant excess sensitivity, but Runkle fails to do so. Jappelli (1990) points out that this may have to do with the sample splitting technique. He uses information on discouraged borrowers from the Survey of Consumer Finances (SCF) to identify the characteristics of the people that are constrained and finds that not only financial assets and wealth but also demographic variables such as age, marital status and family size are predictors for constrained status. The SCF does not collect information on nondurable consumption. However, the results from this study have lead to a refinement of the sample splitting technique, where the connection between constrained status and demographics is estimated using the SCF and the obtained estimates are then used to predict constrained status in another data set containing demographics and panel data on consumption, but no information on constrained status. This approach has been employed by Garcia et al. (1997), Jappelli et al. (1998) in order to get a sample split that increases the likelihood of getting a sample

of truly constrained households. They both find evidence that liquidity constraints play a role. This does indicate that the approach has better power than the previous approaches.

The test is, however, still not completely satisfactory because constrained status is likely to be idiosyncratic, for example because of idiosyncratic shocks to consumption. This information is lost by applying two different data sets to identify constrained status. Moreover constrained status is likely to be non constant across time, for example to vary with the business cycle, Fissel and Jappelli (1990). There are two even more serious objections to these approaches, though. First, most studies use food consumption. This reduces the power of the test because food consumption has low income elasticity, and is therefore not the type of good that is expected to be much affected by credit constraints. Secondly, and most important, people who are precautious and face a possibility of being constrained in the future may reduce consumption today. Ex post these people may actually end up never to have been constrained at any point. To control for this effect some exogenous variation in access to credit is needed. Otherwise the effect of constraints will be underestimated.

Meghir and Weber (1996) take a structural approach to the problem of identifying departures from the standard additive model that does not rely on testing for excess sensitivity. They recognise that the fallacy of the standard model can be due both to habit forming preferences and to credit constraints, and both cases will create temporal dependency. Credit constraints will not affect the distribution of expenditures across (nondurable) goods but only depress the total level of expenditures. Habits, on the other hand, will influence the current distribution of expenditures on commodities through past demands. They test for this using the panel data on food, transport and services from US Consumer Expenditure Survey (CEX), and do not find evidence in favour of credit constrained behaviour, except possibly for young households. This result could, however, be due to that Meghir and Weber do not consider a broader consumption measure that includes

durables. Consumption of durables is more sensitive to credit constraints than nondurable consumption.

A number of recent studies try to address some of the issues raised above. Ziliak (1998) recognises that the use of data on food consumption does not give a high power to the test. He uses the income and wealth data in the PSID to impute total expenditure by exploiting that total expenditure in a period is related to income and the change in wealth across the period. Eberly (1994) models adjustments in the car stock using the SCF. Car consumption has the virtue of being a better candidate for identifying effects of credit constraints because car consumption is more income elastic than food consumption. Both Ziliak (1998) and Eberly (1994) find evidence that a substantial fraction of the households being constrained. However, neither Ziliak (1998) nor Eberly (1994) address that households that are potentially constrained in the future but not at the present and have a precautionary motive may depress consumption already now in the anticipation of the potential future constraint.

Alessie, Devereux and Weber (1997) (henceforth ADW) take a different approach and investigate the effect on consumption of durables vs. nondurables of a credit reform that reduces down payment requirements. ADW exploit the reform and the timing of the introduction of it to identify constrained behaviour. However, the study is limited by not having panel data. They take recourse to synthetic panel data methods where a panel is constructed by taking averages across cohorts. Using this type of data it is not possible to deal with idiosyncratic effects which are likely to be important.

Browning and Crossley (2004) look at adjustments in consumption of nondurables and small durables as a response to moderate changes in transitory income for a sample of Canadians that have recently become unemployed. They identify movements in transitory income by exploiting changes in the Canadian unemployment benefit system and find that households mainly cut back on

durable expenditures leaving nondurable expenditures almost unchanged. Cutting back temporarily on durable expenditures by postponing replacement as opposed to cutting back on nondurable expenditure will make the utility loss associated with being constrained smaller. This is because a worn durable, for example a pair of jeans, is still serviceable in the next period whereas expenditures on nondurables, such as food, typically are required in every period for utility not to drop drastically.

Finally Hurst and Stafford (2002) investigate if people who are likely to be liquidity constrained, those with low liquid assets or being unemployed, use housing equity for financing consumption. They use the PSID wealth surveys of 1989 and 1994 together with a detailed survey on mortgage shopping from 1996 and find that people likely to be constrained do take out housing equity for consumption. Hurst and Stafford find this by checking if constrained households pay higher interest rates, if they refinance their mortgage differently or if their wealth position changed between 1989 and 1994 in a way different than for unconstrained households. Hurst and Stafford do not have exogenous variation in credit access. Consequently there is a risk that households taking out housing equity are inherently different from households that do not. Moreover, they do not check directly for effects on consumption data.

In this study the objective is to investigate if a large shock to credit access affects consumption. The shock to credit access is provided by a credit market reform introduced in 1992. The reform gave access to use owner occupied housing as collateral for consumption loans. Some transaction costs are incurred when accessing housing equity. Therefore households are most likely to run down liquid assets first. Following Zeldes (1989) the sample is split according to liquid assets and the change in consumption across the point of introduction of the reform is compared for the low and high liquid asset households. If low liquid asset households are constrained and they take out housing equity to be able to expand consumption to a larger extend than an otherwise similar

high liquid asset households then it is taken as evidence that households in the low liquid asset group on average have been credit constrained prior to the reform, i.e. they have not been able to obtain as much credit as they wish, at least not sufficiently cheap. It is found that some households, particularly among the 30-50 year olds, have been constrained, and the analysis provides an estimate of the expected change in the marginal utility of money from lifting the constraint.

The analysis presented here extends the work of Hurst and Stafford (2002) and ADW in particular. The work of Hurst and Stafford is extended by testing the consumption smoothing role of housing equity directly on consumption data and by exploiting an exogenous shock to credit. This allows estimation of the parameter of interest, the marginal utility of money. The present study extends the analysis of ADW by using household level panel data and a very large exogenous shock to credit access. The shock provides an increase in access to credit comparable to one year of disposable income or more for a substantial fraction of the households. The analysis is based on panel data with information on income and wealth for the period 1987-1996. These data make it possible to impute total expenditure at the household level for years around the reform. Household level panel data allows taking in to account idiosyncratic aspects, and the use of information on total expenditure implies that consumption of goods that are most likely to be affected by limitations in credit access is also considered. In total, the test for credit constraints presented here should have high power compared with much of the earlier literature.

The next section outlines the details of the reform, and presents some aggregate evidence showing that the movements in consumption of durables and nondurables around the reform is consistent with the hypothesis that some households have been constrained prior to the reform. Section 3 sets up a formal model that mimics the features of the aggregate evidence and generate predictions that can be tested on micro data with household level information about total expenditure. A crucial element in the implementation of the test for credit constraints in this paper

is imputation of total expenditure. Section 4 presents the data, and the approach to imputing total expenditure at the household level. Section 5 gives results, and the final section sums up the analysis.

2. The Reform and Aggregate Evidence

The credit market reform exploited for identification in this paper takes effect 21 May 1992. The crucial part of the reform for the purpose here is the introduction of the possibility for house owners to establish a mortgage and use the proceeds from the mortgage loan to finance non housing consumption, i.e. to use the house as collateral for consumption loans.

The financing of real property in Denmark takes place via mortgage banks, so called mortgage credit institutions. Mortgage credit institutions offer loans where the borrower's real property is used as collateral for the loan. It is possible to mortgage up to 80% of the property value. Real credit loans are typically associated with lower costs than loans established in commercial banks. The house owner needs to provide other financing for the remaining 20% of the value of the house. One option is mortgage deeds where the seller of the house issues a mortgage deed, thus classified as an asset to him, to the buyer for whom it is registered as a liability. Loans through the mortgage credit institutions are funded by the issuing of callable mortgage credit bonds with fixed coupon rates. The principal of the loan depends on the price of the underlying bond. When the bond price is below par a higher number of bonds must be sold to meet the funding requirements. This typically makes the principal of the loan larger than the loan proceeds paid out. Before the reform it was possible to establish mortgage loans based on bonds with a maturity of up to 20 years that were only to be used to the financing of real property.

The reform changed the rules about mortgaging in three ways. The most important here is that the reform introduced the possibility to use the proceeds from a mortgage loan for other purposes

than financing real property, i.e. the reform introduced the possibility to use housing as collateral for consumption loans established through real credit institutions. The establishment of loans for non housing purposes is limited to 60% of the value of the house. For the median household in the whole sample in 1991 this part of the reform provided an increase in access to credit comparable to more than one year of disposable income. For people with liquid assets corresponding to less than one months of disposable income, the definition of a credit constrained household in this paper, the median household in 1991 obtained an expansion in access to credit for consumption purposes corresponding to almost 80% of the annual disposable income and for some households the expansion in credit access is much more.

Another feature of the reform is that the maximum maturity of real credit loans is expanded from 20 to 30 years. For people who already had mortgaged to the limit prior to the reform, and therefore could not establish additional mortgage loans for non housing consumption, this option provided a possibility for getting more liquidity.

The final element of the reform gave the option to re-mortgage. Re-mortgaging gives the borrower the possibility to lower the cost of the loan when the market interest rate falls. A borrower is entitled to redeem a real credit bond *at par* at any time prior to maturity, for example by prepayment. This enables the borrower to exploit changes in the market rate of interest in order to reduce the costs of funding. If the interest rate falls, the borrower may prepay his loan, and raise a new loan at the lower coupon rate. This may lower his monthly net payment, but may also imply a larger principal of the new loan relative to the old loan if the price of the bond underlying the new loan is below par. While the two former parts of the reform influence the access to credit, this part of the reform provides house owners with the option to lock in low interest rates in order to obtain lower monthly payments on the mortgage and an overall gain in life time wealth.

In this paper the interest is in the two first elements of the reform providing access to extra credit. These two elements should be exploited only by households who are credit constrained in order to smooth consumption. All households constrained or not, are likely to benefit from the third element of the reform, the remortgaging option, and it is important for the objective set out here, that the estimation technique applied is able to purge for this. This issue will be taken up later. Instead at this point some aggregate evidence on the development of consumption around the reform is presented.

People that are credit constrained and experience a sudden access to extra credit, are expected to increase total expenditure. While constrained these households are likely to have had lower levels of durable purchases so that replacement is postponed relative to what would have been the case had they not been constrained. This adjustment has enabled them to maintain a consumption flow of nondurables as well as a flow of services derived from durables albeit from durables depreciated more than what is optimal for the household. In this way the constrained household minimise the welfare loss from being constrained. For example, being constrained in a period a household may want to postpone replacement of the car rather than cutting back on food consumption. By symmetry when a constrained household obtains access to additional credit it is expected to expand durable purchases by more than non durable purchases. This will be developed formally in section 3.

In figure 1 total aggregate private sector expenditure from the National Account Statistics is illustrated along with aggregate consumption of transport/communication, including purchases of new cars, and aggregate purchases of clothes and food. Total expenditure had been decreasing up to 1990, and then start to increase again hereafter. In 1994, however, the increase takes off. There is indication that the increase in aggregate expenditure happens at the same time as durable expenditures, for example expenditures on transport/communication (including purchases of new

cars) and expenditures on clothes expand. Also food expenditures increase but at a slower rate than expenditures on durables.

[Figure 1 about here; see end of paper]

The pattern in figure 1 is indeed indicative of the mechanism outlined above. In the next section this is put in to a formal model.

3. Theory

An intertemporal model of consumption with two goods, a nondurable good and a durable good is presented. The setup is closely connected to the work by Hurst and Stafford (2002), ADW, and Browning and Crossley (2004).

The consumer is assumed to face the following intertemporal optimization problem

$$\max_{c_t, S_t, X_t} E\left[\sum_{s=0}^{\infty} \beta^s u\left(c_t^n, S_t\right)\right] \tag{1}$$

s.t.

$$X_t = \left(1 + r_{t-1}\right) X_{t-1} + y_t - c_t^n - c_t^d - f_t R_t \tag{2}$$

$$X_t \leq \phi_{1t} + \phi_{2t}\left(p_t^H H_t - M_t\right) \tag{3}$$

$$c_t^d = S_t - \left(1 - \delta\right) S_{t-1} \tag{4}$$

Where

c_t^n = Nondurable consumption in period t

S_t = Durable (non housing) stock at the end of period t

X_t = Liquid assets and housing equity removed at the end of period t

r_t = Interest rate on risk free asset in period t

y_t = Disposable income in period t

c_t^d = Quantity of durable purchased in period t

f_t = Transaction costs associated with new mortgage in period t

R_t = Take value one, if new mortgage is established in period t

M_t = Mortgage at the end of period t

δ = Depreciation rate of durable

ϕ_{1t} = Time specific constant

ϕ_{2t} = Parameter indicating the possibility to use housing equity as collateral

H_t = Stock of housing at the end of period t

p_t^H = House prices at the end of period t

Utility is derived from nondurable and durable consumption[1]. The stock of the durable is treated as a continuous variable, i.e. durables, S_t, are summarised as a stock of efficiency units. This is, of course not very realistic, but convenient and sufficient for the purpose here. The household holds a liquid asset X_t, and a housing asset, H_t, that is less liquid. Equation (2), gives the period-to-period budget constraint; the household enters period *t* with liquid assets X_{t-1} that earns returns r_{t-1}, and receives disposable income[2] y_t. Out of this he spends an amount for nondurable consumption, c_t^n, durable consumption c_t^d, and some transaction costs f_t in case he establish a new mortgage (after the reform). Transaction costs include a fixed component and a capital loss incurred when establishing the mortgage. The latter component is a function of the market rate of the bond

[1] The interest of the paper is in the development in nondurable and durable consumption following the credit market reform, but housing and leisure are left out from the utility function. A recent paper by Del Bocca and Lusardi (2003) find that the choice of mortgage influence women's participation in the labor market. Along similar lines the credit market reform should increase demand for housing because the reform makes housing serve a double purpose as both housing and collateral, and we should observe more people upgrading or moving in to owning from renting. In this case there is no evidence in the raw data that the action takes place along these margins. In the empirical analysis labour and housing is conditioned on, since some elements of consumption, for example energy, may be non separable from housing and labour.

[2] Disposable income is net of mortgage interest payments. This is of particular importance here since households that are constrained prior to the reform will be expected to increase mortgage interest payments by more than similar but unconstrained households.

underlying the mortgage, as outlined in the previous section. The presence of transaction costs imply that the household will run down liquid assets before accessing housing equity. Removed housing equity that is not allocated for consumption plus other liquid assets that is left after decisions have been made in period *t* is passed on to the next period as X_t. Equation (3) is central to this paper. Equation (3) states that loans taken with housing as collateral should be within the limits of a constant ϕ_{1t} plus the ϕ_{2t} fraction of housing equity, $\left(p_t^H H_t - M_t\right)$. ϕ_{1t} is a parameter that indicate time varying access to credit. It may be a function of household specific characteristics, but cannot be a function of the choice variables in the optimization problem. ϕ_{2t} is a parameter that indicate the access to housing equity for consumption purposes. Before the reform $\phi_{2t} = 0$, and after the reform $\phi_{2t} = 1$ provided that $\phi_{2t}\left(p_t^H H_t - M_t\right) < 0.6 p_t^H H_t$, i.e. the household can maximally mortgage 60% of the total house value for non housing consumption[3,4].

The only prices introduced in the model are house prices. This is because there is not much variation in the relative price of durables to nondurables. House prices, however, vary considerably relative to prices of durables and nondurables. House prices steadily declined up to 1993 and started to increase drastically hereafter. In figure A1 in the appendix prices of different durables and nondurables are shown together with house prices. Generally house price changes imply changes in credit access in post reform years, and a house price increase can provide access to credit for households that did not have any housing equity before. Therefore, both the development of house

[3] Note, for a constant value of ϕ_{1t} (3) dictates that if p_t^H is decreasing then the consumer should pay back the part of the collateralised loan that exceeds the new and lower housing equity. House prices were actually decreasing in the period 1987-1993, cf. figure A1 in appendix A. ϕ_{1t} is allowed to vary across time so that lenders do not require this to happen. It is crucial, though, that changes in ϕ_{1t} is not a result of actions taken by the individual as part of his optimization problem.

[4] In this way the model assumes that people do not have access to credit. In reality people may have access to credit but at higher lending rates, so that borrowing rates are exceeding lending rates by more before the reform than after. Analytically, the case where borrowing rates exceed lending rates is similar to the one developed here, see for example Browning and Lusardi (1996).

prices and the development of the market interest rate will influence the observed mortgaging activity across time.

Denoting λ_t the marginal utility of wealth, and μ_t the shadow price of the borrowing restriction the first order conditions of the problem are given by[5]

$$\frac{\partial u}{\partial c_t^n} = \lambda_t \tag{5}$$

$$\frac{\partial u_t}{\partial S_t} = \lambda_t - E_t\left[\beta\lambda_{t+1}(1-\delta)\right] \tag{6}$$

$$\lambda_t - \mu_t = E_t\left[\beta(1+r_t)\lambda_{t+1}\right] \tag{7}$$

$$\mu_t\left(X_t + \phi_{1t} + \phi_{2t}\left(p_t^H H_t - M_t\right)\right) = 0 \tag{8}$$

(5) is the usual first order condition for nondurable consumption. (6) gives the marginal utility of durables. For the λ-constant case marginal utility of durable consumption is derived from the part of the durable that is depreciated in the period, δ. (7) is the Euler equation with credit constraint. Equation (7) states that households try to smooth marginal utility of money across time. If the household is credit constrained it will not be able to smooth marginal utility of money between periods. The shadow value of the credit constraint, μ_t, drives in a wedge between marginal utility in period *t* and *t+1*. Since $\mu_t > 0$ for constrained households their marginal utility will be higher in period *t* than in period *t+1*. Substituting in (5) yields the standard Euler equation for nondurable consumption with credit constraints.

[5] Also a restriction that agents should be house owners is imposed

$$\frac{\partial u_t}{\partial c_t^n} - \mu_t = E_t\left[\beta\left(1+r_t\right)\frac{\partial u_{t+1}}{\partial c_{t+1}^n}\right] \tag{9}$$

(9) states that if the household is constrained in period t then marginal utility of nondurable consumption is higher in t that in $t+1$. If the utility function is monotone then this amounts to saying that nondurable consumption is lower in periods where the household is constrained.

Combining (5) and (6) with (7) yields the marginal rate of substitution between durable and nondurable consumption

$$\frac{\partial u_t}{\partial S_t} = E_t\left[\left(\frac{r_t+\delta}{1+r_t}\right)\frac{\partial u_t}{\partial c_t^n} + \left(\frac{1-\delta}{1+r_t}\right)\mu_t\right] \tag{10}$$

(10) shows that when the household is constrained marginal utility of the durable stock is higher than that of nondurable consumption. So when the household is constrained it will cut back more on durable consumption than nondurable consumption. Conversely, if the constraint is lifted then the household will expand more on durable expenditure that on nondurable expenditure.

The empirical analysis will be based on data for total expenditure, denoted $c = c^n + c^d$. A central prediction of the model is that households that are constrained prior to the reform will access home equity and expand consumption relatively more than an otherwise similar household that was not constrained before the reform. It is this experiment that will be mimicked in the empirical analysis to identify the effects of liquidity constraints on consumption. The effect of the credit market reform in period t on total expenditure for a constrained and an unconstrained household is illustrated in figure 2.

[figure 2 about here; see end of paper]

In the left panel is illustrated a household that is constrained before the reform is introduced in period *t*. Had the reform not been introduced total consumption for this household would have been c_t^-, but the reform gives access to use the housing equity as collateral, and the household therefore consumes $c_t^+ > c_t^-$ and obtains a gain in utility. For the unconstrained household the possibility to use housing equity as collateral does not have any impact on the consumption level, and $c_t^+ = c_t^-$.

To make the model operational for empirical testing isoelastic utility, $u_t = \left[\frac{c_t}{1-\rho}\right]^{1-\rho}$, and rational expectations are assumed, and the log approximation is invoked. The Euler equation for an unconstrained consumer can be written

$$\Delta \ln c_{t+1}^0 = \frac{1}{\rho}\ln\left[\beta\left(1+r_t\right)\right] - \tilde{\varepsilon}_{t+1} \tag{11}$$

where c_t^0 is consumption for the unconstrained, and $\tilde{\varepsilon}_{t+1} = \frac{1}{\rho}\ln\left(1+\varepsilon_{t+1}\right)$. Similarly, the Euler equation for a constrained consumer can be written

$$\begin{aligned} \Delta \ln c_{t+1}^1 &= \frac{1}{\rho}\ln\left[\beta\left(1+r_t\right)\right] - \frac{1}{\rho}\ln\left(1+\varepsilon_{t+1}-\frac{\mu_t}{\lambda_t}\right) \\ &\approx \frac{1}{\rho}\ln\left[\beta\left(1+r_t\right)\right] - \tilde{\varepsilon}_{t+1} + \frac{1}{\rho}\ln\left(\frac{\mu_t}{\lambda_t}\right) \end{aligned} \tag{12}$$

where, c_{t+1}^1 is consumption for the constrained, and $\tilde{\varepsilon}_{t+1} = \frac{1}{\rho}\ln\left(1+\varepsilon_{t+1}\right)$. The difference between (11) and (12) gives the parameter of interest conditional on ρ.

$$\Delta \ln c_{t+1}^{1} - \Delta \ln c_{t+1}^{0} \approx \frac{1}{\rho} \ln\left(\frac{\mu_t}{\lambda_t}\right) \qquad (13)$$

According to (13) comparing consumption growth of a constrained consumer with an unconstrained but otherwise identical consumer and conditioning on the value of the coefficient of relative risk aversion, ρ, should give an estimate of the parameter of interest, $\ln\left(\frac{\mu_t}{\lambda_t}\right)$. The interpretation is as follows: an estimate $\ln\left(\frac{\hat{\mu}_t}{\lambda_t}\right) = 0.05$ indicates that the marginal utility is expected to decrease by 5% due to reform.

In summary, the theoretical model outlined predicts that when the constraint is lifted a consumer will expand total expenditure by more than an unconstrained but otherwise similar consumer. Moreover, by comparing two such consumers it is possible to obtain an estimate of the parameter of interest, the marginal utility of money. This is going to form the basis of the empirical analysis presented in the next two sections.

4. Data

The data used in this study are based on Danish public administrative registers which give annual longitudinal wealth and income information on a 10% random sample of the population in the period 1987 to 1996. This information exists because Denmark had a wealth tax in this period, and it lead to the details of both income and wealth holdings being automatically reported by banks and other financial intermediaries to the tax authorities for all Danish tax payers. The income and wealth information is used to impute consumption at the individual household level according to a simple accounting identity where total expenditure in a period is linked to income and the change in wealth

across the period. The imputation is developed by Browning and Leth-Petersen (2003) who also investigate the quality of it using data drawn from the Danish Family Expenditure Survey (DES) for the year 1994-1996. These data give diary and interview based information on expenditures on all goods and services, which can then be aggregated to give total expenditure in a sub-period within the calendar year. The households in the DES can be linked to their administrative income/wealth tax records for the years around their survey year, making it possible to directly check the reliability of the imputation against the self reported total expenditure measure. Browning and Leth-Petersen (2003) find that the accounting imputation provides a measure that performs quite well in terms of matching individual households subjective statements about total expenditure. The next section gives a description of the imputation, and section 4.2 a description of the data. Most of sections 4.1 and 4.2 contain a summary of what is already presented in Browning and Leth-Petersen (2003). Many details are left out and the reader is referred to the original text here fore. In section 4.3 the sample selection criteria's and some descriptive statistics will be presented.

4.1 The Imputation

The simplest approach to deriving an expression for total household consumption from the income-tax register is based on an accounting identity in which total expenditure is calculated by subtracting savings components from disposable income for the household. The calculation of total disposable income from income-tax registers is, in principle, straight forward, while savings components are identified by calculating changes in wealth from the end of one tax year to the end of the next. In this section the identity that forms the basis for deriving total expenditure from income-tax registers at the household level is defined.

Consider a household that begins year *t* with a portfolio (vector) of assets $\{A_{kt-1}\}$ where A_{kt-1} is the level of asset *k* at the end of period of *t-1*[6]. These assets are held throughout the year and earn a net return i_{kt} for asset *k*. During the year the household also receives earnings (including transfers) of e_t and pays taxes of τ_t. Total expenditure throughout the year is given by c_t. At the end of the year the household sells the assets $\{A_{kt-1}\}$ at prices p_{kt} and buys a new portfolio $\{A_{kt}\}$ at the same prices. The identity of revenue and purchases gives

$$\begin{aligned} c_t + \sum_k p_{kt} A_{kt} &\equiv \left(e_t + \sum_k i_{kt} A_{kt-1} - \tau_t \right) + \sum_k p_{kt} A_{kt-1} \\ &= y_t + \sum_k p_{kt} A_{kt-1} \end{aligned} \tag{14}$$

so that consumption equals disposable income, y_t, if the agent leaves the end-of-period-*t* value of the portfolio unchanged. If disposable income and all assets and asset prices were observed then it would be possible to use this equation to construct a measure of consumption, c_t. In the data used here the stock of each asset (except for housing) is not observed but only the values of each at the beginning and end of the year: $W_{ks} = p_{ks} A_{ks}$ for $s = t-1, t$. To deal with this equation (14) is re-arranged to give

$$\begin{aligned} c_t &= y_t + \sum_k p_{kt} A_{kt-1} - \sum_k p_{kt} A_{kt} + \sum_k p_{kt-1} A_{kt-1} - \sum_k p_{kt-1} A_{kt-1} \\ &= y_t - \Delta W_t + \sum_k \left(p_{kt} - p_{kt-1} \right) A_{kt-1} \end{aligned} \tag{15}$$

[6] The notation is changed slightly compared to the one used in the previous section. All assets are here collected in a vector $\{A_{kt-1}\}$.

where $W_t = \sum W_{kt}$ and Δ is the first difference operator. The final term on the right hand side is the capital gains on the portfolio held at the beginning of the year. The price change term is not observed. Most of the asset/liability variables available are composed of quite diverse assets/liabilities which have very different returns; for example, one asset group includes both cash-in-hand and interest bearing bonds. Consequently it is not attempted to construct a measure of the final term, except for housing. In the results section some consistency checks will be performed to make sure that the omission of this term is not the driving force behind the results. Thus, the following equation is used for imputing consumption[7]:

$$c_t = y_t - \Delta W_t \qquad (16)$$

Browning and Leth-Petersen (2003) refer to this as the *accounting imputation* since it is based directly on the accounting identity

4.2 The Register Data

The study is based on a 10% random sample of the Danish population. The data set contains longitudinal information from different public administrative registers that are merged together. It holds detailed information on family composition, characteristics of the dwelling, and most importantly in this context high quality longitudinal information on income and wealth from the public income and wealth tax registers. The income tax registers contains information about total taxable income and transfers, taxable wealth, and total final tax payments. Information in these registers is based on the tax form. Many entries on the tax form, both relating to the income, assets and liabilities, are reported directly from employers, banks and other credit institutions, and are

[7] With allowance for housing capital gains.

therefore considered reliable. For the purpose of implementing (16) information about total taxable income, some non-taxable income components, final tax payments, wealth, and wealth for the previous year is needed, so that a change-in-wealth measure can be calculated. One notable feature of the register data is that the data on asset holding can be divided into a number of categories. Unfortunately, the definitions of these categories are not stable across the observation period, and the level of detail decreases in the latest years of the sample period, particularly after the reform. An overview is given in figure A2 in the appendix. Before the reform assets are given in six different categories: housing assets, equity, deposited mortgage deeds, cash holdings, bonds, and other assets. Housing assets are defined as the cash value of property as set by the tax authorities, and the content of equity, deposited mortgage deeds, cash holdings self explaining, the latter is more complex. This category contains self reported information about non-deposited bonds, a particular type of unquoted shares (in ships) as well as the value of investment objects and high value objects such as cars, boats. The quality of the information in the latter category is low. No information is held about accumulated pension funds. The bulk of wage earners are enrolled in employer organised pension schemes where pension contributions are deducted before the salary is paid out. As pension contributions are not taxable before they are paid out, pension funds do not appear on the tax form. One exception is if the scheme is privately organised in which case contributions are included in the total expenditure measure. The size of the liability stock is also available in the registers. This is because the wealth tax is paid of net wealth. Liabilities are generally registered for different categories such as mortgage and bank debt. Importantly, the size of the mortgage is known up to 1993. A measure of liabilities that is consistent across the observation period can, however, only be obtained for the total size of the liability stock, cf. figure A2 in Appendix A. More details are given by Browning and Leth-Petersen (2003).

4.3 Descriptive Statistics and identification of constrained households

The sample used in the analysis is drawn from gross sample with information about 10% of the Danish population for the period 1987-1996. To focus the analysis a relatively homogenous sub-sample hereof is selected to minimize the risk of making erroneous inference. First, all self employed individuals are left out because such individuals have highly unstable income-tax conditions, and because own-business wealth is not likely to be measured well. Moreover it is required that the individual sampled is not living together with his parents, and that he is not part of a common household. This is necessary in order to identify the income and wealth variables of individual households. Also, it is required for a person to enter the sample that he is aged between 18 and 75, and that the household does not move in the sample period. Movers are deselected because the interest is not in the moving decision as noted in section 3. The accounting imputation is noisy and generates some negative values of total expenditure. A household with negative imputed consumption is deselected. Finally, conditional on these selection criteria it is required that the household is observed in all years in the period 1987-1996. This leaves a sample of 41,703 households of which 28,109 live in owner occupied housing. The latter is the group of interest in this paper, because they are the ones potentially gaining access to extra credit because of the reform. The sample of renters will be used to perform a consistency check of the results for owners.

A crucial assumption in this paper is that credit constrained households can be identified as households with little or no liquid assets, where liquid assets are defined as the amount of non housing assets in 1991, the year prior to the reform. This is similar to the approach taken by Zeldes (1989), Runkle (1991) and Ziliak (1998). The analysis here will be done for two different sample splits. In the most restrictive split, denoted D1, the low liquid asset group is delimited to have liquid assets worth less than one month of disposable income. In the second split, denoted D2, households

in the low liquid asset group are allowed to have liquid assets corresponding to two months of disposable income.

When the sample is split according to these two criteria for being constrained the number of observations is distributed as shown in table 1.

[Table 1 about here; see end of paper]

The model presented in section 3 suggests that following a shock households wish to run down liquid asset before accessing housing equity, since doing this is associated with transaction costs. According to the model the sample should then be split in to two groups, one with no liquid assets, and one with positive liquid assets. Most people, however, get paid out their salary a few days before the turn of the year, where the holding of assets are summarised for tax purposes. For many people liquid asset holdings corresponding to one months of disposable income thus amounts to having virtually no liquid assets as a buffer, hence the D1 split. For some households our definition of liquid assets may include assets that are in fact not very liquid. To allow for this the second sample split is introduced[8].

It is of some interest to present the portfolio composition for these groups, because it turns out that the portfolio composition is quite simple for the majority of the sample. In table 2 is presented the distribution of the portfolio for the constrained sample, and in table 3 for the unconstrained sample according to sample split D1. Although each row in the tables does not give assets and liabilities for the same person it seems safe to conclude from table 2 and 3 that the majority of households in the sample holds only two assets, cash and housing, and does this whether

[8] It is recognised that this type of sample splitting does not necessarily capture those who are truly constrained, cf. Jappelli (1990). As mentioned in the introduction the approach by Jappelli et al (1998) is more attractive; they estimate the probability of being constrained as a function of demographics using data from a financial survey, the SCF, containing information on constrained status but not consumption, and take the estimates to another sample with information on demographics and consumption but not constrained status, where they predict the likelihood of being constrained as a function of demographics. In this case a survey with information on constrained status does not exist.

constrained or not. Similarly, it appears from table 2 and 3 that most people have simple liability structures holding only bank loans and mortgages. Particularly very few households appear to hold stocks and bonds. In terms of the imputation of total expenditure this is attractive, because it suggests that the failure to take capital gains/losses into account in the imputation may be a relatively small problem. Finally, a similar picture as given by the numbers in table 2 and 3 appears when the sample is split according to the D2 sample split. These tables are therefore not presented here.

[Table 2 about here; see end of paper]

[Table 3 about here; see end of paper]

The interest here lies in giving a description of the development of consumption. Figure 3 gives box plots of total expenditure and disposable income across the period 1988 to 1996 for all house owners. The left graph show that imputed consumption maintains some of the features from the aggregate numbers presented in figure 1. In particular, a substantial increase in consumption appears to take place in 1994. Since the imputed consumption measure relies heavily on disposable income, cf. (16), one could justly be worried that the movements in the consumption measure just mimic those of disposable income. The right hand graph in figure 3 shows that this is not the case.

[Figure 3 about here; see end of paper]

Box plots of imputed consumption on the two different sample splits are given in figure 4. Again the features that were observed in the aggregate numbers are maintained. Consumption is generally

increasing from 1990 throughout 1996, and appears to accelerate sharply in 1994. Moreover, the sample splits indicate that the low liquid asset group seems to exhibit more variability in consumption than does the group with more liquid assets.

[Figure 4 about here; see end of paper]

Again it seems important to confirm that the movements observed in figure 4 are not just a mirror of the movements in disposable income. On the one hand, this is what the excess sensitivity is really about - for the constrained part of sample. On the other hand one would be worried using this type of imputation if it does not tell a lot about movements in total expenditure but rather tells something about movements in disposable income. If this is the case the data do not contain much information about the effects of credit constraints. Box plots of disposable income across the observation period are shown in figure 5. They suggest that the movements in imputed consumption are not just due to movements in disposable income.

[Figure 5 about here; see end of paper]

The evidence presented thus far appears to be consistent with the hypothesis that some movements in consumption have taken place after the introduction of the credit market reform. It is still needed, however, to look into the micro level decision more detailed to verify that movements in consumption are really due to the credit market reform. This is the subject of the next two sections.

4. Empirical strategy

In this paper the empirical test for credit constraints will be based on the prediction that households that are constrained at time *t* will have a larger consumption growth from *t* to *t+1* than households that are not constrained if the constraint is lifted in period *t+1*. It is assumed that consumers with a low level of liquid assets in 1991 are constrained immediately prior to the reform, and the sample is split accordingly. Specifically, two sample splits are applied: one split where households with liquid assets corresponding to less than one month of disposable income by the end of 1991 are considered constrained, and another split where households with liquid assets corresponding to less than two months of disposable income by the end of 1991 are considered constrained. The test is implemented by statistical matching, where for each individual in the constrained group an individual from the unconstrained with similar observed characteristics is found, and their consumption growth around the reform is compared.

The approach to testing for credit constraints is different from the approaches used in previous papers, and there are good reasons for this. As already laid out the most popular approach is to test for excess sensitivity, for example combined with sample splitting according to some indicator of constrained status. This is a weak test for many reasons; some of them mentioned in the introduction. Ziliak (1998) uses an imputation that is similar in nature to the one used here. He tests for excess sensitivity and takes indications of excess sensitivity as evidence that a fraction of the households in the sample are liquidity constrained. The consumption measure used here, like Ziliaks (1998), has the strength over the consumption measures used in most studies testing for excess sensitivity that it contains information about total consumption. It is, however, imputed using income and wealth data, and the power of the excess sensitivity test is likely to be even lower in this context. Even though there is evidence that it has good quality compared to what is known from the previous literature, cf. Browning and Leth-Petersen (2003), it is certainly measured with error. Therefore a test for excess sensitivity is likely to be biased towards accepting excess

sensitivity because of the prominent role played by income in the imputation. Consequently, excess sensitivity tests are not performed here. Another strategy could be to split sample according to liquid assets and estimate parameters consistently on the unconstrained sample by GMM/IV, cf. Zeldes (1989), and then use these parameters to evaluate the expected change in marginal utility of money for the constrained sample following the reform. Doing this one effectively assumes that constrained and unconstrained do not have unobserved characteristics that make them inherently different, an assumption that will be maintained in this paper. Here, the Euler equation will, however, not be estimated by GMM on the unconstrained sample. Consider how the change in log consumption is imputed: $\Delta \ln c_{t+1} = \ln\left[y_{t+1} - \left(W_{t+1} - W_t\right)\right] - \ln\left[y_t - \left(W_t - W_{t-1}\right)\right]$. If the components of this are measured with error then one will have to take recourse to variables dated *t-2* as instruments when estimating the Euler equation dated *t+1*, and the potential problems associated with weak instruments will then be imminent. Taken together it is therefore crucial to employ a different estimation strategy that exploit the data at hand better.

An advantage of the data set used in this paper is that all the components of the collateralised loans constraint (3) are observed along with a host of other variables that are conventionally included in Euler equation studies. It therefore seems natural to implement the test by statistical matching where for each household believed to be constrained another household is found that is identical in terms of a number of observed characteristics except that it is not constrained. In particular housing equity, the level of net total assets, the level of liquid assets is observed. It is therefore possible to match people with similar access to credit after the reform, but where one had a low level of liquid assets before the reform and the other one not. To ensure that the matching procedure compares a constrained household with an otherwise similar household that is not constrained, households are also matched on a number of other variables that are known from the empirical literature on consumption Euler equations to correlate with consumption growth: family

composition, age, and labour supply. Moreover, matching is done on unemployment insurance membership. The ideal experiment compares two households that are identical in terms of the life cycle model, i.e. households with the same life time wealth, except that one individual is constrained prior to the reform, and the other one is not. Households are therefore also matched on disposable income and the size and the value of the house as indicators for the level of life time wealth. Matching is done on the observed values of these variables in the year immediately preceding the reform, 1991, to ensure that the variables that could potentially be affected by the reform have not been so. The implicit assumption made is that a situation with low liquid assets by the end of 1991 has arisen because the household has experienced a negative income or consumption shock, so that a situation with low liquid assets at the end of 1991 is not a consequence of maximizing behaviour that makes the constrained households systematically different from the unconstrained for unobserved reasons. This is similar to Zeldes (1989). Finally, note that it would not be correct to match on pre-reform consumption since the consumption level is depressed below the desired level for those constrained implying that constrained households would be matched with unconstrained households with lower life time wealth.

Having matched each household in the constrained sample with a household in the unconstrained sample, the change in log consumption for the constrained and the unconstrained around the reform is compared in order to check if the constrained household exhibits larger consumption growth than the unconstrained household. If it does it is taken as evidence that credit constraints have influenced the intertemporal consumption plan as shown in the theory section. Note, that because each constrained household gets assigned a control the matching estimator allows for heterogeneous responses to lifting the credit constraints. As noted in section 2 there are three elements of the reform; two of them gives additional access to the housing equity and the third element introduces the possibility to remortgage so that low market interest rates can be locked in

and a gain in life time wealth achieved. To check for credit constraints the interest centres on the two first elements of the reform, and these should only be exploited by those who are constrained before the reform. Both constrained and unconstrained households have an incentive to exploit the remortgaging option. Thus, if matching is done successfully, so that a constrained individual is matched to an otherwise identical unconstrained individual, the effect of remortgaging on consumption should cancel out when comparing growth in consumption, since both individuals should have exploited this option if profitable.

The objective is to obtain an estimate of the effect of the reform on consumption growth around the reform for a constrained household. That is the expected growth of the a priori constrained household conditional on pre-reform characteristics should be compared with the growth rate it would have experienced had it not been constrained. This is known from the evaluation literature as the average treatment effect on the treated, and is given by (17).

$$E\left(\Delta C_{1,t+1} - \Delta C_{0,t+1} \middle| D_t = 1, X_t\right) = E\left(\Delta C_{1,t+1} \middle| D_t = 1, X_t\right) - E\left(\Delta C_{0,t+1} \middle| D_t = 1, X_t\right) \qquad (17)$$

$\Delta C_{j,t+1}$ is the log consumption change measured at time *t+1* for a household with constrained status *j* at time *t*. *t* indicates pre-reform time period and *t+1* indicates post-reform time period. $D_t = 1$ indicates that the household was constrained prior to the reform. X_t is a vector of observed characteristics at time *t*. As mentioned conditioning is done on pre-reform values of X to ensure that matching is done on variables that are clearly exogenous to the outcome of the reform. Potentially, the household may adjust behaviour so that variables such as income, labour supply, and housing assets may change as a response to the reform. By conditioning on pre reform values of these variables they are surely not under influence of the reform.

The difficulty in implementing the estimator is in estimating $E\left(\Delta C_{0,t+1}\middle|D_t=1,X_t\right)$, i.e. the change in consumption conditional on X_t for the constrained had they not been constrained. This is a counterfactual. It is therefore assumed that $E\left(\Delta C_{0,t+1}\middle|D_t=1,X_t\right)=E\left(\Delta C_{0,t+1}\middle|D_t=0,X_t\right)$, i.e. that conditional on observed characteristics X_t the expected change in consumption for the constrained had they not been so is the same as the expected change in consumption for the unconstrained, i.e. those who are not affected by the credit market reform but otherwise have similar characteristics. This amounts to assuming mean independence. In terms of the Euler equation this corresponds to assuming that $E\left(\widetilde{\varepsilon}_{0,t+1}\middle|D_t=1,X_t\right)=E\left(\widetilde{\varepsilon}_{0,t+1}\middle|D_t=0,X_t\right)$. If $\widetilde{\varepsilon}_{0,t+1}$ is a rational expectations error and X_t is equal to the information set, $X_t=I_t$, so that $E\left(\widetilde{\varepsilon}_{0,t+1}\middle|I_t\right)=0$ this will be satisfied by construction. The assumption necessary here is slightly weaker: conditional on pre reform observed characteristics X_t, the mean expectation error of the unconstrained group has the same expected value as the expectation error of the constrained group had they not been constrained, or equivalently that the biased is balanced between the constrained and the unconstrained samples. This amount to assuming that conditional on X_t the constrained group differs from the unconstrained group only by being constrained. This, for example, means that conditional on X_t the constrained group is not allowed to have different attitudes to risk.

An important feature of the data applied here is that consumption is imputed and is therefore measured with error. Assume that the measurement error is additive in log consumption, so that $\Delta\tilde{C}_{j,t+1}=\Delta C_{j,t+1}+\Delta\omega_{j,t+1}$, where $\Delta\tilde{C}_{j,t+1}$ is the observed measure, $\Delta C_{j,t+1}$ is the true but unobserved measure and $\Delta\omega_{j,t+1}$ is the measurement error. For the matching estimate to give an unbiased estimate of the mean effect of the reform on the constrained households it is required that conditional on X_t, on average the measurement error cancels out between the constrained and the

matched unconstrained households, i.e. $E\left[\Delta\tilde{C}_{1,t+1}\middle|D_t=1,X_t\right]-E\left[\Delta\tilde{C}_{0,t+1}\middle|D_t=0,X_t\right]$ $+\left(E\left[\Delta\omega_{0,t+1}\middle|D_t=0,X_t\right]-E\left[\Delta\omega_{1,t+1}\middle|D_t=1,X_t\right]\right)=E\left[\Delta\tilde{C}_{1,t+1}\middle|D_t=1,X_t\right]-E\left[\Delta\tilde{C}_{0,t+1}\middle|D_t=0,X_t\right]$. As mentioned in section 3 the measurement error is likely to relate to the portfolio composition of the household and to be most important where capital gains are not taken in to account in the imputation. It was shown that most households in the constrained and unmatched unconstrained groups hold simple portfolios consisting of assets and liabilities for which unaccounted capital gains are not likely to be important.

The estimator proposed here is similar to the so called conditional difference-in-difference estimator of Heckman, Ichimura and Todd (1997). In this case the estimator is derived directly from the theory, and has the same characteristics as other Euler equation estimates that unobserved specific levels effects are differenced away. What remains are unobserved characteristics, over and above what is caused by the constrained status, that cause growth rates of consumption to differ across individuals. This assumption is, however, similar to the one used by Zeldes (1989) estimating Euler equations by GMM on the unconstrained sample and subsequently using the obtained parameter estimates to infer the difference in marginal utility between the constrained and the unconstrained sample. Using that approach the whole group of unconstrained households are effectively used as a control group. This introduces a potential bias because the distribution of the characteristics in the control group may differ from the distribution of the characteristics in the constrained group. The matching approach overcomes this by picking a control group where the distribution of the characteristics of the control and the treatment group are similar, cf. Heckman, Ichimura and Todd (1997).

As a practical matter it is difficult to match on a high dimensional X_t. The practice in the economic literature using matching methods is therefore followed and the result of Rosenbaum and

Rubin (1983) that matching can be done on the propensity score, provided that this is known, is exploited.

Matching on the propensity score requires that

$$E\left(\Delta C_{0t+1}\middle|D_t=1,P\left(X_t\right)\right)=E\left(\Delta C_{0,t+1}\middle|D_t=0,P\left(X_t\right)\right) \qquad (18)$$

Furthermore it is required that $P\left(D_t=1\middle|X_t\right)<1$, so that common support is feasible. This is to make sure that for every constrained household it is possible to find an unconstrained household that has the same observed characteristics.

The simplest matching method available, the so called one-to-one matching, where each individual in the constrained group is paired with a single individual from the unconstrained group is employed. Matching is done with replacement, so that the same individual from the unconstrained group can act as matched control for different constrained individuals.

5. Results

In this section results from estimating the average effect of the credit market reform on consumption for those households that were constrained prior to the reform are presented. Results are presented in two steps. First, the main set of results is presented for the two sample splits. Next a consistency check is performed as supplementary evidence to confirm that the main results are indeed indicative of credit constraints.

Estimates are obtained by statistical matching. For each person in the constrained group a match is found in the unconstrained group, and the change in log consumption is then compared between the constrained and the matched unconstrained. This is done for the whole sample of constrained as

explained in the previous section. The matching is done by matching on the probit propensity score. The probit model gives the probability of being constrained as a function of housing equity, disposable income, the number of children, single status, and membership of unemployment insurance, age, labour supply, and the value and size of the house. All these variables are measured in 1991, the year preceding the introduction year of the reform. All continuous variables are split into intervals and it is the dummy variables indicating the relevant interval that is included in the probit model. This is to protect against our results being driven by functional form assumptions in the probit index. Estimates of the probit models are given in table 4.

[Table 4 about here; see end of paper]

The estimation results in table 4 indicate that the probability of being constrained is negatively correlated with the size of the housing equity; it is increasing with the number of children, and increasing with female labour market participation. There is a tendency that the probability of being constrained decreases with the income level, and the size and the value of the house consistent with these factors acting as indicators of life time wealth. The age dummies indicate that particularly households aged over 60 are less prone to be constrained.

The probit estimates are used to calculate the propensity score for all households in the sample. It is crucial for the validity of the matching estimator that there is common support for the constrained and the unconstrained groups. Figure 6 shows kernel densities for the constrained and unconstrained for the D1 and the D2 split.

[figure 6 about here; see end of paper]

Generally, for both sample splits the graphs indicate that there is common support. The D1 graph of densities of propensity scores points to that there may be a support problem at the right tale of the distribution. All the calculations have been repeated conditioning on the difference in propensity scores between constrained and matched unconstrained not exceeding 0.0001 in order to check if lack of common support is any problem. This did not affect the estimates. To check the balance properties of the propensity scores for the constrained and matched unconstrained two-sample t-test for all the included explanatory variables included in the probit estimation are calculated. Each t-test tests for the variable in question if the mean for the constrained group is different from the mean in the matched unconstrained group. If such a test is rejected it is indication that, on average, the constrained households do not have characteristics similar to the matched unconstrained households, so that the functional form of the probit index plays a role in matching. These t-tests are reported in table B2 in the appendix, and they show no evidence of differences in the characteristics between the constrained group and the matched unconstrained group.

The estimates of the average effect of the credit reform on consumption of the constrained group is reported in table 5 for the D1 split and in table 6 for the D2 split. For each split the annualized change in consumption is calculated over four different horizons: 1993-1996 relative to 1988-1991, 1993-1995 relative to 1989-1991, 1993-1994 relative to 1990-1991, 1993 relative to 1991. The consumption effect is calculated for four different horizons to follow when the consumption effect kicks in, if it does so. Besides reporting the estimated average effect on consumption table 5 and 6 also report the estimated average difference in the development in log disposable income between the constrained group and the matched unconstrained group. This is done to check that the estimated consumption effect is not driven by different developments in income between the constrained group and the matched unconstrained group. Finally, also the estimated average change in total liabilities is reported. This is done to confirm that any

consumption effect that might be found is associated with accumulation of liabilities. As mentioned in section 3 the imputed measure of consumption used here does not deal with potential capital gains on the portfolio (except for housing). Thus, if unconstrained households have different portfolios than constrained households then concern could justly be invoked that the consumption effects found here could be due to differences in capital gains between the constrained and the matched unconstrained. Potentially, problems with capital gains are biggest for households holding shares, bonds or similar traded papers. From the descriptive evidence on portfolio composition presented in section 3 it was seen that portfolios are mainly centred on housing and cash, and that the portfolios are not very diversified for neither constrained nor unconstrained households. It is therefore not expected that capital gains are driving the results presented here. However, if constrained households accumulate more debt than unconstrained households it is a good confirmation that constrained households do indeed take out housing equity for consumption purposes. Ideally, this check should be done on the mortgage it self, but due to changes in variable definitions, c.f. figure A2 in Appendix A, it is only possible to do this check on total liabilities.

[Table 5 about here; see end of paper]

From table 5, it is seen that there is a significant consumption effect of the reform on the constrained group according to the D1 split. The estimation results indicate that the effect does not show until 1994, which is consistent with the descriptive evidence given in section 2, and the average effect is estimated to be approximately 5%, i.e. that consumption for the constrained group has on average increased about 5% more than for the matched unconstrained group following the reform. This effect could have been caused by income developing more rapidly for the constrained group than for the matched unconstrained group. Column 2 in table 5, however, shows clearly that

this is not the case. In fact, over all horizons the average development in disposable income for the constrained households is always the same or slightly lower than for the matched unconstrained group. Column 3 confirms that the matched controls have accumulated more liabilities over the period than the matched unconstrained. The effect is given in normal scale, because some households have zero liabilities. This does confirm that the constrained group has financed the consumption expansion by accumulating debt.

At the first glance it may seem that the consumption effects should have been observed immediately after the reform, i.e. in 1992/1993 instead of 1994, since if people are really constrained then they should act as soon as possible in order to increase utility. There can be a couple of reasons for this. First of all, it may be that people have to learn about the new possibilities for using housing equity for consumption purposes. Secondly, there are transaction costs associated with accessing housing equity, c.f. (2), and these transaction costs vary with the market interest rate of the bonds underlying the mortgage, so that when the interest rate is low the transaction costs are low. In figure A1 in the appendix the average market interest rate on mortgage bonds is graphed, and there is no indication that there is a sudden drop in the market interest rate at the point where the consumption effect hits in. A third reason for the consumption effect to show in 1994 may have to do with the collateralised loans constraint. This is a function of the house price, so that if house prices go up then the access to additional credit goes up correspondingly. As it is seen from figure A1 house prices have been declining up to 1993, and increase drastically hereafter and this may be the reason for the boom in consumption activity from 1994. However, as noted in section 2 many constrained households had quite a large housing equity before the reform. Yet another explanation may be related to subjective expectations about house prices. House prices are declining steadily from 1986 to 1993, before they start increasing again. If households do not wish to access housing equity in a period with falling house prices because they perceive declining house prices as

indicative of a permanent decrease in life time wealth then this may explain the timing of the consumption effect. Modelling of subjective expectations of house prices is beyond the scope of this paper.

The results for the D1 split are confirmed when the D2 sample split is applied, as shown in table 6. Consumption effects show from 1994. There is no indication that the consumption effects are caused by the development in disposable income for constrained group relative to the matched unconstrained group. Column (2) shows that the average development in disposable income for the constrained group is not exceeding that of the matched unconstrained group. The constrained group also accumulates more debt that the matched unconstrained group.

[Table 6 about here; see end of paper]

It is not likely that all households in the constrained group respond equally to the reform. To explore this issue the estimated average consumption effect on the constrained group for the two sample splits have been regressed nonparametrically on age of the oldest member of the household. These are shown in figure 7 for the case where effects are estimated over the horizon 1993-1994 relative to 1990-1991, cf. row (3) in table 5 and 6. The graphs show that there is a consumption effect mainly for age groups 30-50, and that the estimated average effect for this age band is about 8%, i.e. that constrained households belonging to the age band 30-50 on average have increased consumption by 8% more than unconstrained but otherwise similar households. There appears to have been no consumption effects for households aged more than 60.

[Figure 7 about here; see end of paper]

The estimated consumption effects can be used to infer the expected change in marginal utility for constrained households due to the reform. According to (13) the expected change in marginal utility for the constrained group is given by $\frac{1}{\rho}\ln\left(\frac{\mu_t}{\lambda_t}\right)$, where ρ is the coefficient of relative risk aversion. Assuming that $\rho = 2$, corresponding to the estimate obtained by e.g. Zeldes (1989), the expected change in marginal utility for the constrained 30-50 year olds is 4%. Alessie, Devereux, and Weber (1997) have analysed the effects of changing rule on down payment requirements in connection with car purchases in Britain and find that the expected change in marginal utility from that reform was about 10%, and a significant effect was estimated only for younger households also in that study.

The estimates presented so far provide the main set of results from this study. To make sure that the effects found are in fact consumption effects caused by the reform, and not caused by the way the empirical analysis is set up and the way the total expenditure measure is derived a consistency check is done where the same estimation exercise is carried out for renters. If the access to housing equity provided by the reform is really the reason for the consumption effects that were found for house owners then no consumption effects should be found for renters. The sample of renters is split into renters with liquid assets corresponding to less/more than one (two) months of income. Matching is done on the same variables as for owners, except that it is of course not possible to match on housing equity and the value of the house.

Estimation results for the D1 split are presented in table 7 and for the D2 split in table 8. The probit estimates, balance t-tests and kernel densities of the propensity scores are referred to appendix C. The estimation results indicate that there is in general no effect of the reform on consumption for constrained renters. In some cases a negative consumption effect is found, but these are associated with a negative development in the disposable income relative to matched

unconstrained. This could be an indication that the constrained households are not matched with unconstrained households with similar life time wealth. Moreover, renters with low liquid assets do on average tend to accumulate more debt than unconstrained. In most cases this result disappears when the median effect is considered (not reported).

[Table 7 about here; see end of paper]

Considering the estimation results for the D2 split, negative consumption effects are found. There is no indication that income is developing radically different for the two groups. These results could be an indication that the constrained households are not matched with unconstrained households with similar life time wealth. Renters with low liquid assets according to the D2 split do on average tend to accumulate more debt than unconstrained, but as before in most cases this result disappears when the median effect is considered (not reported).

[Table 8 about here; see end of paper]

In figure 8 kernel regressions of the estimated average effect of the reform on the constrained is graphed for the two sample splits for renters for the case where effects are estimated over the horizon 1993-1994 relative to 1990-1991. The picture is confirmed. There is no evidence of any positive consumption effect of the reform on the constrained households for renters. Negative consumption effects are estimated for households aged more than 60 when the D2 split is applied. This is probably what causes the average negative consumption effects in table 8. The overall conclusion drawn from the results presented in table 7 and 8, and figure 8 is that the evidence for renters does not contradict the basic result of the analysis that the credit reform has brought positive

consumption effects for house owners with little liquid assets consistent with these households having been constrained prior to the reform.

6. Conclusion

The literature on the effects of credit constraints on intertemporal consumption allocation has shown that it is difficult to provide a powerful test for the effect of credit constraints on consumption. In this study a reform providing an exogenous shock to credit access is used to identify the effects of credit constraints on consumption. The reform gave access for house owners to use housing equity for establishing mortgage loans where the proceeds could be used for financing non housing consumption. The test is developed from a theoretical model of durable and nondurable consumption with time varying credit access. The model shows that consumption effects of lifting credit constraints should be found mainly on durable consumption. The model is tested on household level panel data for total expenditure. Significant effects of the reform on total expenditure are found, mainly for house owners aged 30-50, and the results are robust to a number of consistency checks. Aggregate evidence shows that durable consumption boost at the same point where the micro data indicate an expansion of total expenditure for constrained households.

The estimated effect can be used to calculate the shadow value of the borrowing constraint conditional on the coefficient of relative risk aversion. Assuming the coefficient of relative risk aversion taking the value 2, the shadow value of the borrowing constraint is estimated to be 4% for constrained households aged 30-50. This means that there has been binding constraints before the reform, so that consumption has been depressed for constrained consumers. The reform has brought an expected decrease in marginal utility of 4% for these households.

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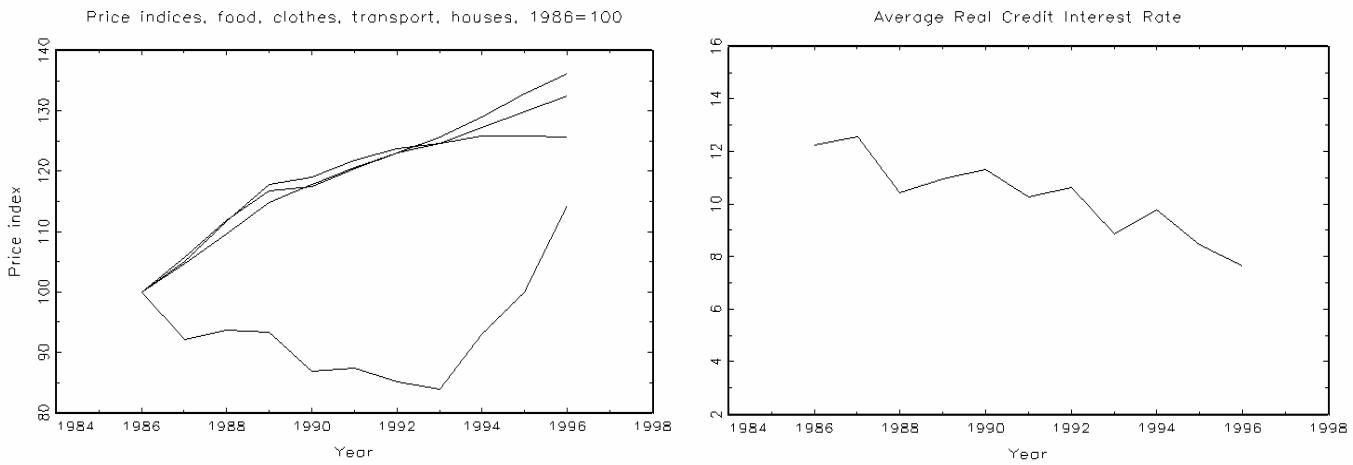
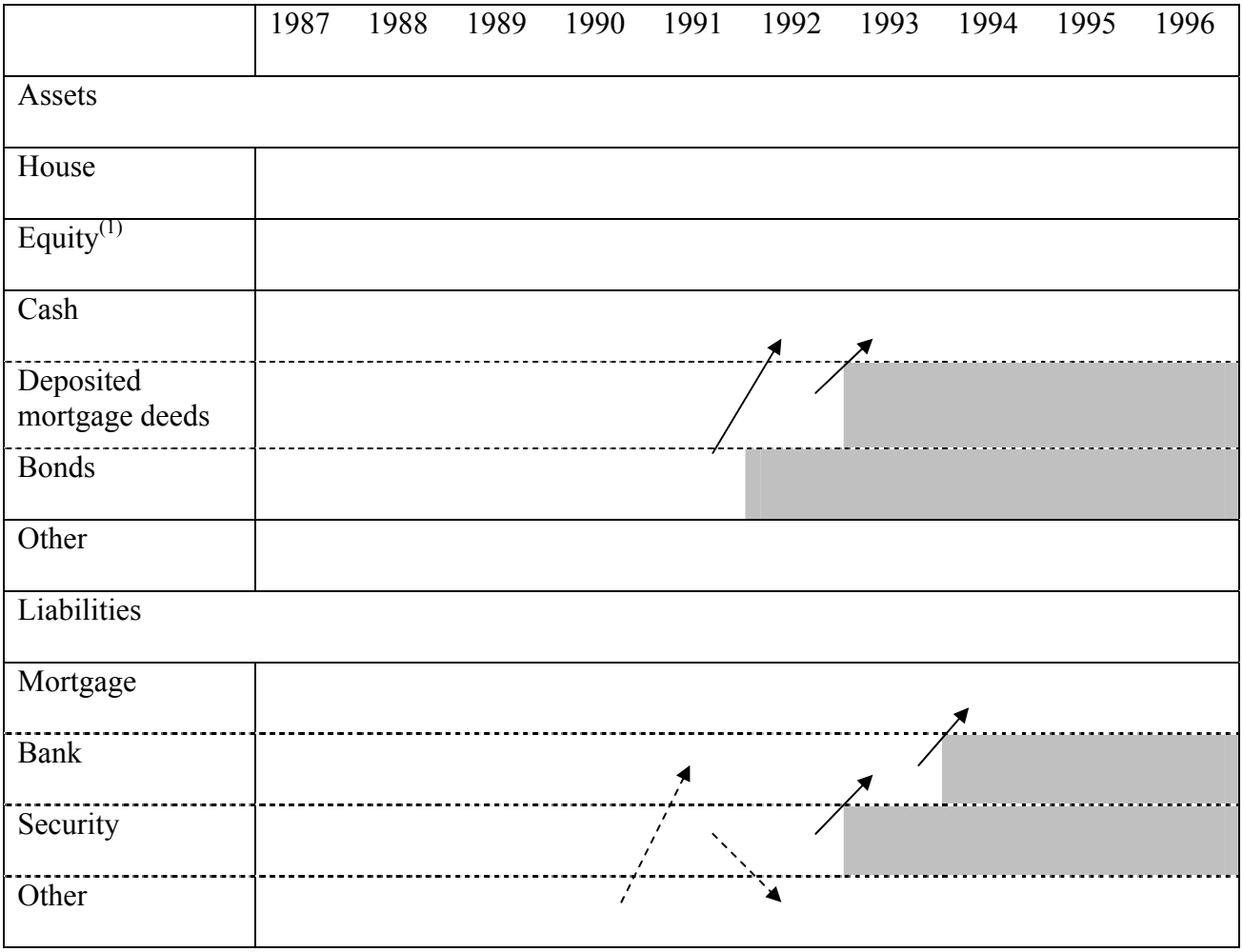
Appendix

Figure A1. Price indices of different goods and houses (left), and average real credit interest rate (right).



Note: Food prices in top graph in 1996, clothes prices second from the top in 1996, and transport prices third from the top in 1996. House prices in bottom graph.

Figure A2. The Development in Definitions of Asset and Liabilities in The Tax Registers.



Note: Solid arrow indicates that a variable is merged into the variable indicated by the arrow. A broken arrow indicates that an item included in a variable is moved to another variable. Shaded areas indicate that a variable ceases to exist.
(1) A particular type of unquoted shares in ships is included in 'other'. Thus, formally, we cannot identify total amount of shares. This is why these categories are considered jointly in Browning and Leth-Petersen (2003).

Appendix B. Summary statistics and balance tests for owners

Table B1. Summary Statistics for owners

	D1				D2			
	Constrained		Unconstrained		Constrained		Unconstrained	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Hous. Eq. ≤ 50000	0.1814	0.3854	0.1100	0.3129	0.1727	0.3780	0.0936	0.2912
50000<Hous. Eq.≤100000	0.0954	0.2938	0.0619	0.2409	0.0919	0.2889	0.0537	0.2255
100000<Hous. Eq.≤150000	0.1143	0.3181	0.0701	0.2553	0.1044	0.3058	0.0633	0.2435
150000< Hous. Eq.≤200000	0.1002	0.3004	0.0778	0.2679	0.0996	0.2995	0.0711	0.2570
250000< Hous. Eq.≤300000	0.0932	0.2908	0.0928	0.2902	0.0948	0.2930	0.0915	0.2884
300000< Hous. Eq.≤350000	0.0855	0.2797	0.0963	0.2950	0.0876	0.2828	0.0982	0.2975
350000< Hous. Eq.≤400000	0.0668	0.2497	0.0929	0.2903	0.0732	0.2606	0.0964	0.2952
400000< Hous. Eq.≤450000	0.0458	0.2091	0.0759	0.2649	0.0494	0.2168	0.0829	0.2757
Hous. Eq.>450000	0.1234	0.3290	0.2341	0.4234	0.1340	0.3407	0.2616	0.4395
Disp. Inc. ≤ 50000	0.0031	0.0553	0.0042	0.0649	0.0032	0.0569	0.0045	0.0667
50000< Disp. Inc. ≤100000	0.0947	0.2928	0.1222	0.3275	0.0940	0.2918	0.1315	0.3380
100000< Disp. Inc. ≤150000	0.2920	0.4547	0.2803	0.4492	0.2889	0.4533	0.2789	0.4485
200000< Disp. Inc. ≤250000	0.1534	0.3604	0.1671	0.3730	0.1569	0.3637	0.1688	0.3746
250000< Disp. Inc. ≤300000	0.0231	0.1501	0.0426	0.2019	0.0242	0.1537	0.0480	0.2137
300000< Disp. Inc. ≤350000	0.0051	0.0713	0.0102	0.1005	0.0050	0.0705	0.0119	0.1086
Disp. Inc.>350000	0.0012	0.0341	0.0043	0.0656	0.0009	0.0302	0.0055	0.0742
1 child	0.2211	0.4150	0.2158	0.4114	0.2319	0.4221	0.2061	0.4045
2 children	0.4067	0.4913	0.2721	0.4451	0.3883	0.4874	0.2427	0.4287
3 children	0.0935	0.2912	0.0459	0.2092	0.0866	0.2812	0.0358	0.1858
4 children	0.0144	0.1193	0.0046	0.0674	0.0116	0.1069	0.0035	0.0594
Single	0.0689	0.2533	0.1022	0.3029	0.0677	0.2512	0.1138	0.3175
Age≤25	0.0007	0.0270	0.0010	0.0314	0.0007	0.0274	0.0011	0.0325
25<Age≤30	0.0362	0.1868	0.0200	0.1400	0.0337	0.1805	0.0167	0.1280
30<Age≤35	0.1140	0.3178	0.0661	0.2485	0.1102	0.3132	0.0536	0.2251
35<Age≤40	0.1976	0.3982	0.1253	0.3310	0.1909	0.3931	0.1071	0.3092
45<Age≤50	0.1753	0.3802	0.1648	0.3710	0.1750	0.3800	0.1616	0.3681
50<Age≤55	0.1032	0.3042	0.1278	0.3338	0.1092	0.3119	0.1312	0.3376
55<Age≤60	0.0683	0.2523	0.1034	0.3044	0.0705	0.2560	0.1130	0.3165
Age>60	0.0725	0.2594	0.2197	0.4141	0.0844	0.2780	0.2580	0.4376
UI Membership	0.8945	0.3072	0.7869	0.4095	0.8870	0.3166	0.7581	0.4283
Labour supply, male	0.9035	0.2952	0.7792	0.4148	0.8913	0.3113	0.7484	0.4339
Labour supply, female	0.8509	0.3562	0.7406	0.4383	0.8473	0.3598	0.7079	0.4547
M^2≤75	0.0503	0.2187	0.0473	0.2123	0.0486	0.2151	0.0477	0.2130
75<M^2≤100	0.1415	0.3486	0.1488	0.3559	0.1430	0.3501	0.1500	0.3571
100<M^2≤125	0.2929	0.4551	0.2960	0.4565	0.2936	0.4554	0.2964	0.4567
150<M^2≤175	0.1342	0.3409	0.1406	0.3476	0.1361	0.3429	0.1412	0.3483
175<M^2≤200	0.0465	0.2107	0.0499	0.2177	0.0464	0.2105	0.0510	0.2200
M^2>200	0.0257	0.1582	0.0277	0.1641	0.0261	0.1593	0.0281	0.1652
House val. ≤200000	0.0203	0.1410	0.0114	0.1061	0.0176	0.1314	0.0106	0.1022
200000<House val. ≤300000	0.0934	0.2910	0.0737	0.2612	0.0877	0.2829	0.0716	0.2578
400000<House val. ≤500000	0.2310	0.4215	0.2164	0.4118	0.2334	0.4230	0.2099	0.4073
500000<House val. ≤600000	0.2276	0.4193	0.2161	0.4116	0.2282	0.4197	0.2121	0.4088
600000<House val. ≤700000	0.1344	0.3411	0.1496	0.3566	0.1385	0.3454	0.1514	0.3584
700000<House val. ≤800000	0.0595	0.2366	0.0811	0.2729	0.0636	0.2440	0.0849	0.2788
House val. >800000	0.0555	0.2289	0.0925	0.2898	0.0573	0.2324	0.1031	0.3041
# obs	6,853		21,256		12,014		16,095	

Table B2. Balance of individual characteristics. Two-sample t-test for D1 and D2 split for Owners.

	D1			D2		
Variable	E(constrain)	E(unconstr)	t	E(constrain)	E(unconstr)	t
Hous. Eq. ≤ 50000	0.1814	0.1782	0.0333	0.1727	0.1744	-0.0200
50000<Hous. Eq.≤100000	0.0954	0.0906	0.0575	0.0919	0.0844	0.1042
100000<Hous. Eq.≤150000	0.1143	0.1208	-0.0744	0.1044	0.1043	0.0011
150000< Hous. Eq.≤200000	0.1002	0.1000	0.0034	0.0996	0.1035	-0.0527
250000< Hous. Eq.≤300000	0.0932	0.0925	0.0087	0.0948	0.0956	-0.0102
300000< Hous. Eq.≤350000	0.0855	0.0841	0.0178	0.0876	0.0839	0.0524
350000< Hous. Eq.≤400000	0.0668	0.0690	-0.0281	0.0732	0.0695	0.0547
400000< Hous. Eq.≤450000	0.0458	0.0479	-0.0286	0.0494	0.0498	-0.0053
Hous. Eq.>450000	0.1234	0.1286	-0.0570	0.1340	0.1487	-0.1838
Disp. Inc. ≤ 50000	0.0031	0.0029	0.0040	0.0032	0.0029	0.0105
50000< Disp. Inc. ≤100000	0.0947	0.0858	0.1070	0.0940	0.0924	0.0217
100000< Disp. Inc. ≤150000	0.2920	0.2768	0.1454	0.2889	0.2670	0.2422
200000< Disp. Inc. ≤250000	0.1534	0.1572	-0.0406	0.1569	0.1573	-0.0051
250000< Disp. Inc. ≤300000	0.0231	0.0209	0.0368	0.0242	0.0219	0.0445
300000< Disp. Inc. ≤350000	0.0051	0.0042	0.0216	0.0050	0.0045	0.0141
Disp. Inc.>350000	0.0012	0.0001	0.0432	0.0009	0.0007	0.0110
1 child	0.2211	0.2117	0.0936	0.2319	0.2216	0.1181
2 children	0.4067	0.4262	-0.1792	0.3883	0.4069	-0.1973
3 children	0.0935	0.0878	0.0683	0.0866	0.0777	0.1247
4 children	0.0144	0.0133	0.0220	0.0116	0.0086	0.0703
Single	0.0689	0.0614	0.0964	0.0677	0.0611	0.0983
Age≤25	0.0007	0.0010	-0.0109	0.0007	0.0003	0.0204
25<Age≤30	0.0362	0.0360	0.0022	0.0337	0.0291	0.0812
30<Age≤35	0.1140	0.1116	0.0267	0.1102	0.1102	0.0000
35<Age≤40	0.1976	0.2055	-0.0800	0.1909	0.1908	0.0020
45<Age≤50	0.1753	0.1681	0.0749	0.1750	0.1733	0.0200
50<Age≤55	0.1032	0.1054	-0.0255	0.1092	0.1061	0.0410
55<Age≤60	0.0683	0.0721	-0.0483	0.0705	0.0747	-0.0605
Age>60	0.0725	0.0705	0.0259	0.0844	0.0798	0.0647
UI Membership	0.8945	0.9057	-0.1320	0.8870	0.9024	-0.2058
Labour supply, male	0.9035	0.9107	-0.0854	0.8913	0.9047	-0.1804
Labour supply, female	0.8509	0.8631	-0.1333	0.8473	0.8629	-0.1953
M^2≤75	0.0503	0.0458	0.0629	0.0486	0.0404	0.1344
75<M^2≤100	0.1415	0.1431	-0.0175	0.1430	0.1461	-0.0384
100<M^2≤125	0.2929	0.2916	0.0125	0.2936	0.2978	-0.0465
150<M^2≤175	0.1342	0.1399	-0.0624	0.1361	0.1330	0.0390
175<M^2≤200	0.0465	0.0448	0.0247	0.0464	0.0418	0.0762
M^2>200	0.0257	0.0232	0.0406	0.0261	0.0236	0.0453
House val. ≤200000	0.0203	0.0187	0.0278	0.0176	0.0163	0.0257
200000<House val. ≤300000	0.0934	0.0838	0.1163	0.0877	0.0825	0.0735
400000<House val. ≤500000	0.2310	0.2362	-0.0520	0.2334	0.2370	-0.0407
500000<House val. ≤600000	0.2276	0.2325	-0.0478	0.2282	0.2314	-0.0371
600000<House val. ≤700000	0.1344	0.1420	-0.0831	0.1385	0.1382	0.0042
700000<House val. ≤800000	0.0595	0.0557	0.0506	0.0636	0.0635	0.0012
House val. >800000	0.0555	0.0533	0.0296	0.0573	0.0600	-0.0420

Appendix C. Probit estimates, propensity score densities, balance tests, and summary statistics for renters.

Table C1. Probit estimates for D1 split and D2 split for renters.

	D1		D2	
Variable	Parameter	Std.err	Parameter	Std.err
Constant	0.0460	0.0997	0.5065**	0.1050
Disposable income ≤ 50000	0.3734**	0.1438	0.4082**	0.1496
50000< Disposable income ≤100000	0.5437**	0.0520	0.6364**	0.0518
100000< Disposable income ≤150000	0.1566**	0.0401	0.1593**	0.0397
200000< Disposable income ≤250000	-0.3242**	0.0452	-0.2863**	0.0455
250000< Disposable income ≤300000	-0.5926**	0.0996	-0.7520**	0.0955
300000< Disposable income ≤350000	-1.0175**	0.2808	-1.1155**	0.2494
Disposable income>350000	-0.8733**	0.3312	-1.3759**	0.3335
1 child	0.4680**	0.0365	0.4677**	0.0382
2 children	0.6605**	0.0466	0.6614**	0.0503
3 children	0.9862**	0.0873	1.0478**	0.1042
4 children	0.9590**	0.1648	0.8656**	0.1914
Single	-0.2948**	0.0370	-0.4020**	0.0366
Age≤25	0.0285	0.1706	0.1247	0.1897
25<Age≤30	0.0473	0.0814	0.0179	0.0872
30<Age≤35	0.0843	0.0605	0.1002	0.0661
35<Age≤40	0.1275**	0.0504	0.0723	0.0547
45<Age≤50	-0.0999**	0.0460	-0.0125	0.0492
50<Age≤55	-0.1701**	0.0484	-0.1906**	0.0505
55<Age≤60	-0.2572**	0.0492	-0.2982**	0.0509
Age>60	-0.7951**	0.0461	-0.8574**	0.0480
UI Membership	-0.0555	0.0376	-0.0386	0.0380
Labour supply, male	-0.0525	0.0377	-0.0930**	0.0378
Labour supply, female	-0.1533	0.0357	-0.1074**	0.0362
M^2≤75	0.0073	0.0819	0.0680	0.0868
75<M^2≤100	-0.0562	0.0806	0.0339	0.0853
100<M^2≤125	-0.0577	0.0868	0.0227	0.0914
150<M^2≤175	-0.1446	0.1565	-0.1876	0.1597
175<M^2≤200	-0.3296	0.2272	-0.3158	0.2221
M^2>200	-0.1403	0.1779	-0.2438	0.1781

Note: The reference household is a couple without children, has income in the interval 150000-200000, aged 41-45, no UI membership, do not participate in the labour market, live in a dwelling sized 126-150 m^2.

Figure C1. Kernel densities of propensity scores for constrained (treated) and unmatched unconstrained (controls). D1 (left) and d2 (right). Renters.

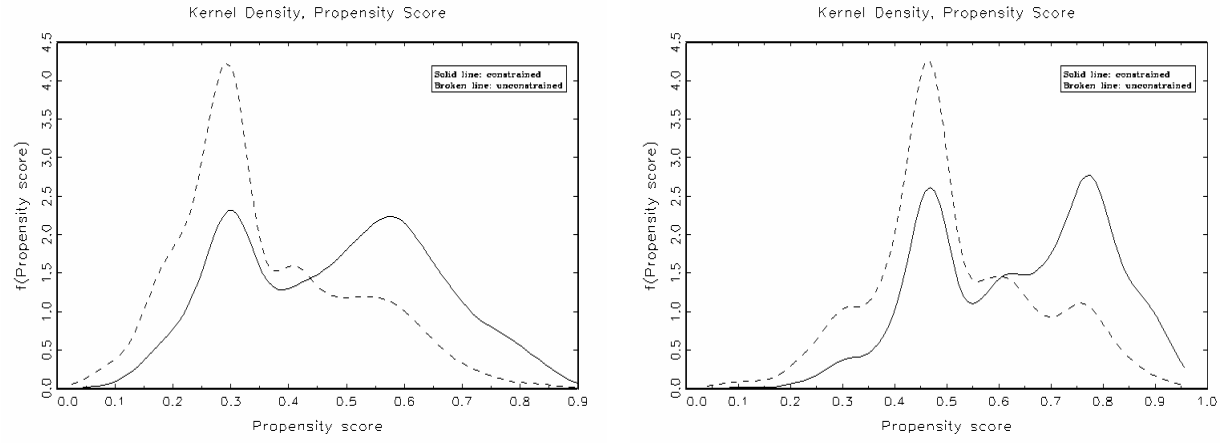


Table C2. Balance of individual characteristics. Two-sample t-test for D1 and D2 split for renters.

	D1			D2		
Variable	E(constrain)	E(unconstr)	t	E(constrain)	E(unconstr)	t
Disp. Inc. ≤ 50000	0.0083	0.0076	0.0148	0.0077	0.0065	0.0261
50000< Disp. Inc. ≤100000	0.3488	0.3609	-0.1066	0.3410	0.3526	-0.1119
100000< Disp. Inc. ≤150000	0.3263	0.3200	0.0563	0.3278	0.3262	0.0159
200000< Disp. Inc. ≤250000	0.0984	0.0966	0.0202	0.1056	0.0960	0.1163
250000< Disp. Inc. ≤300000	0.0112	0.0097	0.0276	0.0112	0.0106	0.0130
300000< Disp. Inc. ≤350000	0.0009	0.0005	0.0135	0.0011	0.0004	0.0309
Disp. Inc.>350000	0.0007	0.0011	-0.0127	0.0005	0.0004	0.0058
1 child	0.1882	0.1797	0.0831	0.1759	0.1811	-0.0556
2 children	0.1392	0.1428	-0.0373	0.1247	0.1298	-0.0596
3 children	0.0384	0.0382	0.0025	0.0320	0.0202	0.1982
4 children	0.0101	0.0083	0.0356	0.0080	0.0079	0.0028
Single	0.5219	0.5226	-0.0062	0.5064	0.5005	0.0558
Age≤25	0.0061	0.0065	-0.0078	0.0058	0.0029	0.0759
25<Age≤30	0.0306	0.0258	0.0730	0.0276	0.0244	0.0547
30<Age≤35	0.0696	0.0645	0.0616	0.0630	0.0520	0.1514
35<Age≤40	0.1307	0.1318	-0.0114	0.1133	0.1181	-0.0564
45<Age≤50	0.1412	0.1446	-0.0353	0.1430	0.1471	-0.0467
50<Age≤55	0.1127	0.1112	0.0157	0.1131	0.1190	-0.0697
55<Age≤60	0.1076	0.1087	-0.0118	0.1103	0.1154	-0.0597
Age>60	0.2488	0.2491	-0.0033	0.2830	0.2836	-0.0063
UI Membership	0.5315	0.5394	-0.0685	0.5294	0.5499	-0.1938
Labour supply, male	0.4109	0.4282	-0.1503	0.4065	0.4246	-0.1722
Labour supply, female	0.4175	0.4228	-0.0454	0.4245	0.4339	-0.0895
M^2≤75	0.4247	0.4267	-0.0172	0.4205	0.4242	-0.0358
75<M^2≤100	0.4366	0.4413	-0.0406	0.4455	0.4473	-0.0179
100<M^2≤125	0.1035	0.1051	-0.0179	0.1010	0.0960	0.0615
150<M^2≤175	0.0070	0.0052	0.0394	0.0065	0.0048	0.0430
175<M^2≤200	0.0025	0.0022	0.0100	0.0025	0.0004	0.0765
M^2>200	0.0043	0.0034	0.0221	0.0040	0.0038	0.0067

Table C3. Summary statistics for renters.

	D1				D2			
	Constrained		Unconstrained		Constrained		Unconstrained	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Disp. Inc. ≤ 50000	0.0083	0.0907	0.0056	0.0746	0.0077	0.0872	0.0053	0.0728
50000< Disp. Inc. ≤100000	0.3488	0.4766	0.3005	0.4585	0.3410	0.4741	0.2908	0.4542
100000< Disp. Inc. ≤150000	0.3263	0.4689	0.3661	0.4818	0.3278	0.4695	0.3809	0.4857
200000< Disp. Inc. ≤250000	0.0984	0.2979	0.1095	0.3123	0.1056	0.3073	0.1042	0.3055
250000< Disp. Inc. ≤300000	0.0112	0.1051	0.0193	0.1375	0.0112	0.1052	0.0227	0.1490
300000< Disp. Inc. ≤350000	0.0009	0.0300	0.0037	0.0609	0.0011	0.0336	0.0046	0.0678
Disp. Inc.>350000	0.0007	0.0268	0.0021	0.0459	0.0005	0.0224	0.0030	0.0548
1 child	0.1882	0.3909	0.1069	0.3090	0.1759	0.3808	0.0894	0.2854
2 children	0.1392	0.3462	0.0585	0.2348	0.1247	0.3303	0.0445	0.2063
3 children	0.0384	0.1922	0.0096	0.0974	0.0320	0.1761	0.0062	0.0786
4 children	0.0101	0.1000	0.0022	0.0472	0.0080	0.0893	0.0018	0.0421
Single	0.5219	0.4996	0.4757	0.4994	0.5064	0.5000	0.4778	0.4996
Age≤25	0.0061	0.0781	0.0031	0.0557	0.0058	0.0758	0.0023	0.0480
25<Age≤30	0.0306	0.1724	0.0164	0.1270	0.0276	0.1640	0.0145	0.1198
30<Age≤35	0.0696	0.2545	0.0337	0.1804	0.0630	0.2429	0.0277	0.1641
35<Age≤40	0.1307	0.3371	0.0564	0.2307	0.1133	0.3170	0.0491	0.2162
45<Age≤50	0.1412	0.3482	0.1040	0.3053	0.1430	0.3501	0.0855	0.2797
50<Age≤55	0.1127	0.3162	0.1048	0.3063	0.1131	0.3167	0.1008	0.3011
55<Age≤60	0.1076	0.3099	0.1178	0.3224	0.1103	0.3133	0.1183	0.3230
Age>60	0.2488	0.4323	0.4783	0.4996	0.2830	0.4505	0.5282	0.4992
UI Membership	0.5315	0.4991	0.4737	0.4993	0.5294	0.4992	0.4519	0.4977
Labour supply, male	0.4109	0.4920	0.3645	0.4813	0.4065	0.4912	0.3508	0.4773
Labour supply, female	0.4175	0.4932	0.3969	0.4893	0.4245	0.4943	0.3783	0.4850
M^2≤75	0.4247	0.4943	0.4236	0.4942	0.4205	0.4937	0.4292	0.4950
75<M^2≤100	0.4366	0.4960	0.4540	0.4979	0.4455	0.4970	0.4489	0.4974
100<M^2≤125	0.1035	0.3046	0.0881	0.2835	0.1010	0.3014	0.0850	0.2789
150<M^2≤175	0.0070	0.0836	0.0068	0.0824	0.0065	0.0806	0.0075	0.0860
175<M^2≤200	0.0025	0.0502	0.0035	0.0589	0.0025	0.0501	0.0039	0.0624
M^2>200	0.0043	0.0656	0.0052	0.0721	0.0040	0.0633	0.0060	0.0774
# obs	5,547		8,047		7,958		5,636	

Figures to be inserted in the text

Figure 1. Aggregate private sector total expenditures, expenditures on transport/communication, food and clothes.

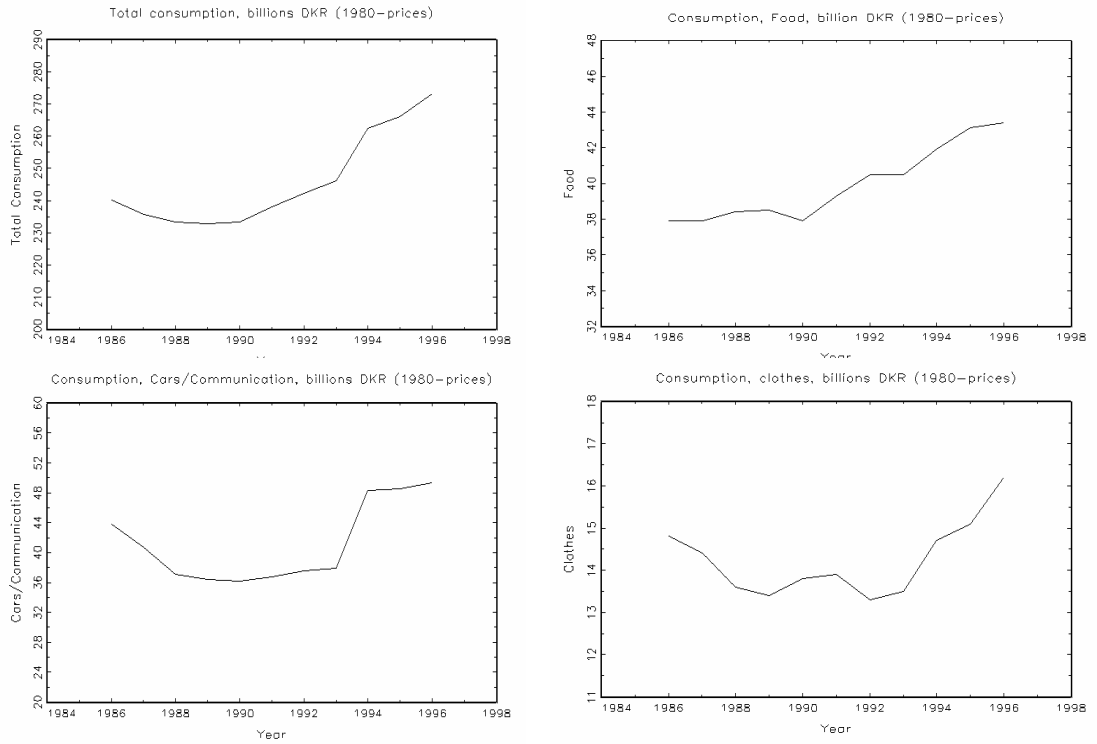


Figure 2. Effect of the reform on a constrained consumer (left) and an unconstrained consumer (right).

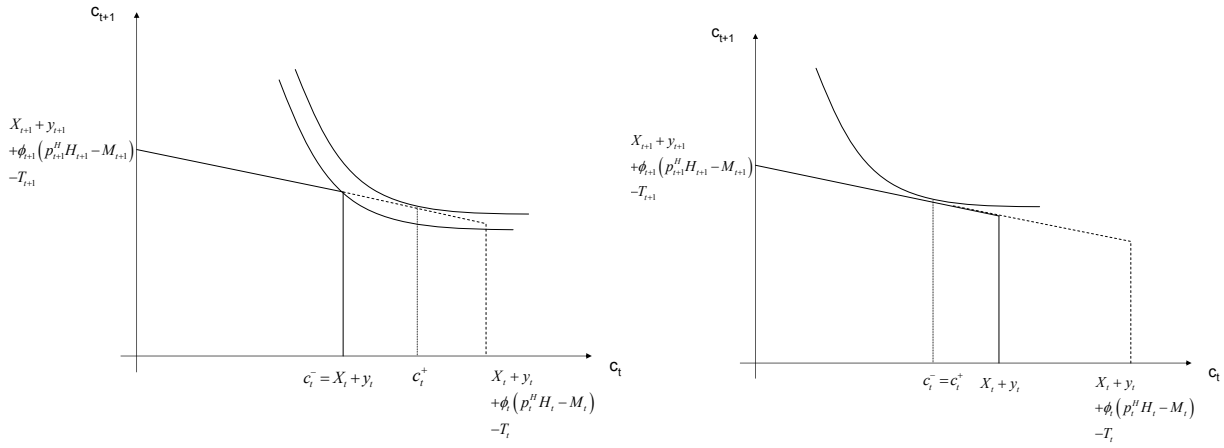


Figure 3. Box plots of imputated consumption (left) and disposable income across the observation period for owners.

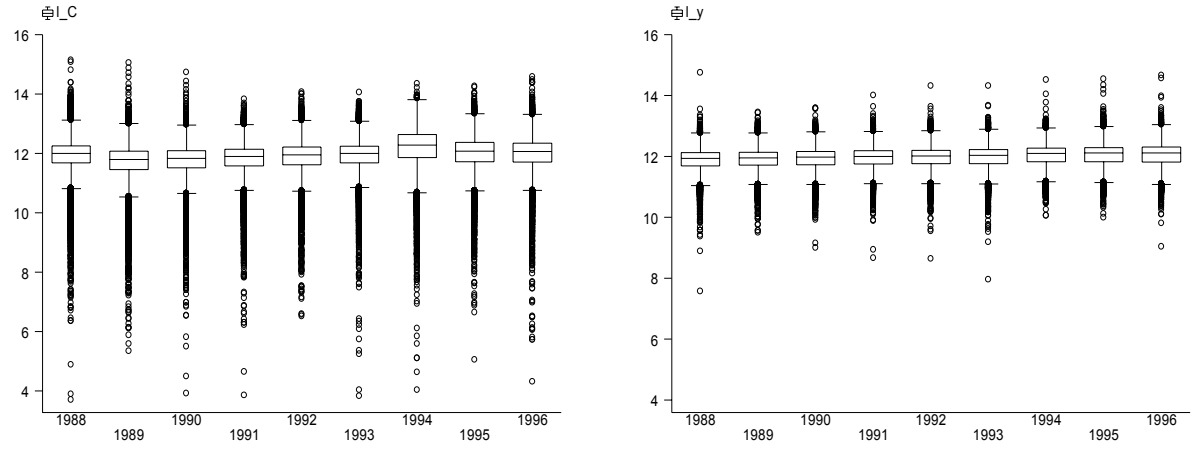


Figure 4. Box plots of imputed consumption across the observation period for the D1 split (left) and the D2 split (right). Top row shows constrained samples and bottom row shows unconstrained samples.

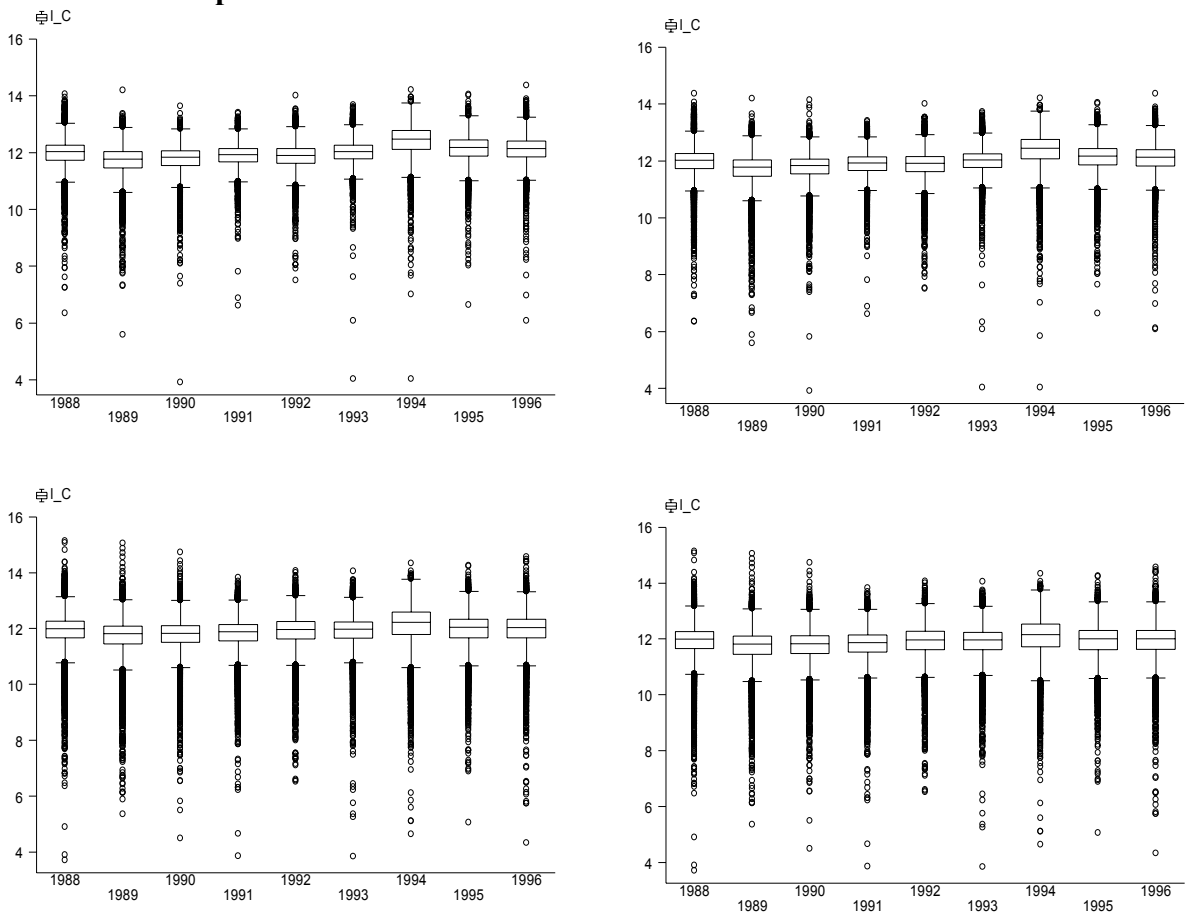


Figure 5. Box Plots of disposable income across the observation period for the D1 split (left) and the D2 split (right). Top row shows constrained samples and bottom row shows unconstrained samples.

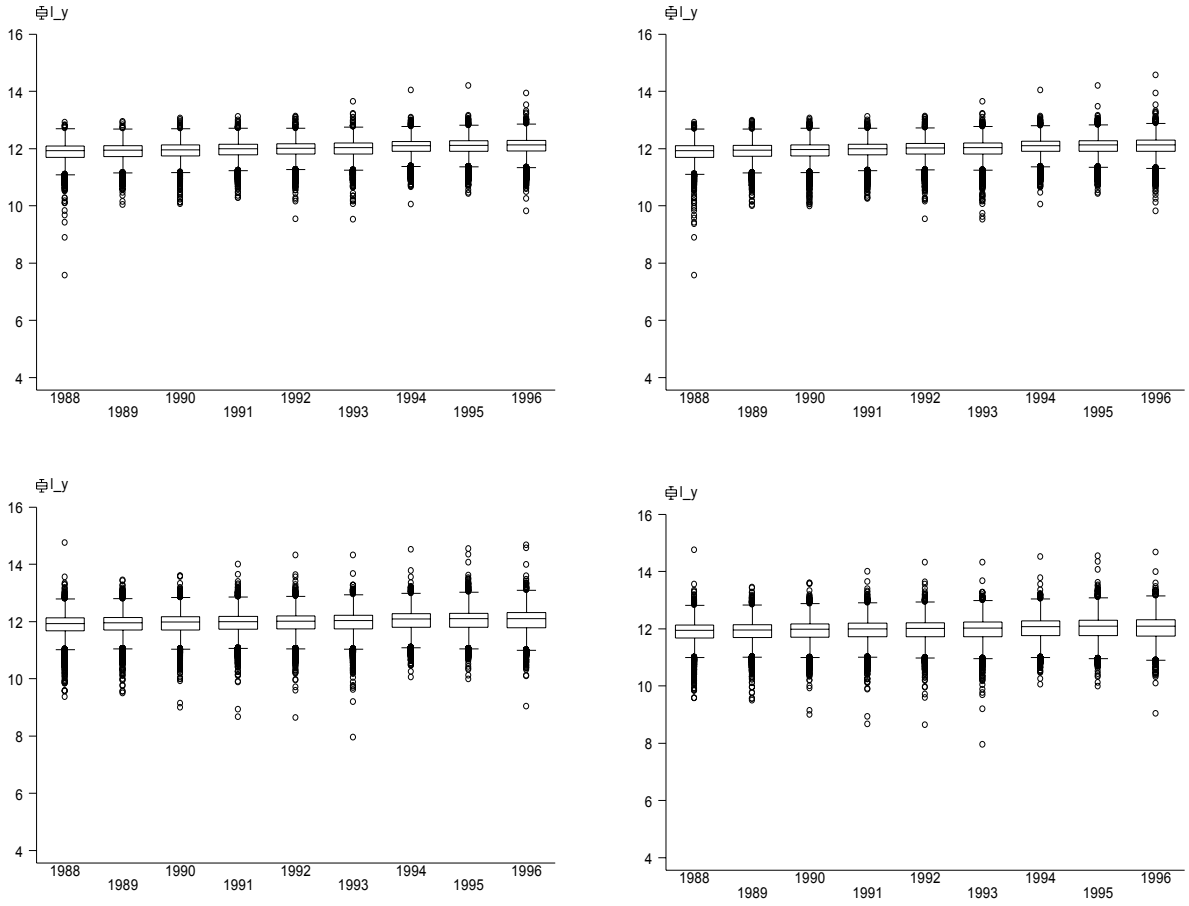


Figure 6. Kernel densities of propensity scores for constrained (treated) and unmatched unconstrained (controls) house owners. D1 split to the left, and D2 split to the right. Bandwidth set to $1.06\sigma n^{-(1/5)}$.

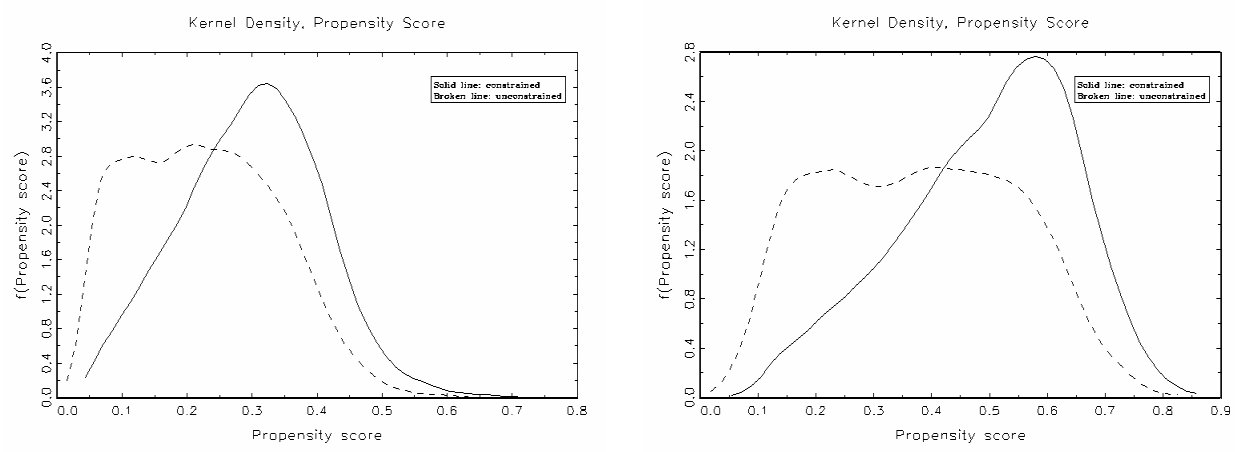
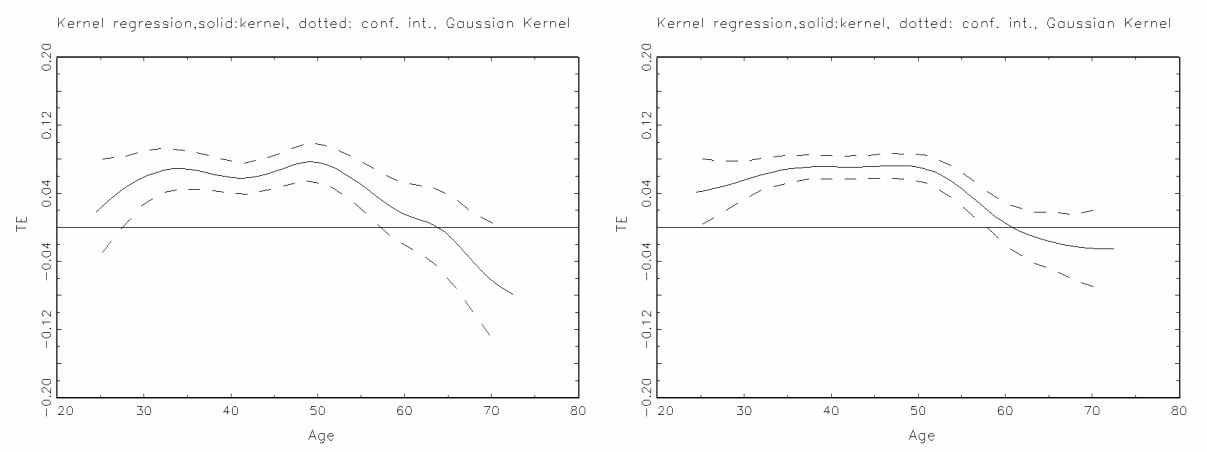
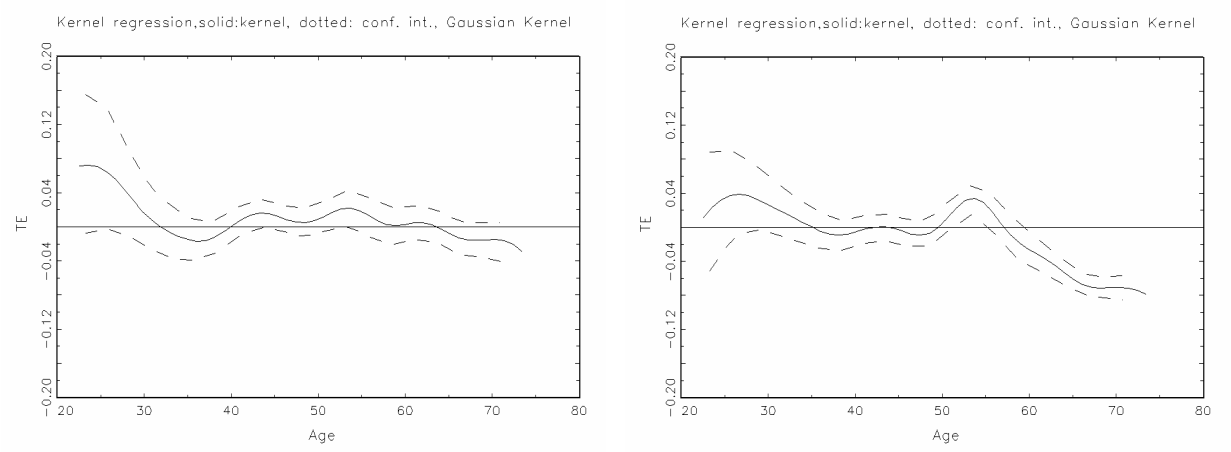


Figure 7. Kernel regressions of estimated consumption effect of the reform on the constrained against age. D1.3 (left) and D2.3 (right). Owners.



Note: Bandwidths have been chosen by generalized cross validation, and bootstrap pointwise confidence intervals, cf. Härdle (1990). The kernel regression in the left panel is over-smoothed relative to the cross validated level. This is only of presentational importance.

Figure 8. Kernel regression of estimated consumption effect of the reform on the constrained against age. D1.3 (left) and D2.3 (right). Renters.



Note: Bandwidths have initially been chosen by generalized cross validation, and bootstrap pointwise confidence intervals, cf. Härdle (1990). The kernel regressions presented in both panels are over-smoothed relative to the cross validated level. This is only of presentational importance.

Tables to be inserted in the text

Table 1. Distribution of households according to the two sample splits

	D1	D2
Low liquid assets	6,853	12,014
High liquid assets	21,256	16,095

Table 2. Distribution of portfolio for low liquid asset group in 1991 according to the D1 split. 6,853 observations

DKK	Assets						liabilities			
Centile	house	equity	cash	Mortg deed	bond	other	Mortg.	bank	Mortg deed	other
0	3,041	0	0	0	0	0	0	0	0	0
10	283,821	0	100	0	0	0	70,826	11,769	0	0
20	354,776	0	1,147	0	0	0	119,511	31,980	0	0
30	405,458	0	2,564	0	0	0	164,147	52,548	0	0
40	456,140	0	3,904	0	0	0	209,319	70,920	0	0
50	496,686	0	5,300	0	0	0	256,287	92,433	0	0
60	537,232	0	6,635	0	0	0	305,745	114,255	0	0
70	577,778	0	8,170	0	0	0	355,491	140,239	2,924	0
80	638,597	0	10,080	0	0	24,036	424,177	173,651	51,879	0
90	719,688	0	12,446	0	0	58,480	522,602	228,221	98,341	4,201
100	1,378,558	19,579	26,940	13,277	15,244	297,271	1,543,404	950,489	665,564	877,193

Table 3. Distribution of portfolio for high liquid asset group in 1991 according to the D1 split. 21,256 observations.

DKK	Assets						liabilities			
Centile	house	equity	cash	Mortg deed	bond	other	Mortg.	bank	Mortg deed	other
0	2,605	0	0	0	0	0	0	0	0	0
10	314,230	0	12,906	0	0	0	15,418	0	0	0
20	375,048	0	18,088	0	0	0	59,080	0	0	0
30	425,731	0	23,129	0	0	0	99,206	1,988	0	0
40	476,413	0	29,567	0	0	0	140,659	8,871	0	0
50	516,959	0	38,079	0	0	0	189,175	24,932	0	0
60	567,641	0	49,753	0	0	0	246,570	45,706	0	0
70	618,323	1,998	67,621	0	0	24366	308,116	71,793	0	0
80	679,142	7,193	96,224	0	1,171	48733	382,246	105,347	24,526	0
90	780,506	22,061	152,932	1,975	48,142	82846	496,447	162,595	81,770	0
100	2,242,374	107,2351	2,012,481	1,764,819	3,022,349	633528	2,023,316	1,554,899	780,959	949,552

Table 4. Probit estimates for D1 split and D2 split for house owners.

	D1		D2	
Variable	Parameter	Std.err	Parameter	Std.err
Constant	-0.9884**	0.0693	-0.4686**	0.0626
Housing equity, ≤ 50000	0.0885**	0.0365	0.1297**	0.0347
50000<Housing equity≤100000	0.0860**	0.0413	0.1371**	0.0394
100000<Housing equity≤150000	0.1503**	0.0394	0.1459**	0.0376
150000<Housing equity≤200000	0.0582**	0.0394	0.1145**	0.0371
250000<Housing equity≤300000	0.0269	0.0390	0.0647*	0.0362
300000<Housing equity≤350000	0.0088	0.0400	0.0354	0.0368
350000<Housing equity≤400000	-0.0845**	0.0418	-0.0396	0.0380
400000<Housing equity≤450000	-0.1423**	0.0461	-0.1408**	0.0416
Housing equity>450000	-0.0872**	0.0395	-0.0636*	0.0360
Disposable income ≤ 50000	0.2359**	0.1463	0.3357**	0.1291
50000< Disposable income ≤100000	0.1798**	0.0370	0.1921**	0.0340
100000< Disposable income ≤150000	0.0827**	0.0220	0.0865**	0.0208
200000< Disposable income ≤250000	-0.1030**	0.0252	-0.1371**	0.0232
250000< Disposable income ≤300000	-0.3007**	0.0512	-0.3919**	0.0451
300000< Disposable income ≤350000	-0.2968**	0.1022	-0.4480**	0.0904
Disposable income >350000	-0.5923**	0.1902	-0.9383**	0.1744
1 child	0.1520**	0.0261	0.2080**	0.0237
2 children	0.3235**	0.0274	0.3481**	0.0253
3 children	0.5104**	0.0402	0.6018**	0.0394
4 children	0.7832**	0.0944	0.7888**	0.0993
Single	-0.0913**	0.0413	-0.2090**	0.0367
Age≤25	-0.4443**	0.2857	-0.5377**	0.2567
25<Age≤30	0.0596**	0.0549	0.0784**	0.0542
30<Age≤35	0.0126	0.0345	0.0678**	0.0338
35<Age≤40	0.0038	0.0281	0.0385**	0.0271
45<Age≤50	-0.0209	0.0281	-0.0412	0.0264
50<Age≤55	-0.0739**	0.0337	-0.0879**	0.0310
55<Age≤60	-0.1360**	0.0391	-0.2070**	0.0355
Age>60	-0.4020**	0.0477	-0.4921**	0.0424
UI Membership	-0.0088	0.0326	-0.0086	0.0294
Labour supply, male	0.2205**	0.0388	0.1737**	0.0342
Labour supply, female	0.1554**	0.0297	0.2131**	0.0270
M^2≤75	0.0512**	0.0478	0.0930**	0.0445
75<M^2≤100	-0.0212	0.0301	0.0220	0.0279
100<M^2≤125	-0.0440**	0.0226	-0.0434**	0.0211
150<M^2≤175	-0.0564**	0.0277	-0.0514**	0.0256
175<M^2≤200	-0.0690**	0.0418	-0.0828**	0.0386
M^2>200	-0.0471	0.0549	-0.0242	0.0503
House val. ≤200000	0.3642**	0.0738	0.3591**	0.0726
200000<House val. ≤300000	0.1182**	0.0371	0.1173**	0.0353
400000<House val. ≤500000	-0.1183**	0.0282	-0.1071**	0.0266
500000<House val. ≤600000	-0.1133**	0.0297	-0.1198**	0.0280
600000<House val. ≤700000	-0.1777**	0.0345	-0.1881**	0.0323
700000<House val. ≤800000	-0.2617**	0.0433	-0.2790**	0.0397
House val. >800000	-0.2740**	0.0464	-0.3339**	0.0424

Note: The reference household is a couple without children, has housing equity in the interval 200,000-250,000, disposable income in the interval 150000-200000, aged 41-45, no UI membership, do not participate in the labour market, live in a house sized 126-150 m^2, valued 300,000-400,000 DKK. All money values are measured in DKK, 1990 price levels.

Table 5. Estimates of the average effect of the reform on the constrained, for consumption, disposable income and liabilities. Estimates for owners according to the D1 split

		Average Effect of the Reform on the Constrained		
		(1)	(2)	(3)
		Q=ln(Consumption)	Q=ln(Disp. Income)	Q=Liabilities[(1)]
1	$[(Q_{96}+Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89}+Q_{88})]/4$	0.0481**	-0.0091**	46,663**
	Std. err	0.0060	0.0032	2,092
2	$[(Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89})]/3$	0.0610**	-0.0058**	34,796**
	Std. err	0.0066	0.0028	1,806
3	$[(Q_{94}+Q_{93})-(Q_{91}+Q_{90})]/2$	0.0549**	-0.0034	14,872**
	Std. err	0.0072	0.0026	1,456
4	$(Q_{93})-(Q_{91})$	-0.0271**	-0.0082**	14,925**
	Std. err	0.0090	0.0027	1,532

Note: All variables are measured in DKK at 1990 price levels. ** significant at 5% level. * significant at 10% level. Matching is done with replacement. Size of constrained group: 6,853, size of matched unconstrained group 4,092.
(1) Liabilities are measured in DKK (normal scale) because there are some individuals without mortgage.

Table 6. Estimates of the average effect of the reform on the constrained, for consumption, disposable income and liabilities. Estimates for owners according to the D2 split

		Average Effect of the Reform on the Constrained		
		(1)	(2)	(3)
		Q=ln(Consumption)	Q=ln(Disp. Income)	Q=Liabilitites[1]
1	$[(Q_{96}+Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89}+Q_{88})]/4$	0.0502**	-0.0084**	46,922**
	Std. err	0.0046	0.0024	1,613
2	$[(Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89})]/3$	0.0585**	-0.0063**	35,395**
	Std. err	0.0051	0.0022	1,453
3	$[(Q_{94}+Q_{93})-(Q_{91}+Q_{90})]/2$	0.0559**	-0.0055**	17,554**
	Std. err	0.0056	0.0020	1,372
4	$(Q_{93})-(Q_{91})$	-0.0502**	-0.0094**	16,083**
	Std. err	0.0071	0.0020	1,138

Note: All variables are measured in DKK at 1990 price levels. ** significant at 5% level. * significant at 10% level. Matching is done with replacement. Size of constrained group: 12,014, size of matched unconstrained group 5,045.
(1) Liabilities are measured in DKK (normal scale) because there are some individuals without mortgage.

Table 7. Estimated average consumption effect of the reform on the constrained. Renters, D1 split.

		Average Effect of the Reform on the Constrained		
		(1)	(2)	(3)
		Q=ln(Consumption)	Q=ln(Disp. Income)	Q=Liabilities[(1)]
1	$[(Q_{96}+Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89}+Q_{88})]/4$	-0.0188**	-0.0144**	7,497**
	Std. err	0.0045	0.0033	1,295
2	$[(Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89})]/3$	-0.0041	-0.0083**	4,873**
	Std. err	0.0045	0.0031	1,055
3	$[(Q_{94}+Q_{93})-(Q_{91}+Q_{90})]/2$	0.0034	-0.0101**	23
	Std. err	0.0053	0.0030	707
4	$(Q_{93})-(Q_{91})$	-0.0633**	-0.0151**	-1,241*
	Std. err	0.0058	0.0031	658

Note: All variables are measured in DKK at 1990 price levels. ** significant at 5% level. * significant at 10% level.
Matching is done with replacement. Size of constrained group: 5,547, size of matched unconstrained group 856.
(1) Liabilities are measured in DKK (normal scale) because there are some individuals without mortgage.

Table 8. Estimated average consumption effect of the reform on the constrained. Renters, D2 split.

		Average Effect of the Reform on the Constrained		
		(1)	(2)	(3)
		Q=ln(Consumption)	Q=ln(Disp. Income)	Q=Liabilities[(1)]
1	$[(Q_{96}+Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89}+Q_{88})]/4$	-0.0504**	0.0012**	1,1883**
	Std. err	0.0040	0.0028	1,011
2	$[(Q_{95}+Q_{94}+Q_{93})-(Q_{91}+Q_{90}+Q_{89})]/3$	-0.0565**	-0.0015	7,750**
	Std. err	0.0045	0.0027	823
3	$[(Q_{94}+Q_{93})-(Q_{91}+Q_{90})]/2$	-0.0146**	-0.0001	361
	Std. err	0.0045	0.0026	567
4	$(Q_{93})-(Q_{91})$	-0.0848**	-0.0134**	-1,063**
	Std. err	0.0051	0.0024	531

Note: All variables are measured in DKK at 1990 price levels. ** significant at 5% level. * significant at 10% level. Matching is done with replacement. Size of constrained group: 7,958, size of matched unconstrained group 760.
(1) Liabilities are measured in DKK (normal scale) because there are some individuals without mortgage.