Liquidity Constraints and Ricardian Equivalence in Estonia

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This paper aims to find evidence of the influence of government deficit on private consumption in Estonia. The data only shows some support for Ricardian equivalence. Two approaches were used in the empirical tests. The Haque and Montiel (1989) equation of consumption was estimated using an instrumental variables technique. The Aschauer (1985) system of equations was estimated with the full information maximum likelihood method. Formal tests based on macro data could neither reject nor confirm the existence of liquidity constraints or Ricardian equivalence. There remains a lot of room for testing both of these hypotheses in Estonia. Further efforts to test liquidity constraints should concentrate on using micro data.

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Introduction

The reaction of private consumption to government expenditure in Estonia has gained little interest in previous literature. However, some facts might have been overlooked. First, the consolidated government budget has been out of balance. Second, Estonian consumers, it is often argued, have strong liquidity constraints – are less capable of taking loans against future income. This might have been true at the beginning of the transition period, but does not correspond to the situation where the public is worried about a lending boom. The objective of this paper is to estimate the extent of Ricardian equivalence in the Estonian economy. To that end the liquidity constraints and finite planning horizons are analysed and empirical estimations carried out.

The existence of Ricardian equivalence has been much debated in previous literature. However, there are no conclusive answers. The literature in favour stresses the importance of consumption smoothing and government bonds as not part of net wealth (Barro 1974). One of the most popular arguments for rejecting Ricardian equivalence is that it assumes perfect capital markets. Seater (1993) counts 12 arguments for why Ricardian equivalence might not hold. Many authors have taken a moderate position, where they see some of the effects of government consumption, but do not see the evidence giving full support to the hypothesis[1].

Robert Barro's article, published in 1974, introduced a modern discussion of Ricardian equivalence. Testing has been conducted using micro and macro data. This paper follows the macro approach. In the approach taken by Haque and Montiel (1989), the hypothesis is that people are divided into two groups: liquidity constrained and unconstrained. The consumption of the constrained depends on their present and previous income. The unconstrained smooth their consumption and the amount consumed depends only on the last period of consumption, which acts as a proxy for an optimal consumption path. In the Aschauer (1985) approach, private and government consumption are estimated in a simultaneous system. All parameters are unconstrained in the first system. In the second, constrained system, the government consumption parameters are plugged into the private consumption function and the system is re-estimated. The parameters of the two systems are then compared.

This paper consists of four sections. Section I includes two models that are used in empirical estimations. Estonian government and private income and expenditures data are presented in Section II. In section III tests for liquidity constraints, finite planning horizons and Ricardian equivalence using the full information maximum likelihood and instrumental variable techniques are carried out. The final section presents concluding remarks.

[1] For a good overview of papers which have tested Ricardian equivalence look at Garcia and Ramajo (2004).

1. Consumption Theory, Liquidity Constraints and Ricardian Equivalence

1.1. Consumption and Ricardian Equivalence

This section introduces consumption functions, defines Ricardian equivalence and presents two methods, which are later used for empirical testing. First, the Keynesian consumption function relates current consumption to current disposable income. The model is of the form:

(1) $C_t = a + bY_t^d$,

where C_t – private consumption,
a – autonomous consumption,
b – marginal propensity to consume,
Y_t^d – current disposable income (net income with transfers added).

Equation 1 brings out the possibility that changing taxes over time would influence the amount of disposable income. Consumption can thus be affected by fiscal policy, implying the possibility of a short-term stimulation of aggregate demand.

According to the permanent income hypothesis (Friedman 1957), total consumption is divided into permanent and transitory components. An increase in current income raises consumption only if people consider themselves to be wealthier (meaning that the increase in income is permanent). Variation in a household's income also includes temporary changes, which are based on possible unemployment or unexpected bonuses. The latter does not increase wealth and that is why it has substantially less influence on consumption. Therefore, fluctuations in consumption are significantly lower than variations in income.

Hall (1978) stresses that even if the income rises, there is some uncertainty about the future income flows. People consume today according to their expectations about the income of tomorrow, and current consumption includes information about all future consumption. A person consuming more than his/her income, implies an expected higher consumption and income also tomorrow and vice versa. Risk aversion is added using the elasticity of inter-temporal substitution. Low elasticity leads to a situation where future income is taken less into account in deciding the amount of present consumption.

Public debt in the form of government bonds is not considered net wealth under the Ricardian equivalence hypothesis. A simple expression of Ricardian equivalence, derived from an inter-temporal budget constraint, can be expressed as follows[2]:

(2) $$\int_0^\infty C_t e^{-rt} dt = A_0 + \int_0^\infty Y_d e^{-rt} dt - \int_0^\infty G_t e^{-rt} dt ,$$

where A – initial (non-human) wealth,
r – interest rate,
G – government expenditures.

[2] For a more thorough insight, see Becker (1995) and Garcia and Ramajo (2004).

In equation (2) public expenditure is a determinant of private consumption. However, how these expenditures are financed is not. As a result of this, changing the timing of taxes will not affect budgetary constraints (Garcia and Ramajo 2004). A deficit based on tax cuts would be offset by increases in private saving rates in the expectation of tax increases to cover the deficit in the future. The result is thus an increase in private savings instead of private consumption. The idea is based on the permanent income hypothesis, which states that consumption can only be affected through changes in the permanent component of income, with transitory changes leaving consumption unchanged. By not rejecting the hypothesis of liquidity constraints, the permanent income hypothesis cannot be a valid concept, so often these two terms are used as substitutes. Ricardian equivalence, in contrast to the Keynesian consumption function, implies no potential for stimulating aggregate demand, interest rates and capital formation through fiscal policy (Barro 1974).

Full acceptance of the Ricardian equivalence hypothesis requires:

a) absence of liquidity constraints,
b) long-term planning horizons, and
c) low tax distortions.

The assumptions behind Ricardian equivalence have been criticised for their lack of empirical evidence (see e.g. Seater 1993, Becker 1995, Barro 1996). However, the Keynesian hypothesis contradicts using evidence on differences in the average propensity to consume through levels of income.

1.2. Liquidity Constraints and Finite Planning Horizons

Liquidity constraints are a methodological problem in evaluating Ricardian equivalence. This is especially true for countries at a developing or transitional stage. Empirical work on Ricardian equivalence in developing countries, accounting for liquidity constraints, is scarce. Initial work by Leiderman and Razin (1988) on the basis of Israeli data and Haque (1988) based on a sample of 16 developing countries concluded in favour of Ricardian equivalence, while Haque and Montiel (1989) after again testing the hypothesis on 16 developing countries reject the proposition in 15 cases (with the amount of liquidity constrained households exceeding 30 percent in 10 out of 16 countries). More recently, Darius (2001) received mixed results on a sample of developing countries – Ricardian equivalence was rejected in some cases based on the structural method by Kormendi (1983), while the reverse was true when testing using a model developed by Haque and Montiel (1989), which includes the capability to account for liquidity constraints. The model from Haque and Montiel (1989) is based on the assumption that the liquidity constrained and unconstrained together, form a weighted average of total aggregate *per capita* consumption. If the constrained consume their entire disposable income each period, consumption becomes

$$C_t = \theta C_t^u + (1-\theta) C_t^c , \tag{3}$$

where C_t^c represents consumption by constrained households and C_t^u by unconstrained households, with θ the share of the unconstrained. The equation to be estimated, which contains disposable income *Y*, is the following:

(4) $C_t = \alpha_1 C_{t-1} + \alpha_2 C_{t-2} + \alpha_3 Y_t + \alpha_4 Y_{t-1} + \alpha_5 Y_{t-2} + \varepsilon_t$,

where ε_t – moving average error term.

According to the no liquidity constraints hypothesis, income should not affect consumption $\alpha_3 = \alpha_4 = \alpha_5 = 0$ and there is Euler type of consumption smoothing $\alpha_1 \neq 0$ and $\alpha_2 \neq 0$. Based on the same equation, the underlying theoretical parameters (interest rate, share of unconstrained population, etc) can be estimated directly. For a presentation of the constraints see Appendix 1 and the paper by Haque and Montiel (1989).

1.3. The Rational Expectations Approach to Testing Ricardian Equivalence

Many papers fail to reject the Ricardian equivalence[3]. According to Seater (1993), this is due to interpreting the hypothesis in a particular way. Among these, Aschauer's (1985) approach to describing consumption dynamics leaves little room for "interpretational vagueness". The model is capable of testing the equivalence hypothesis in a stochastic world, where a separation between expected/unexpected and permanent/transitory changes in government consumption is necessary. According to the model, individuals maximise their utility from both government and private consumption, i.e. effective consumption (the weighted sum of government and private consumption) as in Becker (1995):

(5) $C_t^* = C_t + \theta G_t$,

where θ – the constant marginal rate of substitution between private and government consumption.

G_t – government consumption

Aschauer's two-equation consumption function ready for estimation is of the form:

(6) $C_t = \delta + \beta C_{t-1} + \eta(L) G_{t-1} + \mu(L) D_{t-1} + u_t$

(7) $G_t = \gamma + \varepsilon(L) G_{t-1} + \omega(L) D_{t-1} + v_t$,

where,

D_t – government deficit,

L – the parameters for the lagged values of the variable,

u_t and v_t are the error terms.

[3] Such papers include Garcia and Ramajo (2004), Haque (1988), Evans (1988), Evans (1993), Himarios (1995), Haug (1996), and Brunila (1997).

The parameter restrictions are:

$$(8)\qquad \begin{aligned} &\delta = \alpha - \theta\gamma \\ &\eta_i = \begin{cases} \theta(\beta - \varepsilon_i) & i = 1 \\ -\theta\varepsilon_i & i = 2,...,n \end{cases} \\ &\mu_j = -\theta\omega_j \qquad\qquad j = 1,...,m\,. \end{aligned}$$

Once restrictions from 8 are plugged into equation 7, it is multiplied by θ and $\varepsilon(L)\theta G_{t-1}$ is plugged back into equation 7, then the consumption equation can be obtained:

$$(9)\qquad C_t = a + \beta C_{t-1} + \theta\beta G_{t-1} - \theta G_t + u_t\,.$$

Results from estimating this two-equation consumption function require these restrictions to hold in order to have private consumption dependent on public deficit. Another check for Ricardian equivalence is to test whether θ is significant and different from zero. According to Aschauer, government expenditures substitute private consumption by 20 percent, and debt has no wealth effect on consumption other than signalling future levels of government expenditure (Aschauer 1985, Becker 1995).

2. Government and Private Consumption in Estonia

2.1. Government Deficit and Debt

The research on the validity of Ricardian equivalence concentrates on two issues: how the government budget balance has evolved over time, and what the private consumption and savings trends have been in Estonia.

By law, the central government budgets have to be in balance. This does not imply that the budget actually is in balance. There are ways to incorporate loans and resources not spent in the previous year as a source of income. Even if the initial budget is in balance, its realisation *ex post* can differ from the one agreed upon. According to automatic stabilizers, the budget income is higher and expenditures smaller during economic booms and *vice versa* in recession. The 1999 economic downturn also brought the Estonian budget into deficit. The deficit in the first quarter was 1.5 billion kroons (see Figure 1) and for the full year, the budget deficit reached over 3 percent of GDP.

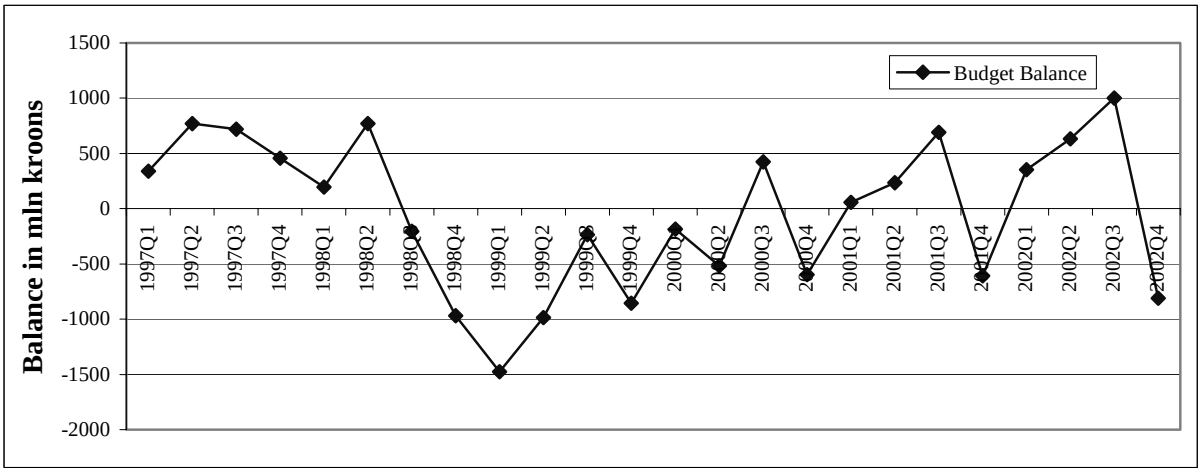

Figure 1. Central government's budgetary balance in Estonia from 1997 Q1 to 2002 Q4 (EEK m)
Source: Statistical Office of Estonia

Public debt in Estonia has remained relatively low. The amount has not increased compared to the beginning of the period (see Figure 2). Instead, the Estonian government has a 'stabilisation reserve'. This money is deposited outside of Estonia for specific objectives.

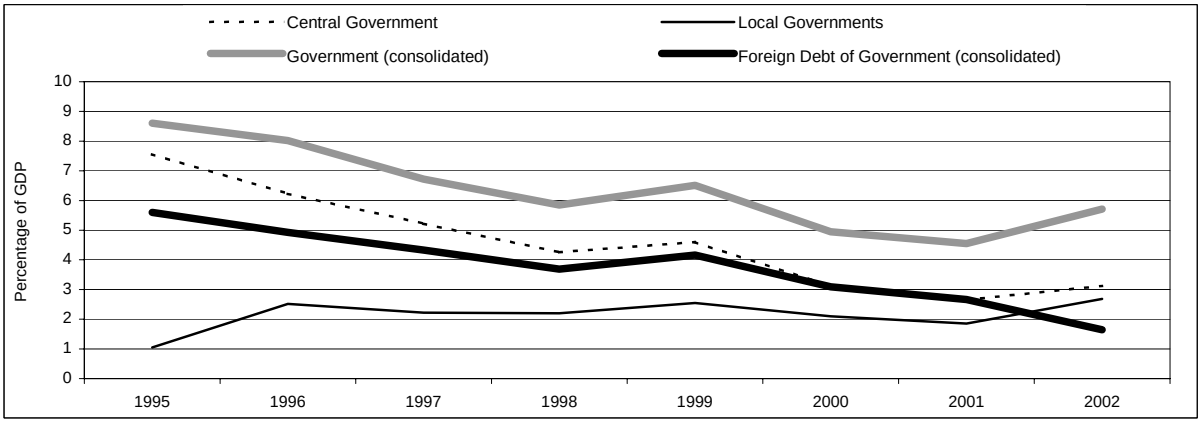

Figure 2. General government debt
Source: Statistical Office of Estonia

The deficit and debt in Estonia has mainly been financed by foreign loans (see Figure 2). There are no domestic bonds[4]. Therefore, the fundamental question raised by Barro (1974), of whether

[4] The central government took loans from abroad and in the last years, local governments have increased their expenditures by using local bank loans.

consumers take government bonds as net wealth, is not relevant. By definition, there is no wealth effect. Instead, the only effect that should be considered is a possible future increase or decrease in income (and respectively a decrease or increase in taxes).

Since May 2004 when Estonia joined the EU, the Estonian government has to follow the rules of the Stability and Growth Pact. There are no serious problems in fulfilling the criteria or any expectations of possible changes to the balance of budget rule.

2.2. Income, Consumption and Liquidity Constraints

Do Estonians behave according to the Keynesian consumption function or the permanent income hypothesis? According to the permanent income hypothesis, the amount consumed does not depend on expected changes in the present period income, but on the total expected future income. Hence, a person whose income today is lower than the average of his/her lifespan should borrow money from the capital markets, and a person whose present income is higher than the expected future income should save money in order to smooth consumption. In case the budget is in deficit, it is necessary that people should be able to save money for the future (their income is higher than the minimum cost of living). In the case of a budget surplus, the absence of borrowing constraints is necessary.

There are three ways of understanding liquidity constraints (Hayashi 1985): the interest rate constraint,

1. the quantity constraint, or
2. the cash in advance constraint.

The interest rate constraint means that the interest rate for borrowing money is higher than the rate for giving a loan. This holds for most people, as the government bond interest rate is lower than that of the average private loans. The quantity constraint limits the amount they can borrow. When there are no liquidity constraints, the maximum loan should be equal to the sum of the discounted expected future income. In the context of Ricardian equivalence, only those people who cannot consume at the optimal level are considered to have liquidity constraints. Households, that have little or no access to loans, can still follow an optimal consumption path if their expected future income is equal to the present level. Whenever lower taxes are expected, people should start consuming today by taking loans based on the future increases to their income.

According to the life-cycle theory, young people represent an evident candidate group for possessing liquidity constraints. Their present income is lower than their expected future income. Other groups of people are temporarily unemployed or passive on the labour market. A temporarily small income might decrease the person’s borrowing ability. The working population might also have liquidity constraints, but it is conditional on their expected future income. In certain groups, the expected wage (growth) is not necessarily high. In addition, they might become unemployed, which places the expected income below the present level.

Retired people form a separate group. According to life-cycle theory, they should not be liquidity constrained. Even if their lifetime average income is higher than the one they have today, previous savings should compensate for the decrease in income. However, in Estonia many pensioners do not possess any wealth to spend. Hence their consumption depends equally on the expected dynamics of pensions. In that respect, it becomes important how government finances present debt. On the one hand, they can raise income tax and continue transferring money to the elderly; while on the other hand, the use of consumption tax has an impact on expected savings as well as possible cuts in future pensions to balance the budget. The same logic holds for an initial government surplus, where a rise in expenditures or a cut in taxes is possible. There is no data available that describes the pensioners' expectations of their future income (government transfers) in Estonia. The situation is about to change with the introduction of the 'second pension pillar', which consists of personal savings during the working years.

Liquidity constraints can appear when people are not able to save money. This would be the case if the current income were lower than the minimum required for subsistence. Poverty and a high level of non-monetary income can lead to a situation where saving is not possible even if people expect an increase in taxes.

Another caveat in the estimation is taking into account the consumption of durables and money spent on investment goods. A purchased or renovated apartment is an investment, which people can resell at a profit. Therefore interest payments on loans that are taken for investment purposes should not be taken into account as investment but savings. Durables (cars, refrigerators, etc.) are a class of goods where the moment of buying and consuming are different. From the consumption point of view, an expensive durable lasts over a long period and helps smooth consumption while the data shows a single-period jump in consumption. Hence the investment goods and durables should be excluded from consumption.

Even, if the literature concentrates on testing whether liquidity constraints are present or not, a simple analysis of loan availability for different groups in the population and their saving behaviour enables some general conclusions to be drawn. This serves as a basis for empirical testing of liquidity constraints as one of the main assumptions of Ricardian equivalence.

Personal income has significantly increased in Estonia since 1996. Respective increases in expenditure have been similar (see Figures 3 and 4). The correlation coefficient for private consumption and income based on the survey is 0.99 (see Figure 3). The correlation of consumption and disposable income based on GDP data is 0.82 (see Figure 4). While the data based on questionnaires could be more accurate, it is not available for quarterly intervals.

This co-movement indicates that people in Estonia consume a similar proportion of their income. The data shows one episode where the income and consumption did not follow the same pattern – this was in the aftermath of the Russian crisis in 1998, when people started to save more money (see Figures 3 and 4). However, the higher savings were spent a year later (i.e. year 2000; see Figure 3). That period also coincides with the public sector budget deficit in Estonia. This reaction mimics the expected behaviour of Ricardian equivalence. The example shows that Estonians use precautionary savings and hence there is some consumption smoothing over the years. However, no conclusions on liquidity constraints can be drawn at this stage, as it is difficult to separate precautionary and 'Ricardian' savings (see Carroll 2001).

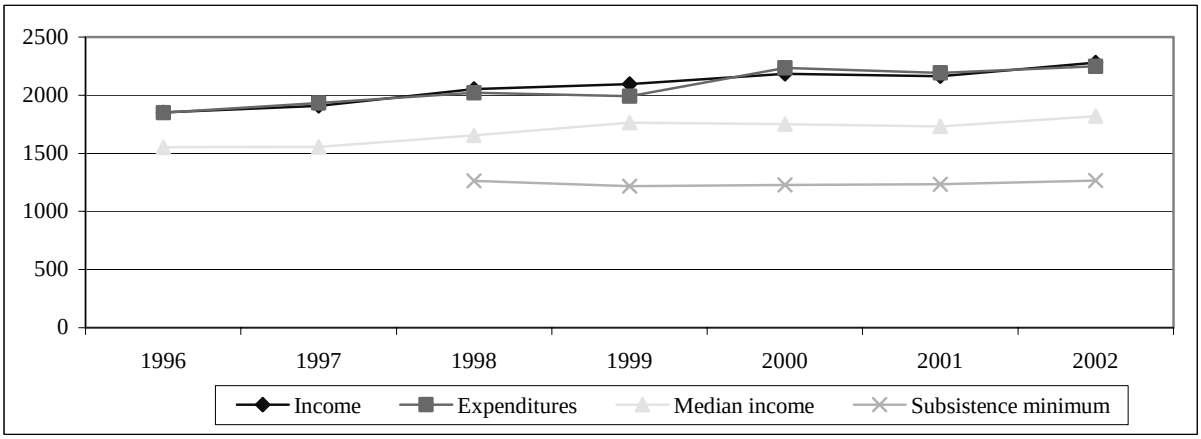

Figure 3. Real income and expenditures per household member, based on household survey data (year 2000 prices, EEK)
Source: Statistical Office of Estonia

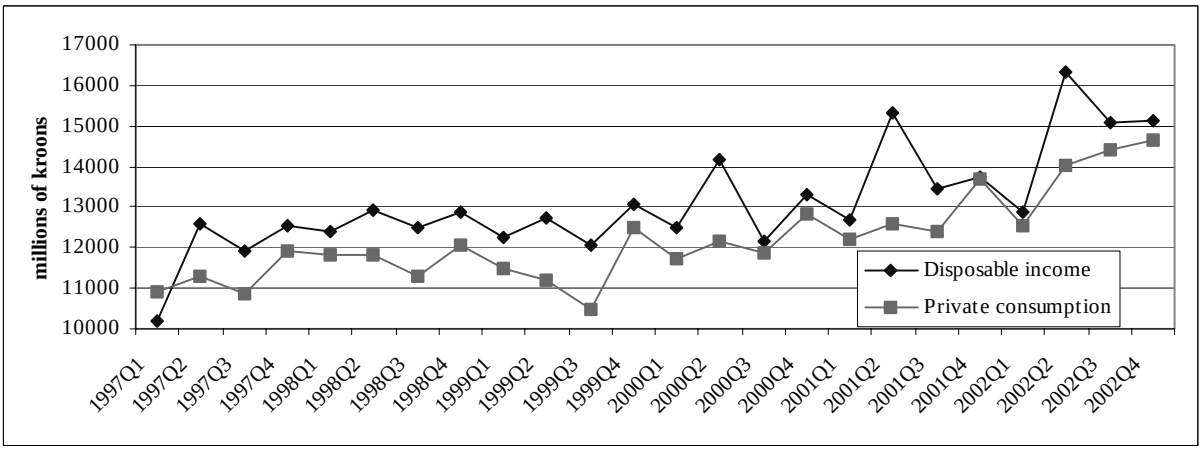

Figure 4. Income and expenditures in Estonia, based on GDP data (EEK m)
Source: Statistical Office of Estonia

Both, the ability to take loans and save money are equally relevant. This depends on the distribution of income among Estonian households. It can be seen from Figure 3 that the median income is significantly lower than the mean income. This indicates high disparities in income. Therefore the minimum subsistence level can be of concern for a significant proportion of households. The income of those in the lowest decile is almost ten times less than the income for those in the highest (see Figure 5).

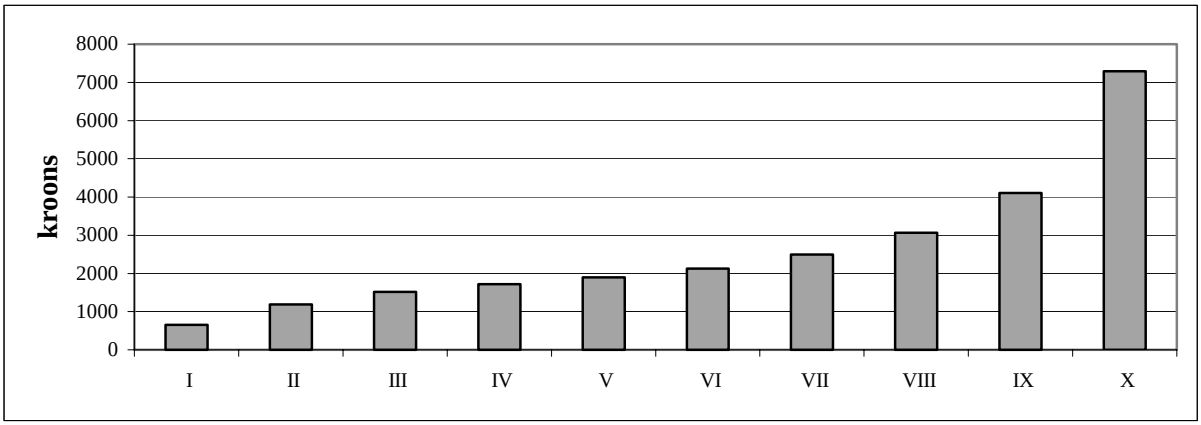

Figure 5. Average monthly disposable income per household member by income deciles, 2002 (EEK)
Source: Statistical Office of Estonia, *Household Living Niveau*, 2001

There is 23.4 percent of the population of Estonia living in the lowest two household income deciles, earning 9.1 percent of the total income (see Table 1). Their income is also below the subsistence level. The lower groups can be considered to be liquidity constrained from both sides, in terms of saving and borrowing money. However, we do not know their expected future income. On the other hand, as the share of their expenditures is low in comparison to total consumption, these households are less important in influencing aggregate consumption numbers.

Table 1. Share of the population and their disposable income as a percentage of the total disposable income shown in deciles, 2002

Income decile	Share in total population	Share in total disposable income of all households
I	11.9	3.1
II	12.5	6.0
III	9.9	6.0
IV	8.6	6.0
V	8.8	6.7
VI	9.6	8.2
VII	10.1	10.1
VIII	10.2	12.6
IX	9.9	16.3
X	8.5	25.0

Source: Statistical Office of Estonia, *Household Living Niveau*, 2002.

The main income source for households is wages (approx. 66%) after different transfers (approx. 27%). Ownership as income is small (0.5%). The distribution depends heavily on the income

decile (see Table 2). Income from wages amounts to less than 40% for those in the lowest income group and approximately 80% for those households in the highest. More than half of the people's income from wages is less than 60% of their total income. Poorer households are more heavily dependent on government transfers (pensions, child benefits, etc.), which is their major source of income. For example, the average income from pensions is around 17%, but for retired people it is their main source of income.

Table 2. Distribution of income based on source (shown as a percentage)

	I decile		**V decile**		**X decile**	
	1996	**2002**	**1996**	**2002**	**1996**	**2002**
Income from wages	45	37	50	45	73	76
Income from self-employment*	...	...	11	4	12	6
Pension (transfer)	25	30	31	42	4	3
Child benefit (transfer)	21	17	4	3	1	1
Other transfers	10	14	3	4	3	3
Other income	1	3	1	2	7	11
Total	100	100	100	100	100	100

* … signifies that income has been negative
Source: Statistical Office of Estonia

Non-monetary income forms a significant part of real income (up to 5%; see Table 2) and consists of work-related benefits such as mobile phones or cars and income from (meal) production at home. None of these income sources are appropriate for getting a loan from a bank or saving for the future. Since 1995, labour income has increased, but has remained relatively low.

In Estonia, the two highest deciles have a 40.5 percent share of the total disposable income of all households. For half of these households, government transfers and income other than salaries make up 50–65 percent of the household's disposable income[5]. It is therefore reasonable to argue that people on a lower income that comprises a larger share of government transfers, are more likely to be liquidity constrained than the others.

Estonian households spend approximately 95% of their income, out of which one half is for food and non-alcoholic beverages and housing. Forty percent of households spend more than 60% of their income on these primary expenditures (see Table 3).

[5] Source: Statistical Office of Estonia, *Household Living Niveau*, 2001

Table 3. Distribution of expenditures (shown as a percentage)

	I decile		V decile		X decile	
	1996	**2002**	**1996**	**2002**	**1996**	**2002**
Food and non-alcoholic beverages	54	45	51	41	31	23
Housing	17	17	21	20	14	12
Clothing and footwear	5	4	5	5	9	7
Household equipment and operation	4	4	3	3	7	7
Transport	4	5	4	7	10	10
Others	16	25	16	24	29	41
Total	100	100	100	100	100	100

Source: Statistical Office of Estonia

Nominal interest rates have declined significantly in Estonia (see Figure 6). The developments of the real interest rate are more complex because of high levels of inflation at the beginning of the period. Bank deposit rates have remained close to zero or negative during the full period with the exception of the crisis years when banks offered high rates to attract money. This is another reason for households to diverge from their optimal consumption path.

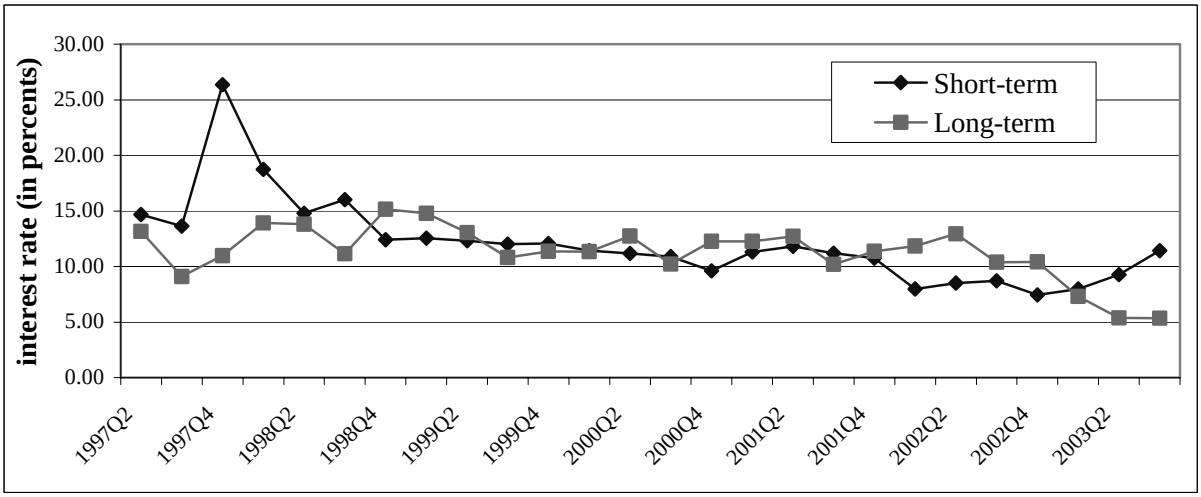

Figure 6. Development of interest rates in Estonia (shown as a percentage)
Source: Eesti Pank

Although there has been rapid development in the financial sector and growth in the number of loans to the households, this does not directly translate into low liquidity constraints for households. First, the loans have to be long term. Credit of only one-year duration, allows for consumption smoothing within a single year, but is not relevant for Ricardian equivalence.

Secondly, the smoothing of consumption over time in the view of the permanent income hypothesis excludes the consumption of durables. The statistics show (see Figure 7) that the majority of loans are housing loans, which are part of the investment expenditure and are excluded from consideration. Consumption loans have increased by comparison with 1997, but have remained stable since 2001. Unfortunately there is no information about the use of most of these loans. Peaks in the number of consumption loans in the first part and of other loans in the second part of the period indicate a transfer of loans to students.

Thirdly, the 1997 Estonian Stock Market crash and 1998 Russian crisis led to credit rationing (Pikkani 2000). During and after this period, loans were not given out, contributing to positive net savings in 1999.

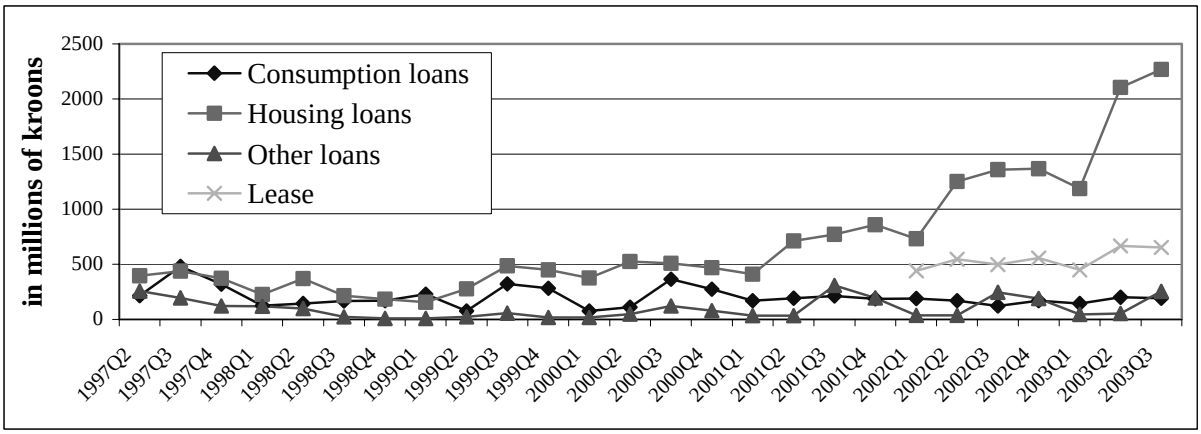

Figure 7. Monthly loans and lease turnover in Estonia according to purpose (EEK m)
Source: Eesti Pank

Answers to many questions remain unsolved when aggregated macro level data is used. Research using micro data could provide deeper insights into the borrowing constraints and planning horizons of Estonian households. This could be the subject of further analysis. The paper will now proceed with empirical testing of Ricardian equivalence at the level of aggregate income and consumption.

3. Empirical Results

3.1. Tests for Liquidity Constraints

This section introduces estimations for finding evidence of the public debt effect on consumption. The models that are used here were described in section I. At first, the Haque and Montiel (1989) model is estimated as an attempt to test the main assumptions behind Ricardian equivalence – liquidity constraints. The results from this model will be supplemented by the

outcome of the Aschauer (1985) rational expectation approach. A description of the variables can be found in Appendix 2.

As for Haque and Montiel (1989), real variables in the estimation process were used. As noted in section I, the methodology behind this approach requires the use of the instrumental variable technique in the estimation process. For this purpose the non-linear two-stage least squares were used with the instruments consisting of the second lags of real private consumption (Statistical Office of Estonia), real government expenditures (Ministry of Finance), world real interest rate (Euribor from the European Central Bank), real public deficit (Ministry of Finance), terms of trade (Statistical Office of Estonia) and 12-month real interest rate on loans granted to individuals (Eesti Pank). The data is quarterly from 1997Q1 to 2002Q4.

The private income and consumption series used in the regression can be analysed as stationary[6]. Since only the coefficients on disposable income are subject to tests, subtracting C_{t-1} from both sides will satisfy the stationarity condition for testing the parameters of interest[7]. The estimation results for the unrestricted and restricted models are reported in Table 4. All series of variables were smoothed using the Hodrick-Prescott[8] (HP) filter. Due to the iteration method used, the results were somewhat sensitive to the initial values used. Two approaches were used – estimating the initial values based on ordinary least squares and giving reasonable initial values. The results presented in the table below were robust to these specifications. Those models with different lag structures (namely lags of up to one year and one-year moving average) did not improve the results significantly. The models with a seasonally adjusted time series (using a Census X12 filter) did not give conclusive results: the estimated parameters were heavily dependent on the starting values imposed.

[6] The Augmented Dickey-Fuller (ADF) test could reject the unit root for private consumption at the 10% significance level and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test statistic could not reject stationarity at 5% significance. The ADF test could reject the unit root for disposable income at 1% significance and KPSS reject stationarity at the 1% level. For both tests, trend and intercept were used. As the time series is short, the tests may give biased results. However, a cointegrating vector can be found between the private disposable income and consumption, in the estimated model and the error term is white noise.

[7] Haque and Montiel (1989) with reference to Stock and West (1987) conclude that "conventional test statistics remain valid in the presence of integrated regressors as long as the regression in question can be rearranged so that the parameters of interest appear as coefficients of stationary mean-zero variables".

[8] The smoothing parameter is 1600 as recommended for quarterly time series.

Table 4. Estimation results for private consumption

	Unrestricted		Restricted*		Prob(unrestr= restricted)
	Coefficient	**(s.e.)**	**Coefficient**	**(s.e.)**	
Private cons(-1)	2.02	0.11	*1.98*		0.68
Private cons(-2)	-1.00	0.11	*-0.96*		0.69
Disposable income, (α_3)	-0.04	0.08	*-0.001*		0.73
Disposable income (-1), (α_4)	0.04	0.12	*0.006*		0.75
Disposable income (-2), (α_5)	-0.02	0.06	*-0.009*		0.81
R (interest rate)			1.02	0.002	
s (weight)			0.93	0.007	
γ (horizon effect)			0.85	0.01	
θ (liquidity constraints)			1.01	0.005	
R^2_{adj}	0.99		0.99		
Durbin-Watson	2.53		2.29		

* The restricted equation parameters are as in Appendix 1. The equation estimated is the following: Priv_cons=(R/γ*(1+γ*s))* Priv_cons(-1)+((-1)*s*R^2/γ)* Priv_cons(-2)+ +(1-θ)*Disp_inc+((-1)*R/γ*(1+γ*s-θ*(γ+s)))* Disp_inc(-1)+((1-θ)*s*R^2/γ)* Disp_inc(-2). Numbers in italics are calculated based on the estimated values.

Not all reported coefficients are in accordance with that suggested by the theory (see the restrictions for equation 4 in Appendix 1). The parameter on private consumption with the lag of one exceeds unity, but should not be double that amount – the second lag is, and should be negative. The overreaction of the first lag is compensated by the negative value of the second lag, so the sum of the two slightly exceeds the first, indicating that consumption expenditures have a positive trend. The coefficient for the contemporaneous effect of disposable income should be positive but less than one, indicating that an increase in income results in a rise in

consumption. But the coefficient is negative, not different from zero, indicating that disposable income has no effect on private consumption. Also, the first and second lags have reverse signs. The first lag of income should be negative and the third, positive but below the absolute value of the second. Statistically they are not different from zero, indicating that income has no influence over consumption.

Testing for the liquidity constraints in the model where the HP filter was used showed the existence of no binding liquidity constraints. Joint and separate testing of the coefficients showed that it is not possible to reject the no liquidity constraints hypothesis: $\alpha_3 = \alpha_4 = \alpha_5 = 0$ (see Table 5).

Table 5. Testing for the liquidity constraints and long planning horizons

	Test Statistic	Value	df	Probability
α_3 =0 (disp_inc)	F-statistic	0.22	(1, 16)	0.64
	Chi-square	0.22	1	0.64
α_4 =0 (disp_inc(-1)) planning horizon effect	F-statistic	0.14	(1, 16)	0.71
	Chi-square	0.14	1	0.71
α_5 =0 (disp_inc(-2))	F-statistic	0.16	(1, 16)	0.69
	Chi-square	0.16	1	0.69
α_3 =0, α_5 =0 (liquidity constraints)	F-statistic	0.14	(2, 16)	0.87
	Chi-square	0.28	2	0.87
α_3 =0, α_4 =0, α_5 =0 (long planning horizon and liquidity constraints)	F-statistic	0.83	(3, 16)	0.50
	Chi-square	2.50	3	0.48

As Haque and Montiel (1989) show in their articles, the restrictive parameters can be estimated directly (see Appendix 1). Table 4 includes the results of the restricted model estimation. The parameters are similar to the results of the unrestricted model when the values are calculated using the restrictions. From the estimated parameters, the real interest rate is slightly above 0 and nobody was liquidity constrained, as $1-\theta$ is not different from zero. The planning horizon is sufficient in this context as the coefficient is statistically different from zero, indicating that households operate in a multi-year context. Parameter *s* is below one, being consistent with theory. Also here, the results did not change when different lag structures were used. The tests on the model with the seasonally adjusted data were not stable as the initial model standard errors were unstable. However the conclusion remains unchanged, there are no significant liquidity constraints.

3.2. Rational Expectations Approach

The two-equation approach (Aschauer 1985) was presented in section I. The validity of the equivalence hypothesis is tested through the null hypothesis of valid cross-equation restrictions (equation 8). If they do not hold, debt can be considered as net wealth and there is empirical evidence that the Ricardian equivalence hypothesis does not hold. The estimation process requires that the system of two equations (6 and 7) be estimated subject to restrictions in order to acquire estimates of the initial model-based parameters. Because of the non-linear nature of such estimation, full-information maximum likelihood (FIML) is used, as suggested by Aschauer (1985). The results of the FIML estimation process are presented in table 6. The time-series are seasonally adjusted using the ARIMA X-12 filter. The results of the model where data was smoothed using the HP filter are similar and the parameter coefficients are not presented.

Table 6. Estimation results of the rational expectations model

	Unrestricted	**(s.e.)**	**Restricted***	**(s.e.)**	**Prob(unr=restric)****
Priv_cons					
C(6), (α)*			-6423.43	5889.03	
C(7), (θ)*			-5.72	2.61	
C(8), (β)*			0.54	0.17	
Constant	-8019.63	4665.89	*-10609.87*		0.58
Priv_cons(-1)	-0.23	0.57	*0.54*		0.18
GEXP(-1)	3.43	2.27	*1.19*		0.32
GEXP(-2)	1.69	2.57	*0.94*		0.77
DEFICIT(-1)	0.80	0.58	*0.51*		0.61
DEFICIT(-2)	0.43	1.01	*-0.16*		0.56
R^2_{adj}	0.90		0.82		
Durbin-Watson	1.76		2.16		
GEXP***					
Constant	218.24	746.64	457.11	715.40	0.75
GEXP(-1)	0.55	0.45	0.75	0.38	0.66
GEXP(-2)	0.41	0.48	0.16	0.35	0.60
DEFICIT(-1)	0.03	0.11	0.09	0.10	0.59
DEFICIT(-2)	0.0004	0.12	-0.03	0.11	0.81
R^2_{adj}	0.89		0.88		
Durbin-Watson	2.44		2.20		

* Results based on the restricted model Priv_cons=(C(6)-C(7)*C(1))+C(8)* Priv_cons(-1)+
+C(7)*(C(8)-C(2)))*GEXP(-1)-(C(7)*C(3))*GEXP(-2)-(C(7)*C(4))*DEFICIT(-1)-
-(C(7)*C(5))* DEFICIT(-2) Numbers in italics are calculated based on the estimated values.
** The probability that the coefficients of the unrestricted equations are equal to the restricted. The probabilities are based on the Wald tests, using standard errors from the unrestricted system
*** GEXP=C(1)+C(2)*GEXP(-1)+C(3)*GEXP(-2)+C(4)*DEFICIT(-1)+C(5)* DEFICIT(-2)

For Ricardian equivalence to hold, the cross-equation restrictions have to be valid. The evaluation can be done by comparing the unrestricted equation parameters with the restricted equation parameters. From the restricted model, the government expenditure parameters are estimated directly, but the private consumption function coefficients have to be calculated by using the restrictive equations 8.

The unrestricted and restricted equation parameters are different. In Table 6, the coefficient for private consumption has a negative value in the unrestricted model, but a positive value in the restricted system. But since all the coefficients in the initial unrestricted model were statistically not different from zero, the hypotheses on the differences in the parameters of the restricted and unrestricted equation systems could not been statistical confirmed. The coefficients that are statistically not different from zero do not indicate a poorly performing model. Instead, they

indicate no significant influence from government expenditures and the deficit on consumption. Ricardian equivalence cannot be rejected.

As with the Aschauer (1985) paper, a reduced-form model was estimated (see Table 7). The second lags for government expenditures and deficits are removed from both equations. The joint test could reject the hypothesis that the excluded parameters were zero at the 5 percent confidence level. The standard errors decrease significantly and the tests reject similarities in the consumption equation parameters. This evidence rejects Ricardian equivalence.

Table 7. Results of the reduced model

	Unrestricted	**(s.e.)**	**Restricted***	**(s.e.)**	**Prob(unr=restric)****
Priv_cons					
C(6), (α)*			-5894.77	6950.21	
C(7), (θ)*			-5.39	2.92	
C(8), (β)*			0.52	0.16	
Constant	-5849.39	2218.32	*-9842.06*		0.07
Priv_cons(-1)	0.05	0.18	*0.52*		0.01
GEXP(-1)	3.87	0.76	*2.23*		0.03
DEFICIT(-1)	0.91	0.24	*0.41*		0.04
R^2_{adj}	0.90		0.85		
Durbin-Watson	2.21		2.23		
GEXP***					
Constant	127.24	1052.45	338.13	1038.74	0.84
GEXP(-1)	0.98	0.24	0.93	0.24	0.85
DEFICIT(-1)	0.02	0.10	0.08	0.05	0.56
R^2_{adj}	0.86		0.84		
Durbin-Watson	2.64		1.92		

* Results based on the restricted model: Priv_cons=(C(6)-C(7)*C(1))+C(8)*Priv_cons(-1)+ +C(7)*(C(8)-C(2)))*GEXP(-1)-(C(7)*C(4))*DEFICIT(-1) Numbers in italics are calculated based on the estimated values.

** The probability that the coefficient of the unrestricted coefficient equals the restricted. The probabilities are based on the Wald tests, based on the unrestricted system standard errors.

*** GEXP=C(1)+C(2)*GEXP(-1)+C(4)*DEFICIT(-1)

The other way of testing for Ricardian equivalence is by using the parameter θ, the reaction of private consumption to government expenditures. In Tables 6 and 7, it is negative indicating that increasing government expenditures would increase private consumption. This does not correspond to the definition of Ricardian equivalence, where people expect rising taxes along with an increase in government expenditures. Therefore, the results of the Aschauer (1985) model are inconclusive with respect to the existence of Ricardian equivalence.

Conclusions

The Ricardian equivalence hypothesis has caused much debate in economic literature. Unfortunately there is not much discussion of it in Estonia. This paper makes an attempt to understand the phenomena in Estonia.

During the short period under investigation, both, private income and consumption have increased significantly. There was one episode where income grew quicker than expenditures and the government balance went into deficit. This was after the Russian crisis when uncertainty rose significantly. This episode corresponds to Ricardian behaviour. However, the increase in private saving was caused by a general uncertainty rather than expectations of a tax increase.

Two approaches were used to estimate Ricardian equivalence using macro-level data. When testing for liquidity constraints and optimal consumption, the results showed that it was not possible to reject the hypothesis that there are no constraints. As disposable income and private consumption are highly correlated, the results of the model depended on the use of the HP filter. The results were not dependent on the lag structure used.

The parameter estimates for the rational expectations approach were more stable. The initial model coefficients were insignificant and Ricardian equivalence could not be rejected. The reduced model parameters had smaller standard errors and tests for the existence of Ricardian equivalence could reject it at a high confidence level.

One reason why the empirical tests could not reject Ricardian equivalence might be that the government deficit is not perceived as a possible reason for tax increases in the future. The relationships that were estimated above do not necessarily hold for the future budget deficits/surpluses.

Future research should concentrate more on testing the liquidity constraints in Estonia using micro level data. After identifying household groups that behave similarly, Ricardian equivalence should be estimated only on those who are expected to behave similarly (e.g. active labour force) and exclude those with different patterns (e.g. pensioners).

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Appendices

Appendix 1. Haque and Montiel (1989) Model Constraints

Equation to be estimated:

$$C_t = \alpha_1 C_{t-1} + \alpha_2 C_{t-2} + \alpha_3 Y_t + \alpha_4 Y_{t-1} + \alpha_5 Y_{t-2} + \varepsilon_t$$

with the following restrictions:

$$\alpha_1 = \frac{R}{\gamma}(1 + s\gamma) > 1,$$

$$\alpha_2 = -\frac{sR^2}{\gamma} < 0,$$

$$\alpha_3 = 1 - \theta \; ; \; 0 \leq \alpha_3 \leq 1,$$

$$\alpha_4 = \frac{-R}{\gamma}\left(1 + \gamma s - \theta[\gamma + s]\right) < 0,$$

$$\alpha_5 = (1-\theta)\frac{sR^2}{\gamma}; \; 0 \leq \alpha_5 \leq \alpha_2,$$

$$\varepsilon_t = \theta\left\{(1-s)\tilde{H}_t^u + U_t - R(1-s)\tilde{H}_{t-1}^u - R\left(1 - \frac{1}{\gamma}\right)U_{t-1} - \frac{R^2}{\gamma}U_{t-2}\right\},$$

where **R = (1 + r),** ***r is fixed interest on government bonds purchased last period,***

γ – fixed probability of surviving to the next period,

s – proportion of household wealth in the consumption of the unconstrained,

θ – proportion of liquidity constrained in the economy,

Appendix 2. Description of Variables

Short name	Long name	Source	Comments
DEFICIT	Public deficit	Ministry of Finance	Real government deficit is reached through deflating the deficit using the government expenditures deflator
Disp_inc	Disposable income	Statistical Office of Estonia	Calculated from the national accounts by using the following formula: *Y-IP--MI+TR-IB*, where *MI* represents retained earnings and mixed income, and *IB* represents the income balance. Nominal household disposable income was deflated using the GDP deflator in order to get real household disposable income.
GEXP	Government expenditures	Statistical Office of Estonia	
Priv_cons	Private consumption	Bank of Estonia	GDP statistics