a/ working paper

WP 2015/05 (March)
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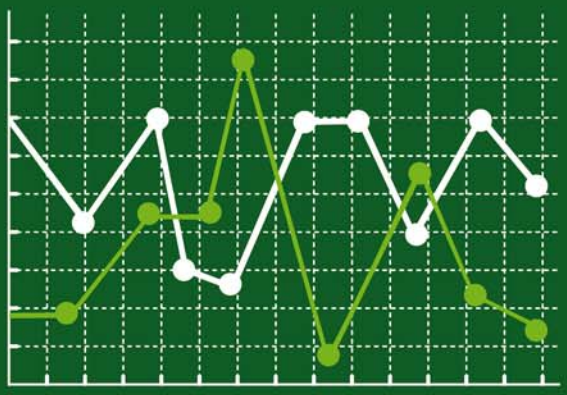

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How Did Household Indebtedness Hamper Consumption during the Recession? Evidence from Micro Data*

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Abstract - The paper investigates the extent to which household indebtedness suppressed consumption during the economic downturn in 2008-2009. The paper uses a unique quarterly panel dataset containing financial information on over 100,000 individuals. The dataset covers the period 2005-2011, when there were large changes in credit volumes, income and consumption in Estonia, a new EU member country. The estimations show that indebtedness measured by the debt-to-income ratio and the debt service ratio hampers consumption over the whole business cycle. The negative impact of the debt service ratio is, however, substantially stronger during the recession than in the pre-crisis and post-crisis periods, while the negative effect of the debt-to-income ratio is relatively stable over the sample period. The findings suggest that household indebtedness is amplifying the recession and the debt repayment burden indicates the mechanism which is at work.

JEL codes: E21, D14, E32

Keywords: household indebtedness, debt repayment burden, debt-to-income ratio, amplification effect, recession.

* The author would like to thank Lennart Kitt for his help with the database, seminar participants at TTÜ and Eesti Pank, participants at the HFCS network meeting in the ECB, the ECEE5 and IISES 9th conferences, and Atif Mian, Karsten Staehr, Tiiu Paas, Alvar Kangur, Lenno Uusküla and Jaanika Meriküll for useful comments. This work was supported by the Estonian Science Foundation grant number SF0140059s12.

1. Introduction

This paper investigates the impact of household debt on consumption during the 2008-2009 recession using administrative data. Household debt has increased extensively, exceeding corporate debt in many countries, and the discussion about the economic implications of household debt has received a great deal of attention in the past decade.[1] A list of studies emphasise the role of household debt in explaining macroeconomic fluctuations and the need to use micro-level data to understand the driving forces behind the business cycles; see the overview by Mian & Sufi (2010a). That paper is one of the few studies to examine the topic with micro panel data.

The issue of the implications of indebtedness is highly relevant in countries in Central and Eastern Europe (CEE), in which household finance started to emerge after the introduction of market-based financial systems in the 1990s. The liberalisation of the financial system led to the entry of foreign-owned banks and this increased access to financial services, including credit products (Beck & Brown 2011). Since then, rapid household credit growth has been observed, and it was particularly rapid in new EU member states until the outbreak of the crisis in 2008. To some extent the credit upsurge was justified by the convergence process, but several studies have identified a household credit boom in the CEE countries (Coricelli et al. 2006, Barrell et al. 2009, Herzberg 2010). Policy institutions were not able to manage the rapid credit expansion in the 2000s, arguably because they lacked previous experience of capital inflows (Hilbers et al. 2005). Consequently, CEE countries suffered severely from the 2008-2009 recession. There is evidently a need to identify the channels through which household indebtedness contributed to the severity of the recession.

The link between household debt and the real economy is household consumption. There are two different strands of theories explaining the effect of household debt on consumption. One strand covers most conventional explanations elaborated from the Life-Cycle / Permanent Income Hypothesis of Modigliani (1954) and Friedman (1957), which note the improved ability to smooth income shocks and so reduce consumption volatility. In the other strand, several policy oriented papers highlight the increased vulnerability of households because of their increased indebtedness and the negative implications of household debt (Barba & Pivetti 2009, Girouard et al. 2006 and Debelle 2004). A new set of macroeconomic models emphasises the role of credit frictions, where household indebtedness amplifies a recession; see Guerrieri & Iacoviello (2013) and Justiniano et al. (2013) among others.

Although several theoretical studies rely on the amplification effect of household debt to explain recent macroeconomic developments, there are only a few studies that use micro data to investigate the underlying assumptions. Dynan (2012) and Cooper (2012) use the US Panel Study of Income Dynamics (PSID) to analyse the role of household debt in the consumption contraction of households during the last recession. Brown et al. (2012) use the Life in Transition Survey from 2010 to investigate the impact of mortgages on the consumption cutback in European countries. Andersen et al. (2014)

[1] Cecchetti et al. (2011) have highlighted how the total non-financial debt in advanced economies has been rising markedly during the past three decades. Starting at a relatively modest 167 per cent of GDP three decades ago, total non-financial debt has reached 314 per cent of GDP, with the largest contribution to the rise coming from the debt of the household sector, which added 56 percentage points to the increase in the debt.

examine household leverage and consumption using Danish register data. Given the amount of discussion about the implications of household debt for the economy, there is a great need for microeconomic evidence on the behaviour of indebted households. The current paper addresses this research gap.

The paper contributes to the literature in several ways. First, it uses a unique database which contains quarterly information from 2004:Q4 to 2011:Q4 to investigate the role of household debt in consumption fluctuations. Alongside the financial data, the database includes inflows and outflows from the sight accounts of each individual and this information can be used to proxy income and consumption flows. The quarterly frequency of the data over seven years is a unique feature of this dataset as no such database has been used before for analysing consumption dynamics. The time period includes periods of rapid economic growth, a very deep recession and the subsequent recovery. On top of that, the number of indebted individuals in the database is over 100,000, which allows different sub-samples to be examined without precision being lost from the estimations.

Second, the paper examines the implications of indebtedness in a small open country, which experienced the largest increase in the household debt burden of any European country in 2000-2007 as the debt-to-disposable income ratio increased from 15 per cent in 2000 to 88 per cent in 2007, while credit tightening was prevalent from 2008 in Estonia.[2] Households in Estonia experienced very volatile income and consumption changes during the last business cycle.[3] Rapid developments in the credit markets and big swings in household income and consumption in Estonia make it possible to investigate the relationship between consumption, income and debt in different parts of the business cycle. Herzberg (2010) tentatively suggests that the decline in consumption in the Baltic countries was partly induced by the debt overhang, meaning that over-leveraged households cut back spending.

Third, the paper investigates the impact of different debt variables on consumption. The relationship between the debt-to-income ratio, the debt service ratio and consumption is less investigated in the literature than the relationship between the debt-to-assets ratio and consumption. All three ratios indicate different mechanisms for how indebtedness spills over into consumption. The results of the paper reveal that the debt-to-income ratio and the debt service ratio have different effects on consumption and that the debt service ratio identifies the channel by which indebtedness amplifies a recession.

The findings can also improve the understanding about the impact of household debt on consumption in other countries that had high rates of debt accumulation in the 2000s. The relationship between indebtedness and consumption growth is expected to be stronger in countries in which the development of financial systems was rapid during the period of economic growth as rapid debt accumulation discloses vulnerabilities. However, as there are only a few studies on the topic available, it will be difficult to

[2] Source: Eurostat database at http://ec.europa.eu/eurostat/data/database. (nasa_10_ki, Gross debt-to-income ratio of households).

[3] The following statistics illustrate the arguments. The average real gross wages increased annually by 13 per cent in 2007 and fell by 5 per cent in 2009. The unemployment rate in Estonia was one of the lowest in Europe at 4.6 per cent in 2007 but by 2010 it was one of the highest at 16.7 per cent. In 2005-2007 real consumption grew annually by 9-13 per cent, but in 2009 it plummeted by 15 per cent from its level of 2008. Source: Eurostat database at http://ec.europa.eu/eurostat/data/database. Further details from the author upon request.

draw any distinctions between different European countries. The current estimations serve as a starting point for further investigation of this topic.

The paper proceeds as follows: Section 2 provides a brief overview of the theoretical and empirical literature. Section 3 introduces the hypothesis and the models to be tested. Section 4 introduces the dataset and Section 5 delivers the main features of the variables. Section 6 provides the estimation results. Finally, Section 7 summarises the findings.

2. Literature on the role of household debt in a business cycle

There is a wide range of literature about the relationship between private debt and the business cycle; see Jordà et al. (2011) and the references therein. But there are only a few empirical studies that investigate the role of *household* debt in the business cycle. The seminal paper by King (1994) extends Fisher's debt-deflation theory of an amplification mechanism for the business cycle to the household sector. He relates the deep and long recession in the beginning of the 1990s to the increase in the debt burden during the 1980s. He supports the theory with empirical evidence from ten developed countries for the period 1984 to 1992 and shows that the slowest recoveries from the global recession in the early 1990s occurred in countries where households had accumulated substantial debt relative to their disposable income.

Similar conclusions have been drawn for the 2007-2009 recession by Glick & Lansing (2010) and Mian & Sufi (2010b), both of which use aggregate data. Glick & Lansing (2010) examine data from 16 advanced countries and find that the countries with the fastest increase in household credit had the deepest declines in real consumption during the recession. Mian & Sufi (2010b) investigate household leverage from 2002 to 2007 across US counties. They find that the counties with the largest increase in the debt-to-income ratio in 2002-2006 showed the largest declines in durable consumption, starting at the end of 2006. The recession began earlier and became more severe in counties with high debt growth than it did in those with low debt growth. These studies identify the negative role of household debt in a recession; however, disaggregated data are needed to provide an understanding of the reasons behind the relationship.

The use of micro level data for studying the implications of household debt for consumption during the last recession is rare. There is one study by Brown et al. (2012) that examines the impact of household debt on consumption in CEE countries, which typically experienced faster debt growth rates than other European countries during the pre-crisis period up to 2008. Brown et al. (2012) use the Life in Transition Survey from 2010. The dataset contains a categorical variable for households' consumption changes. They include in the model a binary variable depicting the presence of a mortgage and find that Eastern European households with mortgages cut back their consumption more than households without mortgages. They do not find such a pattern among Western European households. As the dataset is cross-sectional and includes limited information about liabilities and consumption, it does not fully reveal the behaviour of households.

There are two studies which focus on the relationship between household debt and consumption using the US Panel Survey of Income Dynamics (PSID). Cooper (2012) uses the survey from 1999-2009 and compares the different consumption responses to income changes of households with high debt growth and households with low debt

growth during the boom. He finds no difference in the consumption response of the two sub-samples. Conversely, Dynan (2012) uses two waves of the PSID survey, from 2007 and 2009, and finds that highly leveraged households with a high debt-to-asset ratio had weaker consumption during the last recession than less leveraged households had. As she finds that high debt also dampened consumption in 2005-2007, it is not clear whether the negative impact on consumption can be related to the recession.

A further study by Dynan and Edelberg (2013) discusses the possible reasons why high indebtedness might hold back consumption beyond the standard wealth effect. The standard wealth effect entails that consumption is positively affected by wealth increases; as debt is negative wealth, the negative relationship between debt and consumption may be induced by the conventional wealth effect. However, they describe several other ways in which leverage may restrain consumer spending, such as by increasing the current borrowing constraints or raising the probability that borrowing constraints will be faced in the future. As indebtedness is taken into account by credit providers when determining credit availability for indebted households, high indebtedness may lead to current or future credit constraints. It is easier to measure the current or actual credit constraints than to identify household's fear of potential credit constraints in the future as the latter is related to household's subjective perceptions. The fear of potential credit constraints is expected to make households cautious in their current consumption decisions.

Another linkage between indebtedness and consumption lies in precautionary motives. Indebtedness entails additional risks to households as they are more vulnerable to negative shocks. Households consider debt servicing to be part of compulsory expenses which they continue to pay under any circumstances (Eurobarometer 2014). Therefore, high leverage can make households uncomfortable and they may limit consumption for precautionary reasons. Brown et al. (2005) find that unsecured debt has a negative influence on psychological well-being while the qualitative Eurobarometer survey discloses that households experienced negative emotions such as fear about their inability to pay back their loans during the 2008-2009 crisis.

Dynan and Edelberg (2013) use rough proxies for a cut in consumption in the 2009 Survey of Consumer Finance (SCF) to explore the different hypotheses. They find that leverage affects consumption beyond its effect on access to credit. They suggest that high leverage may hinder consumption by increasing households' fears of not having access to credit in the future. However, the results may equally reveal that high leverage makes households uncomfortable, leading them to make conservative consumption decisions.

It has been acknowledged by Dynan (2012) and Dynan & Edelberg (2013) that the survey data have several limitations for investigating the relationship between indebtedness and consumption, such as the large amount of noise, which induces high standard errors that prevent clear conclusions being drawn. Additionally, the relatively long interval between the survey waves makes it difficult to answer questions about particular time periods. This suggests that administrative data should be a valuable source for further research. Baker (2014) uses panel financial data to investigate whether the sensitivity of consumption to income shocks is related to the level of indebtedness. He finds that highly indebted households respond more strongly to

income fluctuations, but he does not investigate the relationship between consumption growth and leverage per se.

Andersen et al. (2014) exploit yearly data from several Danish administrative registers from 2003 to 2011 and examine the relationship between household debt and consumption; as the registers do not contain data about consumption, non-housing consumption is imputed from the income and wealth data. They find a strong negative relationship between the pre-crisis loan-to-asset value ratio and a change in consumption during the 2008-2009 recession. As the negative relationship is evident in different socio-demographic, income and wealth groups, they discard the hypothesis that the relationship is induced by current or potential credit constraints. They argue that the increased uncertainty about future financial conditions in 2008 guided highly indebted households to hold back their consumption. However, the tentative conclusion needs further investigation.

This review asserts that there are a limited number of studies on the role of household debt in explaining consumption behaviour. The current study distinguishes between different debt variables to give additional insights into the channels through which household debt spills over into consumption. Households in CEE countries have experienced more severe drops in income and income expectations than households in other European countries, while facing drastic changes in credit conditions at the same time (Brown et al. 2012, Brixiova et al. 2010). This makes Estonia an excellent case for investigating the role of indebtedness in hampering household consumption. Additionally, investigation of the relationship between debt and consumption in different business cycle periods may shed more light on the role of household debt in amplifying a recession. The paper seeks to contribute to the literature by using a time period which covers both the boom and bust phases in the 2000s.

3. Methodology

The paper investigates how much the relative debt level (the debt-to-income ratio) and the relative debt burden (the debt service ratio) affect consumption growth. The debt-to-income ratio is a conventional measure of indebtedness indicating the ability to manage debt over the repayment period as debt is usually paid back from income. The debt service ratio is the ratio of regular interest and principal repayments to income, and measures the ongoing burden of the debt on households as servicing the debt directly affects the current funds available for spending and saving. The two ratios are related as the debt servicing ratio depends on the amount of debt that has been taken. However, two households with the same debt-to-income ratio may have very different debt service ratios if the maturity of the debt is different. An investigation of both variables can help identify the different mechanisms through which indebtedness works on consumption.

A standard consumption function relates changes in consumption to income innovations (Jappelli & Pistaferri 2010). As households borrow to allocate the use of future income, income expectations increase borrowing. If it is the case that the debt-to-income ratio indicates higher income expectations, a positive relationship between debt-to-income and consumption growth should be observed as consumption decisions take income expectations into account. However, this relationship has not been discussed in the studies which relate household debt to consumption, as a negative relationship has been found between indebtedness and consumption.

As explained in Section 2, indebtedness might relate to future potential credit constraints, meaning that households expect to have difficulties borrowing in order to finance future shocks. This implies that a negative relationship between the debt-to-income ratio and consumption growth should be observed. In Central and Eastern European (CEE) countries the borrowing constraint for households comes mainly from the debt repayment capacity, which is directly related to income, rather than from the value of collateral. This can be explained by the observation that housing equity withdrawal, whereby the home is used as collateral for borrowing for consumption, is more common in countries with advanced financial systems; see Mian & Sufi (2011) for evidence. So a high debt-to-income ratio may indicate a fear of potential credit constraints, as income is an important measure of credit availability.

The same channel may explain the relationship between the debt service ratio and consumption growth, as credit conditions are related to the concurrent ability to service the debt. However, as households are able to choose the duration of the loan which determines the debt service burden, perhaps by extending the repayment period of a loan to lower the debt servicing burden, income is more binding a constraint for future credit than debt repayments are. So if the effect of the fear of potential credit constraints is the main channel through which indebtedness is related to consumption, we would expect the debt-to-income ratio to show a stronger negative effect on consumption than the debt service ratio does.

There is another channel described in Section 2 which can explain the negative relationship between indebtedness and consumption. Highly indebted households should be more concerned about their financial situation than households without debt, because of their larger financial obligations. Larger obligations imply more conservative spending behaviour; this channel can be called the debt distress effect. More servicing of the debt adds an additional burden on households, so the debt distress effect is more explicitly related to the debt service ratio than to the debt-to-income ratio. If the debt distress effect prevails, we should expect it to be the debt service ratio that shows a negative effect on consumption rather than the debt-to-income ratio. An exploration of the two debt variables, the debt-to-income ratio and the debt service ratio, should shed more light on the channels the indebtedness operates through.

The second question is whether household indebtedness has a larger effect on consumption during a recession than at other times in the business cycle. Both of these channels, the concern about potential credit constraints and the distress from the debt burden, are subjective assessments by households and are apparently stronger during a recession. Households are more aware of credit constraints when credit conditions are tighter, so the effect of the fear of potential credit constraints should be different in 2005-2006 and in 2008-2009. Moreover, as households' overall assessment of their current and expected financial situation worsens during a recession, the debt distress is expected to be more prevalent during an economic downturn. This could mean that households might feel more stressed about their debt burden during a recession, leading to a stronger negative relationship between the debt service ratio and consumption growth, ceteris paribus. The strength of the negative relationship between consumption growth and the debt variables during a downturn compared to the relationship in other business cycle periods would indicate the degree of amplification of the recession.

The paper uses a standard consumption model in which consumption responds to unexpected income changes, see Jappelli & Pistaferri (2010) and Attanasio & Weber (2010).[4] Net wealth can be disentangled into liabilities and assets, and the balance of liabilities has been the main interest in the study of Dynan (2012), Cooper (2012) and Andersen et al. (2014). The liabilities are included in the model in a similar way to Dynan (2012) and Andersen et al. (2014), as lagged variables, assuming that the ex ante debt variables may be associated with consumption growth. The relationship between consumption growth and concurrent debt variables is not of interest because debt is used to finance consumption and the contemporaneous variables should capture the expected positive relationship. The focus of the current paper is on whether the previous debt level or the debt burden can be associated with subsequent consumption changes.

The literature exploring the role of debt in a recession at the aggregate level emphasises the implications of high levels of debt accumulation, suggesting that the change in debt matters rather than that in the level of debt. However, at the micro level the debt level is more informative than the changes in the debt, especially in CEE countries where the opportunities for borrowing emerged relatively recently. If the loan was taken for home purchase which was commonly the case, a sharp increase is observed in indebtedness at the moment of borrowing, which is followed by a slow decline induced by debt repayments at the individual level. In these circumstances a link could be found between the slow de-accumulation of debt and change in consumption but this would not help to explain the negative effect of indebtedness on household consumption behaviour. At the micro level the debt level contains more information about a household's decisions than the debt change does.

In addition to the lagged debt-to-income ratio and the lagged debt service ratio, the lagged asset-to-income ratio is included in the model to capture the effect of liquid financial wealth on consumption growth.[5] The following empirical specification of the consumption model incorporating household wealth components is used:

$$\Delta \log c_{it} = \beta \Delta \log y_{it} + \phi DtoI_{it-1} + \psi Dsr_{it-1} + Z'_{it-1}\alpha + \varepsilon_{it} \quad , \qquad (1)$$

where i is an individual person and t denotes time; $\Delta logc_{it}$ is the change in the log of real consumption and $\Delta log\ y_{it}$ is the change in log real income. The coefficient β denotes the sensitivity to income changes, which may also entail information about future income streams. The variable $DtoI_{it-1}$ denotes the lagged debt to income ratio of the previous period and the variable Dsr_{it-1} stands for the lagged debt service ratio of the previous

[4] The standard consumption model assumes that all the predicted changes in income are already taken into consideration when consumption decisions are made. Only unexpected changes in current income or new information about future income should affect consumption. However, current income changes contain new information about future income levels if income changes are relatively persistent, as shown in the study of the persistence of income shocks by Kukk et al. (2015). As the focus of the paper is on the relationship between consumption and balance sheet variables, income change is not decomposed into expected and unexpected income shocks. This simplification should not alter the results of the variables being observed.

[5] The ratios are used rather than gross volumes in order to keep the observations where the value of the variables is zero in the estimations. If the variables were in logs, which would be an alternative approach, these observations would be lost.

period. The coefficients ϕ and ψ depict the effect of the respective ratios on consumption changes. The vector of Z_{it-1} contains the other balance sheet components, such as the lagged asset-to-income ratio, and other control variables that may also affect consumption changes.

There are two issues related to the current consumption model. First, eq. (1) is not the complete consumption model as the model obviously does not include all the determinants of consumption change such as preferences and real wealth. These might potentially be correlated with income and debt related variables, hence the error term ε_{it} is expected to be correlated with the explanatory variables.

Second, there is a substantial number of households who do not own any debt, but it is only possible to estimate the coefficients ϕ and ψ in eq. (1) for indebted households. Debt ownership is affected among other things by the attitude towards debt or the willingness to borrow, as discussed by Chien & Devaney (2001). It is reasonable to assume that unobserved characteristics which affect debt ownership may also affect the consumption change of households. For example, if indebted households are more eager to change their consumption because of preferences which are not observed, the debt variable would pick up this effect and the estimated ϕ and/or ψ will be biased. In this case selection bias needs to be taken into account.

With a panel dataset, a fixed effects model directs both the endogeneity problem and the selection bias and therefore a fixed effects model is used:

$$\Delta \log c_{it} = \beta \Delta \log y_{it} + \phi DtoI_{it-1} + \psi Dsr_{it-1} + Z'_{it-1}\alpha + u_i + \tau_t + \varepsilon_{it} \quad . \tag{2}$$

In eq. (2) the term u_i is the individual fixed effects and the term τ_t the time fixed effects. The individual fixed effects partial out the effect of time-invariant omitted variables such as preferences. The time fixed effects are included to control for time-varying heterogeneity that may stem from omitted common variables or global shocks such as wealth changes induced by aggregate real estate price movements. The current model specification does not control for the endogeneity induced by the effect of the dependent variable on the explanatory variables, such as the wish to increase consumption, which may lead to additional borrowing and an increase in indebtedness. However, as *lagged* explanatory variables are used rather than contemporaneous ones, this particular source of endogeneity is removed.

The main focus of the paper is on household debt, and the coefficients ϕ and ψ show the extent to which the lagged debt variables are associated with consumption growth. If indebtedness dampens consumption growth, the estimated coefficients ϕ and/or ψ should be negative, as households which are indebted at a higher level constrain their consumption growth more than the same households with a low debt level would, ceteris paribus. The current model does not relate the effect of indebtedness to any other variable which determines the consumption change but estimates the impact of indebtedness on consumption growth per se.[6]

[6] Although the consumption sensitivity to income changes is an important research question and the topic has been investigated by Baker (2014), this analysis has been disregarded to keep the focus of the paper.

The debt-to-income ratio may be high because the debt volume is high or because income is low. It is not relevant to distinguish the role of the two components as the *relative* debt level is important when individuals assess their capacity to repay their debt, as the debt is usually repaid from income. The debt ratio can increase either because the debt is increasing in size or because income is decreasing. The same applies to the debt service ratio.

The current model specification does not rule out the possibility that the high debt level or high debt service ratio will affect not only the consumption change but also the other choices of a household such as the labour supply, which would affect the income change. In this case the income change and the debt variables in eq. (2) are correlated and the estimated coefficients ϕ and ψ show only the direct effect of the indebtedness on the consumption change, not taking into account the indirect effect via the income change. The relationship between indebtedness and the labour supply is beyond the scope of this paper.

The parameters ϕ and ψ in eq. (2) can be estimated for different time periods in order to examine the stability of the estimated coefficients. If indebtedness amplifies the recession, the relationship between the lagged debt-to-income ratio or the lagged debt service ratio and consumption change should be different in the period of economic growth and in the recession. More precisely, the amplification effect implies that the negative coefficient ϕ or ψ is lower during the recession (larger in numerical terms) than when the economy is growing. Previous papers in the area do not investigate the dynamics of the impact of indebtedness on consumption over the business cycle. Therefore the following model is also estimated:

$$\Delta \log c_{it} = \beta_t \Delta \log y_{it} + \phi_t DtoI_{it-1} + \psi_t Dsr_{it-1} + Z'_{it-1}\alpha_t + u_i + \tau_t + \varepsilon_{it}, \qquad (3)$$

where the estimated coefficients β_t, ϕ_t, ψ_t and the vector of the estimated coefficients α_t may vary across time periods. In addition to the assumption of time-varying coefficients of ϕ or ψ, it is reasonable to relax the assumption of the constant parameter of β and the vector of constant parameters of α. The sensitivity of consumption to an income change depends on the persistence of the income change, which might vary over the business cycle. Additionally, the effect of assets and repayment problems is allowed to vary. The paper does not focus on the changes in these coefficients, but a relaxation of the assumption about constant coefficients is needed to avoid the estimated coefficients ϕ and ψ picking up the effect of other time-varying coefficients if these are constrained to be constant.

4. The dataset

The paper uses a unique anonymised client database from a financial institution. The database contains quarterly information about individuals who were regular clients of the financial institution from 2004:Q4 to 2011:Q4.[7] The panel structure of the database makes it possible to follow the changes in the behaviour of the same individual over a

[7] Regular bank clients are the clients who have regular inflows to and outflows from their sight accounts.

sequence of time periods. It is therefore possible to compare the effect of debt on consumption over the business cycle.

Although the database contains information from only one financial institution and does not cover all the financial information about an individual, this is not considered to be a major concern. In Estonia there is very high financial inclusion of individuals, as over 90 per cent of individuals own an account at a formal financial institution while over 80 per cent own a card, and these shares are among the highest in Europe (Demirguc-Kunt & Klapper 2012, Beck & Brown 2011). On top of that, the financial sector is very concentrated in Estonia and most individuals make all their financial transactions in one financial institution. The main limitation of the dataset is that it contains information at the individual level while consumption behaviour is conventionally analysed at the household level. A household may have a joint bank account but in most cases the income and expenditure of a household are split between the bank accounts of household members. As the database does not allow household members to be matched, some additional robustness tests are warranted.

An important feature of the dataset is the information about quarterly inflows from legal entities (companies or other institutions) and outflows from the sight accounts of an individual. As mentioned earlier, a majority of the financial transactions of individuals are made through sight accounts, and payments from legal entities can be interpreted as earnings. Alternatively, the total inflow to a sight account could be considered as earnings but this variable is considered to be endogenous as each individual can determine the payments to the sight account which are not made by legal entities. These payments are mainly payments from savings or sight accounts at other financial institutions or transactions between spouses and relatives. Therefore the inflow from legal entities is used, which contains such income sources as salaries, benefits, dividend payments and self-employment activities. The proxy excludes other official or unofficial income. Similarly, as shown by Kukk & Staehr (2014) the survey data contains gaps in the reported income.

The outflows from the sight account exclude payments to savings or other accounts held by an individual that reflect saving decisions. The outflows also exclude payments to the commercial bank that mainly consist of interest and principal payments on the debts. When these transactions are excluded, the rest of the outflows from the sight account can be interpreted as spending. The outflow from the sight account can take the form of payments, transactions or cash withdrawals. There is still some measurement error for the spending variable as the outflows from the sight account do not include imputed rent and the spending on housing is therefore lower for a homeowner than for a renter. As the paper focuses on *changes* in inflows and outflows, the differences in levels do not affect the changes in spending as long as the tenure status does not change during the period, or if it is controlled for by tracking of homeownership. Additionally, the outflows from the sight accounts contain real estate purchases as it is not possible to distinguish the purpose of the payments from the sight accounts. However, it is possible to control for real estate purchases if these are made using a loan. The dynamics of mean inflows and outflows from the sight account are compared to the aggregate statistics in the next section. In order to control for seasonal fluctuations and make the variables comparable to standard measures for households, yearly income values are computed.

Yearly income is the sum of inflows from legal institutions to a sight account in the current quarter and the three preceding quarters. The outflow from the sight account (excluding payments to saving accounts) in the current quarter and the three preceding quarters is used as a proxy for yearly consumption. The yearly consumption and income variables are computed for each quarter.The database contains information on the stock of total financial liabilities of the individual, which comprises the balance of housing loans, consumer loans, overdrafts and revolving credit cards at the end of each quarter. The database includes a flag for any new or any additional housing loan in each quarter. As noted, this is needed to control for outflows from the sight account for purposes other than consumption and for changes in homeownership.

The two variables of indebtedness that are used in the paper are the debt-to-income ratio and the debt service ratio. The first ratio is computed by dividing the stock of debt at the end of the period by the income from legal entities for the preceding year (four quarters). Yearly income is used instead of quarterly income to offset seasonal changes of income, which would lead to seasonal volatility of the ratio as the debt stock is relatively stable across a year. The second variable related to debt, the debt service ratio, is computed as debt payments in the current and three previous quarters divided by the income of the same quarters. The yearly ratio is computed to offset the short-term fluctuations of income. The nominal variables of consumption and income are deflated by the HICP consumer price index and the real variables are expressed in 2005 prices; the variables are expressed in logarithms. The notation of the main variables in the model is given in Table 1. The panel summary statistics of the main variables are given in Appendix A in Table A.1.

Table 1. Description of the main variables in the dataset

Variable	Definition
$\log y_{it}$	Logarithm of real yearly inflow from legal entities to sight accounts of individual *i* in quarter *t*, in EUR in 2005 prices
$\log c_{it}$	Logarithm of real yearly outflows from sight accounts of individual i in quarter t, excluding transactions between saving and investment accounts, in EUR in 2005 prices
$DtoI_{it}$	Debt-to-yearly income ratio; debt stock is measured at the end of quarter t and income is the sum of the income of the four previous quarters
Dsr_{it}	Ratio of annual debt service payments to annual income in quarter t

The dataset contains a variable depicting the stock of financial assets including deposits, funds, bonds and shares at the end of each quarter. It is possible to control for the differences in consumption changes between individuals with different financial assets. The dataset lacks information on the real estate of the individual, but it has been argued by Buiter (2010) that changes in home values do not change the wealth of households and it is posited by Attanasio et al. (2009) that the wealth effect on consumption may

actually capture the effect of common underlying factors which are controlled for by the time fixed effects in the model.

The dataset contains information about the ownership of different saving products such as pension insurance and life insurance that imply regular outflows of savings from sight accounts. These variables are used to control for the outflow from the sight account to the saving products. The dataset includes some demographic variables such as age and gender, and these are used for robustness checks across different sub-samples. The main description and statistics of the additional control variables is given in Table B.1 in Appendix B.

There are in total 2,597,000 observations in the pooled dataset across 29 quarters from 2004:Q4 to 2011:Q4 for 108,000 individuals or around 12 per cent of the working-age population of Estonia. The initial filtering of the total client database has been done by the financial institution, excluding all individuals below the age of 20 in 2011:Q4 and above the age of 70 in 2004:Q4. In order to avoid double banking relationships, the financial institution has excluded all private clients for whom the financial institution is not identified as the main bank for the whole time period of 2004-2011.

Some additional exclusions from the dataset have been applied, such as the exclusion of all individuals who could be identified as farmers, self-employed, entrepreneurs or family doctors as there is evidence that these groups use their private accounts for business purposes. Additionally, the individuals for whom any of the quarterly inflows or outflows of the sight account fall in the upper 99th or 100th percentiles have been excluded. Individuals whose transactions of securities (funds, bonds and shares) fall into the 1st, 2nd, 99th or 100th percentiles were also excluded; extraordinarily large transactions from sight accounts have a higher probability of denoting a transaction atypical of the income or expenses of an individual. Observations with other abnormalities such as negative values for any original variable, or with a debt-to-income ratio or debt service ratio in the 99th or 100th percentile were also excluded.

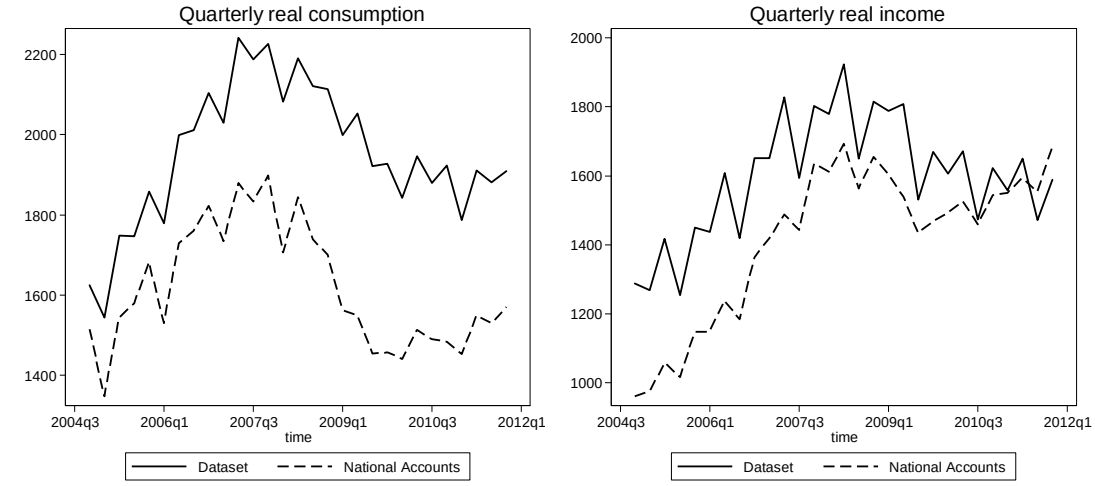
5. Description of the variables and data validation

Although the dataset covers about 12 per cent of the working age population, which is far more individuals than any household survey, additional robustness analysis has been done to validate the representativeness of the data. The summary statistics for the main variables are given in Table A.2 in Appendix A. As the consumption in the dataset is proxied by outflows from the sight account, the variable is compared to the household aggregate per capita consumption.[8] The dynamics for the mean real spending of an individual in the dataset and per capita consumption of the household sector from the National Accounts from 2004:Q4 to 2011:Q4 are presented on the left-hand graph in Figure 1.

The dynamics of the two variables are very similar, and the only difference is that the mean consumption in the dataset is somewhat larger than per capita consumption from the National Accounts. There may be several reasons for this difference. First, the

[8] Total final consumption of the household sector from the National Accounts is divided by the total population. All the aggregate statistics in Section 5 are taken from Statistics Estonia http://www.stat.ee/database and the Bank of Estonia http://www.eestipank.ee/en/statistics. Further details are available from the author upon request.

dataset does not contain individuals younger than 20 or older than 70, and these population groups exhibit lower average consumption than the population group between 20 and 70. Second, the average income in the sample might be higher than the average income in the population as the population group which does not use the services of financial institutions is usually the low-income group. And third, the proxy for consumption in the dataset contains real estate purchases as it is not possible to identify the outflows from the sight account for this particular purpose. However, as mentioned in Section 3, it is possible to control for the real estate purchases with a housing loan in the model.



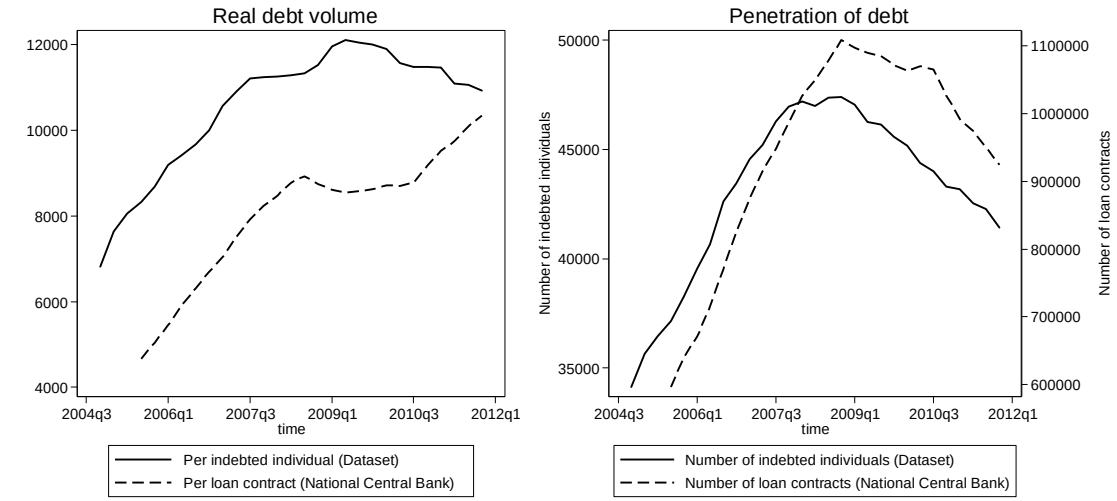
Notes: The variables are expressed in EUR in 2005 prices

Figure 1. The dynamics of quarterly consumption and income from 2004:Q4 to 2011:Q4.

The comparison of the quarterly dynamics of the income variable in the dataset and in the National Accounts is given on the right-hand graph in Figure 1. The income is proxied by the mean of inflows to the sight account in the dataset and per capita disposable income of the household sector is used from the National Accounts. The average income according to the dataset is somewhat higher than the aggregate per capita disposable income. One reason for this is that the sample is drawn from the working age population, which earns a higher income than other population groups like the retired population. Additionally, the mean income in the dataset shows stronger seasonality than the average aggregate income. Again, the reason might be related to stronger seasonality in the earnings of the working age population compared to the earnings of the retired population. Nevertheless, the dynamics of the two income variables are very similar and the evolution of the variables differs only in 2011. The upshot of the analysis is that the dynamics of average consumption and income variables are very similar in the dataset and in the aggregate statistics, suggesting that the dataset reflects the economic situation of households relatively well.

Next, the dynamics of real debt volumes and the penetration of debt are compared to the aggregate statistics from Eesti Pank, the central bank of Estonia. Currently no survey data on financial assets and liabilities are available in Estonia and therefore aggregate

statistics on household debt volumes and loan contracts have to be used for comparison. The left-hand graph in Figure 2 gives the evolution of the mean value of the total real debt balance of an indebted individual in the dataset from 2004:Q4 to 2011:Q4. It is compared to the average real value of the loan contract. As an individual may hold more than one loan contract, the average debt balance of an individual is higher than the average value of a loan contract. The average debt balance increased rapidly during 2007-2008 and peaked in 2009:Q2 but then started to decrease. Housing loans contribute most to the total loan volumes in Estonia, and 80 per cent of the total loan volume was in housing loans at the end of 2004 according to the statistics of Eesti Pank, a share that had increased to 83 per cent by the end of 2011.



Notes: The real debt volumes are expressed in EUR in 2005 prices

Figure 2. The dynamics of mean and median loan volumes for total debt and the number of individuals with debt from 2004:Q4 to 2011:Q4

The right-hand graph in Figure 2 presents the number of individuals who own any type of debt, whether as housing loans, consumer debt, or the balance on credit cards or overdrafts. The number of indebted households increased very fast during 2004-2007, after which there was a decline between 2008 and 2011. The number of loan contracts shown in data from Eesti Pank shows very similar dynamics. The decline in indebted households can be explained by a substantial drop in households' demand for credit during the recession, as found by Meriküll (2015). At the end of 2011, about 40 per cent of households in the sample were indebted, indicating that the behaviour of indebted households would have a major impact on the aggregate behaviour of the household sector.

Additionally, the quarterly dynamics of the debt-to-income ratio are presented in Figure 3 and the quarterly statistics are given in Table A.2 in Appendix A. On the left-hand graph in Figure 3 the debt-to-income from the National Accounts and the dataset are compared. As the debt-to-income ratio is computed for the total population or total sample, it does not take into account the changes in the penetration of debt as seen on the right-hand graph in Figure 2. According to the National Accounts, debt-to-disposable income increased more during the period than the average debt-to-income

ratio in the dataset. The differences can be explained by the higher average income in the sample than in the total population. However, the differences suggest that additional robustness tests need to be done for different income groups to understand the implications of the differences between the aggregate and sample statistics.

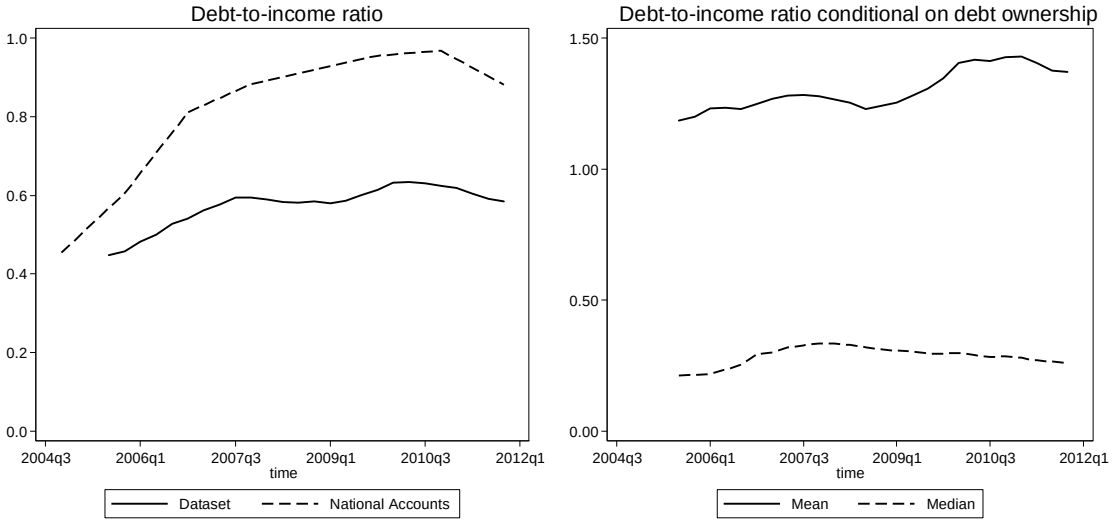


Figure 3. The dynamics of the debt-to-income ratio 2005:Q3-2011:Q4

The right-hand graph in Figure 3 presents the debt-to-income ratio in the dataset when conditioned on debt ownership. This variable reflects the actual indebtedness of individuals taking into account the penetration of debt. This statistic is not available from the aggregate statistics, so the sample statistics are analysed. The mean debt-to-income ratio was relatively stable during the period of economic growth, increasing slightly from 1.18 in 2005:Q3 to 1.28 in 2007:Q3 due to the rise in the debt volumes, and falling slightly to 1.23 by 2008:Q3. A substantial increase in the debt-to-income ratio occurred from 2008:Q3 to 2010:Q2 when the ratio reached 1.42. The increase was mainly induced by the decline in household income, while the mean debt volume was relatively stable (see Figure 1 and Figure 2). Since the beginning of 2011 the debt-to-income ratio has decreased slightly.

Figure 4 presents the dynamics of the debt service ratio while the quarterly statistics are provided in Table A.2 in Appendix A. There are no public statistics about the debt service ratio, neither from any survey nor from aggregate statistics. It is apparent that the debt service ratio of *individuals* found here is higher than the actual debt service ratio of *households* as the debt is usually serviced from one current account which belongs to one household member. However, when the *relativ*e burden across segments and the *changes* in the burden over the business cycle are compared, the differences between individuals and households are expected to be less pronounced. The evolution of the debt burden is expected to be relatively accurate given that the income and debt variables follow the dynamics of the aggregate statistics.

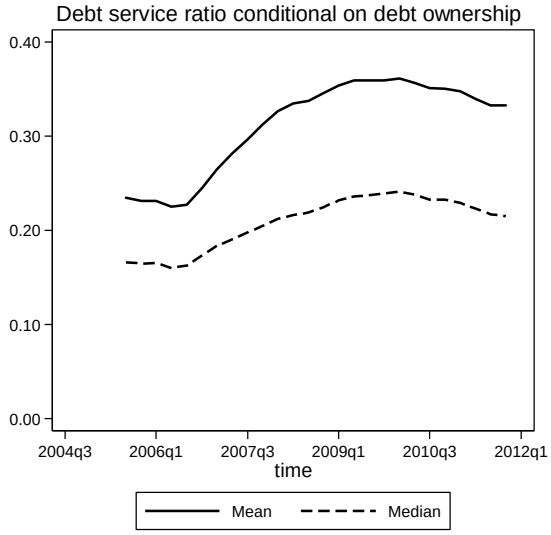


Figure 4. The dynamics of the mean and median debt service ratios 2005:Q3-2011:Q4

The debt service ratio shows larger changes than the debt-to-income ratio does during the sample period. The mean debt service ratio increased from 0.23 in the middle of 2006 to 0.33 in the middle of 2008. The following period showed a modest increase in the ratio to 0.36 by 2010:Q1 and a slight decrease since then. Hence, the debt payment burden of individuals increased even more rapidly when the economy was growing than it did during the recession, and the reason behind the change in the ratio varies over the period. The increase during the period of economic growth was induced by the increases in average debt volumes as given in Figure 2. The increase during the recession was caused by the decline in income as shown in Figure 1.

6. The estimations

6.1. The empirical model

Due to the special features of the database, some adjustment is needed to eq. (2). As shown in Figure 1, there are substantial seasonal fluctuations in the quarterly data for consumption and income, and therefore the income and consumption variables for each quarter are computed on a rolling basis where four previous quarters are added together, as explained in Section 4. In order to estimate the yearly change in consumption for two consecutive years, the difference in log consumption between quarters *t* and *t*-4, $\Delta_4 \log c_{it} = \log c_{it} - \log c_{it-4}$, has been used. The yearly change in income is expressed as the difference in log income between *t* and *t*-4: $\Delta_4 \log y_{it} = \log y_{it} - \log y_{it-4}$. The debt variables are lagged by four quarters, D_{it-4} and Dsr_{it-4}.

The following equation, an extended version of eq. (2), was estimated:

$$\Delta_4 \log c_{it} = \beta \Delta_4 \log y_{it} + \phi DtoI_{it-4} + \psi Dsr_{it-4} + Z'_{it-4}\alpha + X'_{it}\gamma + u_i + \tau_t + \varepsilon_{it}. \quad (4)$$

The vector *Z'* contains wealth-related and debt-related variables which might affect consumption growth, such as the lagged ratio of financial assets to income and a lagged dummy for debt repayment problems. The vector *X'* contains other control variables, which are needed because consumption is a proxy for the outflows from the sight account. A brief description of the control variables required follows.

First, outflows from sight accounts include transfers to saving products offered by other financial institutions. These outflows should not be considered as expenditure but as saving. Transfers to investment and savings accounts in the same financial institution have ex ante been deducted from the outflow of sight accounts. It is also possible to control for regular saving in the insurance products of the financial institution by including a dummy for acquiring a life insurance or a pension insurance product.

Second, the servicing of a housing loan used for home purchase should not be counted as consumption, even though these funds are an outflow from the sight account. So when the outflow from the sight account for a period when a housing loan was taken is compared to the outflow for the following period, a significant decrease in the outflow from the sight account should be observable. On top of that, there might be an additional effect from the housing loan when the individual changes tenure status from renter to homeowner as rent payments are replaced by debt payments. Rent payments are reported as outflows from the sight account while debt payments are not. This might lead to estimated negative coefficients ϕ and ψ even if housing costs remain the same and rent payments equal debt payments while the consumption of other goods is kept the same. Therefore any new or additional housing loan that would alter the results should be taken into account. Initial estimations showed that a new or additional housing loan increases the outflow from the current account in the same and the following quarters. For this reason, dummies for new or additional debt are added for the time periods between t and t-8. The full list of control variables is given in Table B.1 in Appendix B.

The fixed effects model assumes stationarity of the variables as the use of a fixed effects model with a non-stationary series of variables would lead to spurious regression. Most unit root tests assume an asymptotic time property and without a sufficiently long time period the unit root tests are weak. The unit root tests of Harris & Tsavalis (1999) and Im, Pesaran & Shin (2003) can be used for samples with a fixed time period and an asymptotic sample size, which are the features of the dataset used in this study. The Harris-Tsavalis test assumes that all panels share the same autoregressive parameter while the Im-Pesaran-Shin test relaxes the assumption of a common autoregressive parameter. The Harris-Tsavalis test requires a strongly balanced dataset, while the Im-Pesaran-Shin test does not require a balanced dataset, though there cannot be gaps within a panel. Therefore both tests can be implemented only for data series which do not contain missing observations. Both unit root tests take cross-sectional dependence into account.

Empirical studies using aggregate data typically find a unit root and co-integration for household log real consumption and log real income, but I(0) for the variables in differences; see Morley (2007) and the references therein or Aben et al. (2012) for the Estonian aggregate data series. Additionally, empirical evidence suggests that the data series of aggregate household debt and assets may be non-stationary; see Bassanetti & Zollino (2010) and Martinez-Carrascal & Rio (2004). Therefore the unit root tests were

implemented for income, consumption and all wealth-related ratios. The results of the Harris-Tsavalis and Im-Pesaran-Shin tests are given in Table B.2 in Appendix B. Both unit root tests reject the hypothesis that log income change and log consumption change, or the debt-to-income ratio, the debt service ratio and the asset ratio, contain a unit root. The unit root test results are consistent with the results of other studies and the tests suggest that the current model specification in eq. (3) can be estimated by fixed effects.

6.2. Estimations for the full sample period

The main interest of the paper is the coefficients ϕ and ψ, which express the impact of the *previous* debt-to-income ratio and debt service ratio respectively on *current* consumption decisions. The coefficients are expected to be negative under the hypothesis of the negative impact of debt on consumption as discussed in Section 3. The estimations cover the period from 2006:Q4 to 2011:Q4.[9]

The results of the baseline estimations of eq. (4) for the full period using two different debt variables are given in Table 2. The estimated coefficients of the main variables are given in the table while the results for the full model with the control variables are given in Appendix B Table B.3.

The estimations reveal that the hypothesis about the negative impact of debt consumption is confirmed. Table 2 column (1) shows that the coefficient for the lagged debt-to-income ratio ($DtoI_{it-4}$) is -0.048, implying that the average debt-to-income ratio of 1.3 in the sample is associated with a yearly consumption decline of 6.1 per cent. Figure 3 shows that between 2008:Q3 and 2010:Q2 the debt-to-income ratio increased by 0.2 points in the sample, suggesting that during this period the negative effect on yearly consumption change was slightly stronger than it was before 2008.

When eq. (4) is estimated with the lagged debt service ratio, Dsr_{it-4}, the results are quite similar. Table 3 column (2) shows the coefficient for the lagged debt service ratio to be -0.18, implying that the average debt service ratio of 0.31 in the sample is associated with a yearly consumption drop of 5.6 per cent. As the debt service ratio increased between 2006:Q3 and 2010:Q1 by 0.13 points, the suppression of consumption was presumably stronger in 2009 than in 2006.

The third set of estimations includes both the lagged debt-to-income ratio and the lagged debt service ratio in one model to see whether they capture the same effect of indebtedness or whether there are different mechanisms at work as pointed out in Section 3. Table 2 column (3) gives the results for the model with two debt variables. The estimated coefficient of the lagged debt-to-income ratio is -0.037 and the coefficient of the lagged debt service ratio is -0.14. Both variables remain statistically significant, though slightly smaller than in columns (1) and (2), which indicates that the debt variables capture the same mechanism to some extent but both variables carry additional information, When taking into account the average values of the variables, which are given in Table A.1 in Appendix A, the estimations suggest that the debt-to-

[9] Although the database starts from 2004:Q4, the yearly income and yearly consumption variables set the earliest starting time at 2005:Q3. The inclusion of *t*-8 lagged control variables means that the first time period in the estimations is 2006:Q4.

income ratio can be associated with a drop in yearly consumption of 4.8 per cent and the debt service ratio can be associated with a decline in yearly consumption of 4.3 per cent.

Table 2. Coefficient estimates for the full sample period from 2006:Q4 to 2011:Q4

	(1)	(2)	(3)
$\Delta_4 \log y_t$	0.5460***	0.5447***	0.5491***
	(0.0035)	(0.0035)	(0.0035)
$DtoI_{it-4}$	-0.0478***	..	-0.0367***
	(0.0016)		(0.0016)
Dsr_{it-4}	..	-0.1792***	-0.1397***
		(0.0038)	(0.0040)
Other control variables	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
R^2	0.2803	0.2804	0.2819
No. of groups	102 968	102 968	102 968
No. of obs.	1 733 332	1 733 332	1 733 332

Notes: FE estimation of eq. (4). Control variables and time dummies are included in the estimations but not shown in the table. Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

Table B.3 columns (1)-(3) in Appendix B provide the estimation results of Table 2 for all variables including the control variables. Column (4) and column (5) in Table B.3 in Appendix B show the estimations without time fixed effects and without individual effects respectively. The exclusion of time fixed effects alters the estimated coefficient for the debt service ratio, indicating that this variable would pick up negative aggregate shocks when time dummies are not included. When individual heterogeneity is not taken into account, both debt variables are upward biased, meaning the coefficients are less negative, which is consistent with the theoretical assumptions as modelled by Eggertson & Krugman (2012). These are that if borrowing households are less patient than households who do not borrow, the cross-sectional variation will show a smaller negative relationship between consumption growth and indebtedness.

If indebtedness leads to debt repayment problems, individuals will dampen their consumption to improve their financial situation. The current estimations do not pick up the effect of debt repayment problems as the dummy for debt repayment problems is included in eq. (4). The estimated coefficient is provided in Appendix B Table B.3; the dummy is negative and significant. Additionally, the effect of liquidity constraints is controlled for by the inclusion of the lagged financial asset to income ratio in the model. As expected, the estimated coefficient of the financial asset to income ratio is positive (see Appendix B Table B.3).

Appendix B Table B.4 provides additional robustness tests by excluding the other control variables one by one, which are financial assets (column (2)), a dummy for debt repayment problems (column (3)), dummies for saving products (column (4)), and dummies for a new or additional housing loan (column (5)). The estimations of the debt-to-income and debt service variables are somewhat affected by the exclusion of the housing loan dummies, while the estimated coefficients are robust to the exclusion of the other variables. The overall result of the robustness estimations is that the results are robust to different model specifications.

The upshot is that indebtedness is negatively associated with changes in household consumption; households lower their consumption when their debt levels increase. The estimations confirm the hypothesis that debt has a negative effect on consumption and are consistent with other studies; see Andersen et al. (2014), Dynan (2012), and Brown et al. (2012). Only Dynan (2012) includes the debt service ratio in the model, showing that both leverage (the debt-to-asset ratio) and the debt service ratio are negatively related to consumption growth in the period 2007-2009.

The estimations confirm that both debt-to-income and the debt service ratio are important for the consumption decisions of households, so both the relative indebtedness and the current debt burden matter. If there are two individuals with the same debt-to-income ratio, the one who has higher debt repayments because the maturity of the loan is shorter or the interest rate is higher will suppress consumption more than the individual with low debt payments.

6.3. Quarterly estimations

The estimations for the full period do not give any clear picture about the possible mechanism through which indebtedness constrains consumption, they only suggest that there are different mechanisms at work as different debt variables are significant in the model. However, as the effects of the debt-to-income ratio and the debt service ratio on consumption change exhibit similar magnitude, it is not obvious which mechanism is at work. Having different estimations for the period of economic growth and for the recession would shed more light on the mechanisms. If consumption is similarly dampened during the period of economic growth and the recession, then the indebtedness would not amplify the recession. The amplification effect of debt implies that the negative effect on consumption is stronger during an economic downturn than during the other parts of the business cycle. The effect of the fear of potential credit constraints should be stronger during a recession when credit conditions tighten. Similarly, the debt distress effect might be stronger during a recession following the overall sentiment of households.

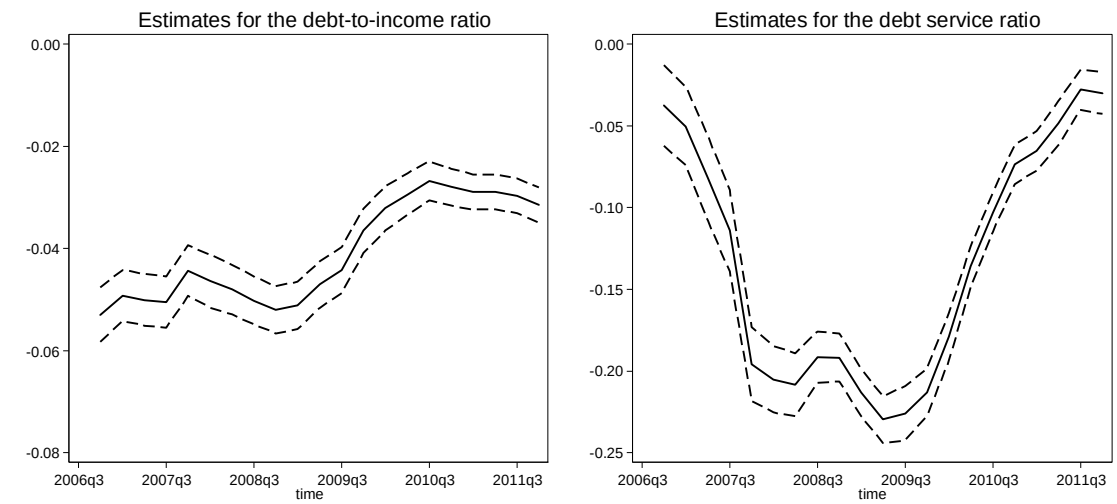
It is usually difficult to assess the change in the effect as frequent data for a long time period are needed. Andersen et al. (2014) use yearly panel data and estimate the model for different time slots, with the initial time fixed at 2007, meaning the relationships between the leverage in 2007 and the consumption changes in 2007-2008, 2007-2009, 2007-2010 and 2007-2011 are estimated. The estimations provide a cumulative effect and the estimated negative parameter for leverage doubles from 2008 to 2010 but remains the same in 2011. Rolling estimations for each time period would provide additional information about the change in the effect of debt on consumption growth.

The dataset used here contains so many quarterly observations that it is possible to estimate the coefficients ϕ and ψ for each quarter separately.

The model including both the debt-to-income ratio and the debt service ratio is preferred, otherwise one variable may capture the effect of the omitted variable as shown in Table 2, and this would make the interpretation of the results more difficult. The model does not suffer from multicollinearity problems as the correlation between the two debt variables is modest at 0.48 and the number of observations is very large.

The following extended model of eq. (3) was estimated:

$$\Delta_4 \log c_{it} = \beta_t \, \Delta_4 \log y_{it} + \phi_t \, DtoI_{it-4} + \psi_t \, Dsr_{it-4} + Z_{it-4}\alpha_t + X'_{it}\gamma + u_i + \tau_t + \varepsilon_{it} . \qquad (5)$$



Notes: The solid line is the coefficient estimator and dashed lines give the 95 percent confidence interval for the estimator

Figure 5. The estimated quarterly coefficients of the lagged debt-to-income ratio and the lagged debt service ratio of eq. (5) for each quarter from 2006:Q4 to 2011:Q4.

In this model the coefficient ϕ_t denotes the impact of the lagged debt-to-income ratio on consumption change and the coefficient ψ_t denotes the impact of the lagged debt service ratio on consumption change in quarter t. It is not only the coefficients for debt variables that are allowed to vary quarterly but all other coefficients are too. All other control variables and time fixed effects in eq. (3) are included in the model. The estimated quarterly coefficients for the lagged debt-to-income ratio and for the lagged debt service ratio are given in Appendix C Table C.1. The dynamics of the estimated quarterly coefficients are captured in Figure 5, where the quarterly point estimates are presented together with the 95 per cent confidence intervals.

Although the estimations for the full period given in Table 2 indicate quite a similar magnitude for the effects of the lagged debt-to-income ratio and the lagged debt service ratio on consumption growth, the quarterly estimations reveal differences. The negative relationship between the lagged debt-to-income ratio and consumption change

fluctuates around -0.05 in 2006-2008 and decreases afterwards. The point estimate is -0.053 for 2006:Q4 and -0.052 for 2008:Q4, indicating that individuals with a 0.1 point higher debt-to-income ratio suppressed their yearly consumption by 0.5 per cent. In 2009 the negative relationship starts to weaken and the point estimate is -0.028 in 2010:Q4, even though the debt-to-income ratio increased slightly between 2008:Q3 and 2010:Q2.

The results suggest that the negative effect of the debt-to-income ratio on consumption does not follow the business cycle. Figure 3 showed that the average debt-to-income ratio increased most during 2009 and in 2009:Q4 an individual needed on average 134 per cent of their yearly income to cover their total debt, compared to 124 per cent of yearly income in 2008:Q4. Nevertheless, the estimated effect of the debt-to-income ratio decreases during the same period from -0.05 to -0.03, meaning that the negative effect on consumption weakens. This is consistent with the study by Dynan (2012), which shows that the negative relationship between leverage and consumption growth is stronger for 2005-2007 than for 2007-2009, although high standard errors make the estimates for 2005-2007 insignificant. Evidently it is important to compare the estimated coefficients for the recession period with the coefficients for the period of economic growth, otherwise the negative relationship between the debt-to-income ratio and consumption change during a recession might be interpreted as a phenomenon exclusive to a recession. The current estimations suggest that the debt-to-income ratio is holding back consumption growth but the effect appears not to be related to movements in the business cycle.

The relationship between the lagged debt service ratio and consumption change shows more variation over the business cycle. The coefficient is estimated to be quite modest at -0.038 in 2006:Q4. Given that the average debt service ratio is 0.25 in the same period, a yearly decline in consumption of only 1 per cent can be associated with the debt service ratio during this period. In 2007 the estimated coefficient reaches -0.20 by 2007:Q4, meaning that the negative relationship between the debt service ratio and consumption change strengthens. The peak is in 2009:Q2 when the point estimate for the lagged debt service ratio is estimated to be -0.23. The negative relationship started to weaken in 2010 and the point estimate of the lagged debt service ratio reached the modest level of -0.03 by 2011:Q4. The findings are similar to those of Dynan (2012), who estimates the coefficient for the debt service ratio to be negative in 2007-2009, meaning that debt obligations crowd out consumption in this period. However, the estimated coefficient in Dynan (2012) is close to zero in 2005-2007, implying no effect on consumption growth in this period.

There is clear evidence that the estimated coefficient for the debt-to-income ratio is relatively stable over the whole business cycle while the debt service ratio varies. The results suggest that the two debt variables do indeed reveal different channels through which household debt spills over into consumption. Apparently, the amplification effect is not induced by the effect of the fear of potential credit constraints as the estimated coefficient of the debt-to-income ratio does not follow the business cycle. The findings are consistent with the study of Meriküll (2015) which shows that it was credit demand that cut borrowing down during the recession rather than credit supply, suggesting that the fear of potential credit constraints in the future is not driving consumption decisions.

The results entail that the debt service ratio constrains consumption much more during the recession than during times of economic growth, all other things being equal. Evidently the results support the hypothesis that debt distress, which is measured by the debt service burden, is related to more conservative consumption behaviour. As explained in Section 2, in a recession households are usually more concerned about their financial situation and the concern may be stronger when households face additional compulsory expenses such as debt repayments. Higher compulsory expenses increase the precautionary motive, leading to more constrained consumption by households than if there are no debt repayments. Debt distress is probably low in a favourable economic environment when the risk of reverse shocks is low. This would explain the marginal negative relationship between the debt service ratio and consumption until 2007 and after 2010.

The increasing negative effect of the debt service ratio on consumption growth goes together with the increasing average debt service ratio shown in Figure 4. The yearly debt payments increased substantially during 2007 compared to yearly income and reached their peak by the second half of 2009 when the debt service ratio was 0.36. In consequence, yearly consumption was suppressed by 8.3 per cent on average in the sample during this period. For comparison, aggregate real consumption declined by 15 per cent in 2009:Q2. It is not possible to estimate the share of the drop in aggregate consumption induced by indebtedness, as current estimations give only the direct effect and it is more complicated to estimate the general equilibrium effects in the whole economy. Mian & Sufi (2012) show that the decrease in aggregate demand induced by the decrease in consumption leads to high unemployment, which has further implications for the economy. Nevertheless, the estimated drop in consumption growth due to indebtedness in the sample is substantial, suggesting an important role for debt in the aggregate consumption growth.

6.4. Robustness tests

As the current estimations were carried out for individuals and not households, additional robustness tests were used for different sub-samples. If spouses share their expenses unevenly, the effect of indebtedness on consumption might be different for males and females. This would complicate the interpretation of the results when individual-level data are used. The quarterly estimation results for the lagged debt service ratio are given in Figure 6 and they show a very similar pattern for the estimations among females and males. The estimated coefficients of the lagged debt-to-income ratio are likewise very similar to the estimations given in Figure 6 and so are not reported here. The similar estimations for the sub-samples suggest that the results are not affected when individual-level data are used rather than household level data.

Another set of estimations were run for different age groups. As younger age groups have higher income expectations than older age groups, the estimations for the sub-groups would reveal whether income expectations may influence the estimations.

The coefficient estimates vary slightly more at the pre-crisis level across age groups and the debt service ratio does not seem to suppress the consumption of individuals aged over 50, as the estimated coefficient is close to zero. However, the general trend in all age groups is similar, as the negative relationship between the lagged debt service ratio and consumption change is stronger during the recession and much weaker before and

after the recession. This indicates there is a similar effect from the debt service ratio across different age groups, suggesting that the debt distress effect does not capture the effect of income expectations.

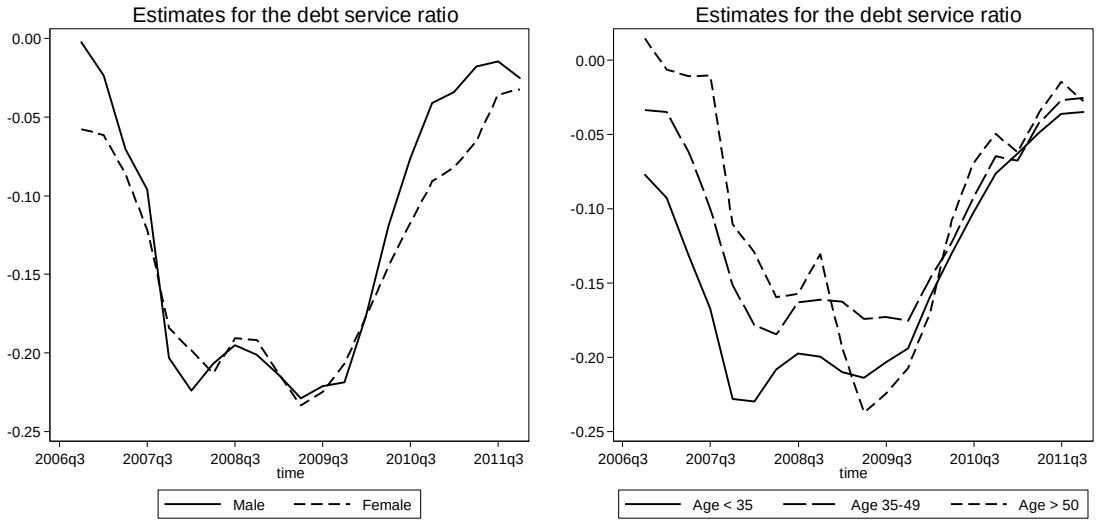


Figure 6. The estimated quarterly coefficients of the lagged debt service ratio of eq. (5) for different sub-samples from 2006:Q4 to 2011:Q4.

As an additional robustness test, estimations were carried out with a different income variable. The baseline estimations use inflow to the sight account from legal entities as an income variable. Alternatively, the total inflow to the sight account could be used as an income variable, although this variable is likely to be endogenous as individuals can arrange more inflows to their sight account if they plan to increase the outflow from the account, for example by making transactions between spouses or relatives or between different sight accounts.

Another set of estimations of eq. (5) was run where total inflow to the sight account was used as a proxy for earnings in the estimations of the debt-to-income ratio, the debt service ratio, the yearly total income and the asset-to-income ratio.

The estimated quarterly coefficients for the lagged debt-to-income ratio are given in Appendix C Table C.1 column (3) and for the lagged debt service ratio in column (4). The point estimates are slightly lower for the debt-to-income ratio and slightly higher for the debt service ratio than the results of the baseline model given in column (1) and column (2). However, the dynamics of the estimated coefficients are very similar to the baseline model, indicating that the way the proxy for income is computed does not alter the main conclusion that the debt service ratio amplifies the recession.

The upshot is that the comparison of the relationship between consumption and different debt variables reveals useful information about the possible mechanisms at work. The debt service ratio discloses more about the consumption decisions of households than the debt-to-income ratio does. The overall negative impact of indebtedness on consumption growth increases substantially when the average debt service ratio increases and the effect is stronger during the recession. The dampening effect is

marginal during the period of economic growth, meaning households only marginally decrease their consumption because of increasing debt burden levels.

The negative effect of the debt service ratio increases substantially during the recession, indicating that the debt service ratio has amplified the recession. The amplification of the recession occurs in two ways. First, households are more reluctant to consume when the debt service ratio is similar to what it was before the crisis. Second, the increase in the debt service ratio during the recession enhances the negative effect on consumption. The results indicate that debt servicing, which can be related to debt distress, played an important role in the consumption cutback during 2008-2009.

Although the results do not give a clear answer as to what exactly induces the increase in the debt distress in the recession, they still provide some policy suggestions. As the debt service ratio is important for consumption decisions, the outcome of policy measures which lower the debt service ratio, such as a decline in the interest rate, will spill over into the real economy by supporting household consumption.

As mentioned in Section 5, housing loans contribute over 80 per cent of the total loan volume in Estonia. As the majority of housing loans have been issued with an adjustable interest rate which is tied to Euribor, the interbank interest rate, changes in Euribor are quickly reflected in the debt repayment amounts. It has been calculated by a commercial bank that their mortgage customers have saved on average over 400 EUR per year from the declining interest rates (Rudzitis et al. 2012).

6.5. The estimations for income quintiles

Claessens & Perotti (2007) suggest that crises have strong redistributive consequences and Mian et al. (2013) highlight that debt causes the negative shocks to be distributed unevenly across households. They show heterogeneity in households' responses to negative shocks. Ampudia et al. (2014) suggest that the debt-to-income ratio for poor households increased during the recession and the heterogeneity in financial pressure might lead to different spending responses.

Further analysis of the different income quintiles would provide additional insights into the distribution of the negative relationship between indebtedness and consumption. Therefore it is investigated whether the impact of indebtedness on consumption differs across income groups. Individuals are divided into five income quintiles and the mean debt-to-income ratio and debt service ratio are estimated for each income quintile and for each quarter.

Figure 7 shows the evolution of the mean debt-to-income ratio and debt service ratio of individuals in different income quintiles. The average debt-to-income ratio is highest for individuals in the highest income quintile, indicating that individuals in higher income groups are more indebted than individuals in lower income groups.

The average debt volume over the whole period is 98 per cent of the yearly income for individuals in the second income quintile and 170 per cent of the yearly income for individuals in the highest income quintile. In the 2000s, when financial deepening occurred in CEE countries, debts were mainly accumulated by higher-income households (Herzberg 2010, Beck & Brown 2011). The pattern is similar to that in the other euro-area countries where the Household Finance and Consumption Survey finds

that the debt-to-income ratio is around 90 per cent higher for households in the highest income quintile than for households in the second income quintile (ECB 2013, p.65).

The rise in the debt-to-income ratio was steeper for individuals in higher income quintiles from 2006 to 2010, meaning that the debt volumes increased faster than income. The debt-to-income ratio increased by 30 per cent for individuals in the fourth and fifth income quintiles while the increase was around 20 per cent for individuals in the second and third income quintiles.

The debt-to-income ratio in the lowest income quintile shows a different pattern as the ratio decreased significantly during the period of economic growth in 2006-2007 and increased again in 2010-2011; the dynamics of the ratio have been driven mainly by income changes. As individuals in different income quintiles experience different dynamics in the debt-to-income ratio, there might be differences in the impact of indebtedness on consumption.

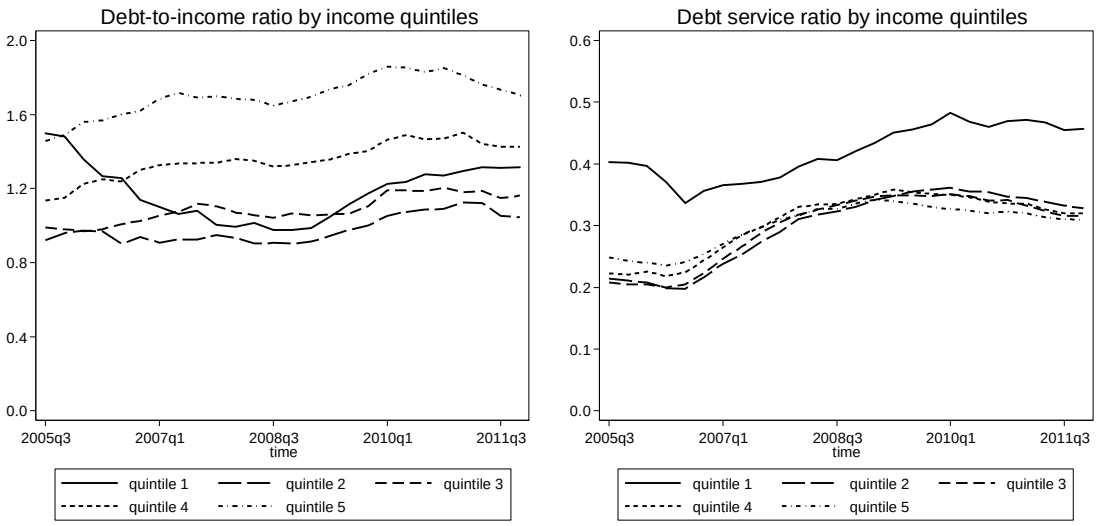


Figure 7. The debt service ratio by income quintiles from 2005:Q3 to 2011:Q4.

The distribution of the debt service ratio across income groups is quite even, although individuals in the lowest income quintile have a somewhat higher debt service ratio than the individuals in other income groups, as the average debt service ratio for the lowest income quintile over all quarters is 0.42 while for the other income quintiles it is around 0.30. In the other euro-area countries the debt service ratio is similarly highest for households in the lowest income quintile, at the same level for households in the middle income groups, and lowest for households in the highest income quintile (ECB 2013). The similar debt service ratio across different income groups may be related to the credit conditions of the credit supplier, which set the maximum share of income that can be used for debt servicing.

The increase in the debt service ratio occurs for individuals in all income groups in 2007-2009. Individuals in the second income quintile experience a rise in the debt service ratio of 80 per cent between 2006:Q3 and 2010:Q1, while individuals in the highest income quintile face a rise of 38 per cent during the same period.

In order to investigate the differences in the consumption change due to indebtedness between different income quintiles over the business cycle, the coefficients ϕ for the lagged debt-to-income ratio and ψ for the lagged debt service ratio in eq. (4) are estimated for each income quintile separately. *Yearly* estimations are implemented rather than quarterly estimations so that the estimations can be presented in a comprehensible form in a table. The model contains all the variables in eq. (4). The following model was estimated:

$$\begin{aligned}\Delta_4 \log c_{it} = & \sum_{p=1}^{5}\sum_{q=1}^{5}\beta_{pq} d_{pq} \log y_{it} + \sum_{p=1}^{5}\sum_{q=1}^{5}\phi_{pq} d_{pq} DtoI_{it-4} + \sum_{p=1}^{5}\sum_{q=1}^{5}\psi_{pq} d_{pq} Dsr_{it-4} + \\ & + \sum_{p=1}^{5}\sum_{q=1}^{5}\alpha_{pq} d_{pq} Z'_{it-4} + X'_{it}\gamma + u_i + \tau_t + \varepsilon_{it}\end{aligned} \quad . \qquad (6)$$

The dummy d_{pq} stands for the income quintile q and the time period p, which is the years from 2007 to 2011. The coefficients ϕ_{pq} and ψ_{pq} denote the impact of the lagged debt-to-income ratio and the lagged debt service ratio respectively on consumption for income quintile q in time period p.

Table 3 gives the estimated coefficients of the lagged debt-to-income ratio in eq. (6). The estimated coefficients are tabulated in a way that makes it easier to follow the evolution of the coefficient over the period in each quintile. The estimation years are given in columns and the income quintiles are given in rows. The estimations suggest that the negative relationship between the lagged debt-to-income ratio and consumption change is quite stable over the years for individuals in all income quintiles. The differences in the estimated coefficients for the different income groups and for the different years are statistically not significant, hence the estimations do not reveal any additional information about the relationship between the lagged debt-to-income ratio and consumption. The results confirm that the debt-to-income ratio does not amplify the recession in any of the income quintiles.

Table 4 provides the estimated coefficient for the lagged debt service ratio in eq. (6). It shows that the negative relationship between the lagged debt service ratio and consumption growth strengthens in all income quintiles in 2007-2009 and weakens in 2010-2011. Hence the negative amplification effect is not concentrated among individuals with lower income but is spread across all income quintiles. The change in the estimated negative coefficient is the smallest for individuals in the highest income quintile, where the estimated coefficient is 8.6 percentage points lower in 2008 than in 2007, while the decline of the estimated coefficient for individuals in the fourth income quintile is 14.4 percentage points. The individuals in the highest income quintile experience a smaller increase in the debt service ratio in 2007-2009 than do individuals in the lower income quintiles. This suggests that although indebtedness suppresses consumption during the recession in all income groups, the weakest amplification effect is observed in the highest income group.

Table 3. Parameter estimates for the lagged debt-to-income ratio by income quintiles over years

$DtoI_{t-4}$	(1) 2007	(2) 2008	(3) 2009	(4) 2010	(5) 2011
quintile 1	-0.0783***	-0.0774***	-0.0652***	-0.0398***	-0.0358***
	(0.0085)	(0.0084)	(0.0072)	(0.0057)	(0.0044)
quintile 2	-0.0864***	-0.0887***	-0.0735***	-0.0469***	-0.0410***
	(0.0055)	(0.0065)	(0.0051)	(0.0040)	(0.0038)
quintile 3	-0.0775***	-0.0894***	-0.0767***	-0.0493***	-0.0457***
	(0.0042)	(0.0038)	(0.0035)	(0.0031)	(0.0030)
quintile 4	-0.0741***	-0.0735***	-0.0726***	-0.0473***	-0.0501***
	(0.0033)	(0.0034)	(0.0032)	(0.0028)	(0.0025)
quintile 5	-0.0665***	-0.0690***	-0.0637***	-0.0513***	-0.0560***
	(0.0035)	(0.0037)	(0.0050)	(0.0033)	(0.0030)
R^2			0.461		
No of groups			102 968		
No. of obs.			1 733 332		

Notes: FE estimation of eq. (6). All explanatory variables and time dummies are included in the estimations but not reported. Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

To summarise, the negative effect of debt on consumption growth is not concentrated in any specific income group and indebtedness affects household consumption in a wide population group. No negative amplification effect on consumption growth is found for the debt-to-income ratio in any income quintiles, but the effect is apparent for the debt service ratio. It suggests that indebtedness plays an important role in determining the consumption decisions of *all* indebted households, regardless of their income level. The hypothesis that it is mainly low-income households that are affected by indebtedness rather than high-income households, and that they then cut their consumption does not appear to be valid in Estonia.

The reason for this may be related to the distribution of debt – Figure 7 shows that high-income groups are the most indebted and the debt service ratio is at the same level as in other income groups, meaning that high-income households are as vulnerable to debt related shocks as low-income households are. This pattern apparently exists in all countries in which financial deepening mainly opened up borrowing opportunities for high-income groups, which have been less credit constrained than low-income households (Herzberg 2010)). The result applies not only to CEE countries but equally to other European countries, for example Andersen et al. (2014) find a similar negative relationship between leverage and consumption in all income groups in Denmark. The upshot of the findings is that the implications of indebtedness are spread among all indebted households, which makes the issue of alleviating the implications a highly relevant one.

Table 4. Parameter estimates for the lagged debt service ratio by income quintiles over years

Dsr_{t-4}	(1) 2007	(2) 2008	(3) 2009	(4) 2010	(5) 2011
quintile 1	-0.0328	-0.0799***	-0.1350***	-0.0072	0.0700***
	(0.0378)	(0.0295)	(0.0237)	(0.0170)	(0.0206)
quintile 2	-0.0386**	-0.1692***	-0.1818***	-0.0490***	0.0325**
	(0.0196)	(0.0144)	(0.0152)	(0.0093)	(0.0148)
quintile 3	-0.0916***	-0.1940***	-0.2325***	-0.0757***	0.0294**
	(0.0157)	(0.0137)	(0.0133)	(0.0079)	(0.0124)
quintile 4	-0.0475***	-0.1915***	-0.2228***	-0.0919***	-0.0267**
	(0.0148)	(0.0124)	(0.0125)	(0.0075)	(0.0113)
quintile 5	-0.0905***	-0.1760***	-0.1387***	-0.0814***	-0.0365***
	(0.0162)	(0.0142)	(0.0150)	(0.0093)	(0.0125)
R^2			0.461		
No of groups			102 968		
No. of obs.			1 733 332		

Notes: FE estimation of eq. (6). All explanatory variables and time dummies are included in the estimations but not reported. Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

7. Conclusions

This paper examines the role of household debt in amplifying the 2008-2009 recession. The topic is highly relevant for the CEE countries, in which household debt exhibited vigorous growth rates before the 2008-2009 crisis that was induced by the financial liberalisation in the first half of the 2000s. The paper uses a unique quarterly panel dataset from a financial institution covering the period from 2004:Q4 to 2011:Q4 and estimates the effect of indebtedness on consumption change over different parts of the business cycle.

The paper estimates a conventional consumption model augmented by two debt variables. The indebtedness is measured by two variables, the debt-to-yearly income ratio and the yearly debt service ratio. The first ratio indicates the debt management capacity while the second variable signifies the debt repayment burden. According to one hypothesis households may reduce their consumption due to the fear of potential credit constraints or because of precautionary concerns. It is argued that the debt-to-income ratio captures the effect of the fear of the potential credit constraints while the debt service ratio mainly indicates the debt distress effect. Additionally, there is a hypothesis that indebtedness amplifies the recession as households hold back consumption during a recession more than during times of economic growth.

Several broad patterns emerge from the results. Household indebtedness, measured as either the lagged debt-to-income ratio or the lagged debt service ratio, has a significant

negative impact on household consumption growth over the whole period of 2006-2011. As both debt variables are negatively related with consumption growth, there are apparently several channels through which indebtedness affects consumption decisions. The dynamics of the effects of the two debt variables are different. The relationship between the debt-to-income ratio and consumption change is relatively stable, expressing a slightly decreasing relationship over the observed period which is apparently not related to the business cycle. The same pattern is observed among individuals in all income quintiles, so no amplification of the recession is detected by the indebtedness expressed by the debt-to-income ratio.

On the other hand, the relationship between the lagged debt service ratio and consumption change varies over the business cycle. The debt service ratio is associated negatively with consumption growth during the recession in 2008-2009, while before and after the recession the negative relationship is marginal. Hence, an amplifying effect of the debt service ratio is found for the recession and the effect is slightly stronger for individuals in the lower income quintiles.

The results suggest that the debt service ratio contains useful information about the link between indebtedness and consumption. It is the debt service ratio rather than the debt-to-income ratio that captures the amplification of the recession. In the literature the importance of the measure of the debt-to-assets ratio is emphasised. The current results do not cancel out the collateral effect which is captured by the debt-to-assets ratio, as it is not possible to test the hypothesis with the current dataset. The current paper sheds light on additional debt related measures and implies that indebtedness constrains consumption through different channels.

The findings are valuable for policy suggestions as debt distress measured by the debt service ratio can be alleviated by lower interest rates, which was also observed in 2008-2009. As the majority of mortgages in Estonia have been issued as adjustable interest rate mortgages, a fall in the interest rate will affect most of the indebted households. Without this happening, the debt service ratio would probably have been higher and the negative effect on consumption might have been even stronger. Additionally, the evidence that the decline in consumption related to the debt service ratio is observed in all income groups highlights the importance of policy measures to relieve the debt payment burden, as this would affect most indebted households.

The general equilibrium effect of households' indebtedness on the aggregate economy is more complicated to estimate and the current study does not give any answer to this question. The drop in aggregate demand because of the drop in household consumption due to indebtedness will have further implications for the real economy through changes in the labour market, changes in prices or changes in saving behaviour. To some extent the broader implications of household debt for household behaviour and the real economy have been explored, see among others Mian & Sufi (2012) and Kukk (2014); but these issues are worth further investigation.

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Appendix A

Table A.1. Panel summary statistics of the main variables

Variable		Mean	St. dev.	Min	Max	Observations
Total spending						
	Overall	8.772	0.777	1.391	14.466	N = 2 597 130
	Between		0.61	5.107	11.944	n = 107 859
	Within		0.439	2.181	13.683	T = 24
Total income						
	Overall	8.737	0.728	5.177	15.289	N = 2 597 930
	Between		0.655	6.322	11.972	n = 107 859
	Within		0.372	4.840	14.099	T = 24
Total income from legal entities						
	Overall	8.530	0.773	-3.026	14.094	N = 2 597 930
	Between		0.706	2.327	11.636	n = 107 859
	Within		0.404	-0.074	13.341	T = 24
Debt-to-income ratio						
	Overall	0.574	1.647	0	21.079	N = 2 597 930
	Between		1.527	0	17.497	n = 107 859
	Within		0.824	-14.385	19.682	T = 24
Debt service ratio						
	Overall	0.138	0.265	0	2.219	N = 2 597 930
	Between		0.221	0	1.969	n = 107 859
	Within		0.159	-1.496	2.252	T = 24

Table A.2. Summary statistics of the debt-to-income ratio and the debt service ratio by quarter, conditional on ownership of debt.

		Debt-to-income ratio			Debt service ratio		
	Quarter	**Mean**	**Median**	**St. dev.**	**Mean**	**Median**	**St. dev.**
2005	3	1.184	0.213	2.106	0.234	0.166	0.233
2005	4	1.199	0.215	2.107	0.231	0.165	0.230
2006	1	1.232	0.219	2.175	0.232	0.165	0.232
2006	2	1.235	0.235	2.176	0.225	0.160	0.228
2006	3	1.229	0.256	2.168	0.227	0.163	0.227
2006	4	1.248	0.295	2.197	0.245	0.173	0.242
2007	1	1.268	0.301	2.240	0.265	0.184	0.267
2007	2	1.280	0.320	2.248	0.282	0.190	0.292
2007	3	1.282	0.329	2.238	0.297	0.198	0.310
2007	4	1.277	0.334	2.220	0.312	0.205	0.325
2008	1	1.266	0.336	2.188	0.326	0.212	0.337
2008	2	1.253	0.329	2.171	0.335	0.216	0.345
2008	3	1.230	0.320	2.118	0.337	0.219	0.345
2008	4	1.242	0.313	2.146	0.346	0.225	0.349
2009	1	1.254	0.307	2.169	0.354	0.232	0.353
2009	2	1.281	0.305	2.218	0.360	0.236	0.355
2009	3	1.308	0.296	2.287	0.359	0.237	0.355
2009	4	1.347	0.297	2.342	0.359	0.239	0.352
2010	1	1.404	0.299	2.447	0.362	0.241	0.355
2010	2	1.417	0.291	2.478	0.357	0.238	0.351
2010	3	1.413	0.284	2.486	0.351	0.233	0.348
2010	4	1.427	0.287	2.477	0.351	0.233	0.349
2011	1	1.430	0.280	2.495	0.348	0.229	0.347
2011	2	1.405	0.270	2.462	0.340	0.223	0.343
2011	3	1.375	0.266	2.408	0.333	0.217	0.338
2011	4	1.370	0.259	2.410	0.333	0.215	0.340
TOTAL		**1.303**	**0.288**	**2.281**	**0.314**	**0.207**	**0.323**

Appendix B

Table B.1. Definitions of all the variables used in the empirical model with summary statistics

Variable	Definition	Mean	St. dev.
$\log y_{it}$	Logarithm of real yearly inflow from legal entities to sight accounts of an individual *i* in quarter *t*, in EUR in 2005 prices	8.530	0.773
$\log c_{it}$	Logarithm of real yearly outflows of sight account of an individual *i* in quarter *t*, excluding transactions between saving and investment accounts, in EUR in 2005 prices	8.772	0.777
$DtoI_{it}$	Debt-to-yearly income ratio; debt stock is measured at the end of quarter t and income is the sum of the income of the four previous quarters	0.574	1.647
Dsr_{it}	The ratio of annual debt service payments to annual income in quarter *t*	0.138	0.265
Finasset_{it}	Ratio of financial assets to yearly income from legal entities at the end of quarter *t*. Financial assets include deposits, investment funds, stocks, bonds and pension funds	0.660	51.923
overdue_{it}	Dummy = 1 if individual has had any repayment problems to the commercial bank in quarter *t*, otherwise = 0	0.008	0.091
lifeins_{it}	Dummy = 1 if the individual has a life insurance contract in quarter *t*, otherwise = 0	0.056	0.230
pensionlife_{it}	Dummy = 1 if the individual has a pension insurance contract in quarter *t*, otherwise = 0	0.090	0.287
newH_{it}	Dummy = 1 if the individual owns a housing loan in quarter t while not having any housing loan in quarter *t*-1, otherwise = 0	0.002	0.047
addH_{it}	Dummy = 1 if the size of the individual's housing loan in quarter t exceeds the housing loan in quarter *t*-1 and the individual owns the housing loan in quarter *t*-1, otherwise = 0	0.005	0.072

Table B.2 Unit root tests

	(1) Harris-Tsavalis test	(2) Im-Pesaran-Shu test
	Statistic (ρ)	**Statistic ($Z_{\tilde{t}-bar}$)**
$\Delta_4 \log c_{it}$	0.6906***	-114.4***
$\Delta_4 \log y_{it}$	0.7170***	-100.6***
$DtoI_{it}$	0.7992***	-15.44***
Dsr_{it}	0.7993***	-254.9***
$finasset_{it}$	0.7367***	-27.35***

Notes: Unit root tests with panel means included, time trend not included, and cross-sectional means removed. Harris-Tsavalis test assumes a common autoregressive parameter and the null hypothesis is that panels contain unit roots while the alternative hypothesis is that panels are stationary. Im-Pesaran-Shu test assumes panel-specific autoregressive parameters and the null hypothesis is that all panels contain unit roots while the alternative hypothesis is that some panels are stationary. Superscripts ***, ** and * indicate that the null hypothesis is rejected at the 1%, 5% and 10% level respectively.

Table B.3 Estimations for the full sample period 2006:Q4-2011:Q4

	(1)	(2)	(3)	(4)	(5)
$\Delta_4 \log y_t$	0.5460***	0.5447***	0.5491***	0.5749***	0.5499***
	(0.0035)	(0.0035)	(0.0035)	(0.0030)	(0.0024)
$\mathrm{DtoI}_{t\text{-}4}$	-0.0478***	..	-0.0367***	-0.0354***	-0.0022***
	(0.0016)		(0.0016)	(0.0016)	(0.0004)
$\mathrm{Dsr}_{t\text{-}4}$	..	-0.1792***	-0.1397***	-0.1872***	-0.0644***
		(0.0038)	(0.0040)	(0.0039)	(0.0022)
$\mathrm{finasset}_{t\text{-}4}$	0.0220*	0.0217*	0.0218*	0.0198*	0.0079**
	(0.0132)	(0.0130)	(0.0131)	(0.0120)	(0.0033)
$\mathrm{overdue}_{t\text{-}4}$	-0.0421***	-0.0354***	-0.0334***	-0.0379***	-0.0550***
	(0.0046)	(0.0046)	(0.0046)	(0.0046)	(0.0042)
$\Delta_4 \mathrm{lifeins}_t$	0.0494***	0.0490***	0.0483***	0.0627***	0.0518***
	(0.0052)	(0.0052)	(0.0052)	(0.0053)	(0.0045)
$\Delta_4 \mathrm{pensionlife}_t$	0.0369***	0.0346***	0.0344***	0.0519***	0.0354***
	(0.0045)	(0.0045)	(0.0045)	(0.0045)	(0.0039)
$\sum_{s=0}^{8} newH_{t-s}$	Yes	Yes	Yes	Yes	Yes
$\sum_{s=0}^{8} addH_{t-s}$	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	No	Yes
Individual fixed effects	Yes	Yes	Yes	Yes	No
R^2	0.2803	0.2804	0.2819	0.2761	0.2931
No of groups	102 968	102 968	102 968	102 968	102 968
No. of obs.	1 733 332	1 733 332	1 733 332	1 733 332	1 733 332

Notes: FE estimation of eq. (4). Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

Table B.4 Robustness of the estimations for the full sample period 2006:Q4-2011:Q4

	(1)	(2)	(3)	(4)	(5)
$\Delta_4 \log y_t$	0.5491***	0.5536***	0.5491***	0.5490***	0.7481***
	(0.0035)	(0.0026)	(0.0035)	(0.0035)	(0.0036)
$DtoI_{t-4}$	-0.0367***	-0.0363***	-0.0367***	-0.0367***	-0.0586***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0022)
Dsr_{t-4}	-0.1397***	-0.1411***	-0.1406***	-0.1403***	-0.0999***
	(0.0040)	(0.0039)	(0.0040)	(0.0040)	(0.0046)
$finasset_{t-4}$	0.0218*	..	0.0218*	0.0218*	0.1393***
	(0.0131)		(0.0131)	(0.0131)	(0.0360)
$overdue_{t-4}$	-0.0334***	-0.0336***	..	-0.0337***	-0.0234***
	(0.0046)	(0.0046)		(0.0046)	(0.0036)
Δ_4 $lifeins_t$	0.0483***	0.0484***	0.0484***	..	0.0425***
	(0.0052)	(0.0052)	(0.0052)		(0.0045)
Δ_4 $pensionlife_t$	0.0344***	0.0344***	0.0345***	..	0.0292***
	(0.0045)	(0.0045)	(0.0045)		(0.0038)
$\sum_{s=0}^{8} newH_{t-s}$	Yes	Yes	Yes	Yes	No
$\sum_{s=0}^{8} addH_{t-s}$	Yes	Yes	Yes	Yes	No
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.2819	0.2798	0.2819	0.2817	0.4383
No of groups	102 968	102 968	102 968	102 968	102 968
No. of obs.	1 733 332	1 733 332	1 733 332	1 733 332	1 733 332

Notes: FE estimation of eq. (4). Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

Appendix C

Table C.1. Estimated quarterly parameters for the debt-to-income ratio and the debt service ratio using different yearly income measures

		(1)	(2)	(3)	(4)
Income measure		**Income from legal entities**		**Total inflow to sight account**	
Year	**Quarter**	**Debt-to-income ratio**	**Debt service ratio**	**Debt-to-income ratio**	**Debt service ratio**
2006	4	-0.0530***	-0.0376***	-0.0780***	0.0178
		(0.0027)	(0.0126)	(0.0031)	(0.0133)
2007	1	-0.0492***	-0.0503***	-0.0724***	-0.0012
		(0.0026)	(0.0122)	(0.0029)	(0.0128)
2007	2	-0.0501***	-0.0821***	-0.0758***	-0.0235*
		(0.0026)	(0.0133)	(0.0029)	(0.0132)
2007	3	-0.0505***	-0.1141***	-0.0757***	-0.0698***
		(0.0026)	(0.0127)	(0.0031)	(0.0126)
2007	4	-0.0444***	-0.1958***	-0.0706***	-0.1659***
		(0.0025)	(0.0116)	(0.0030)	(0.0126)
2008	1	-0.0464***	-0.2051***	-0.0733***	-0.1854***
		(0.0026)	(0.0103)	(0.0033)	(0.0117)
2008	2	-0.0480***	-0.2084***	-0.0751***	-0.1986***
		(0.0025)	(0.0098)	(0.0032)	(0.0145)
2008	3	-0.0502***	-0.1915***	-0.0780***	-0.1771***
		(0.0024)	(0.0081)	(0.0030)	(0.0129)
2008	4	-0.0520***	-0.1918***	-0.0801***	-0.1863***
		(0.0023)	(0.0074)	(0.0029)	(0.0114)
2009	1	-0.0511***	-0.2132***	-0.0781***	-0.2150***
		(0.0024)	(0.0074)	(0.0030)	(0.0128)
2009	2	-0.0470***	-0.2297***	-0.0734***	-0.2313***
		(0.0023)	(0.0073)	(0.0029)	(0.0138)
2009	3	-0.0442***	-0.2260***	-0.0704***	-0.1948***
		(0.0023)	(0.0085)	(0.0028)	(0.0096)
2009	4	-0.0365***	-0.2131***	-0.0605***	-0.1539***
		(0.0022)	(0.0074)	(0.0028)	(0.0121)
2010	1	-0.0321***	-0.1791***	-0.0530***	-0.1191***
		(0.0022)	(0.0074)	(0.0028)	(0.0086)
2010	2	-0.0294***	-0.1360***	-0.0489***	-0.0999***
		(0.0021)	(0.0062)	(0.0026)	(0.0067)

		(1)	(2)	(3)	(3)
Income measure		**Income from legal entities**		**Total inflow to sight account**	
	Quarter	**Debt-to-income ratio**	**Debt service ratio**	**Debt-to-income ratio**	**Debt service ratio**
2010	3	-0.0268***	-0.1030***	-0.0461***	-0.0614***
		(0.0019)	(0.0060)	(0.0025)	(0.0061)
2010	4	-0.0280***	-0.0737***	-0.0464***	-0.0389***
		(0.0019)	(0.0062)	(0.0023)	(0.0091)
2011	1	-0.0290***	-0.0653***	-0.0481***	-0.0331***
		(0.0018)	(0.0061)	(0.0022)	(0.0095)
2011	2	-0.0290***	-0.0485***	-0.0483***	-0.0020
		(0.0017)	(0.0069)	(0.0021)	(0.0087)
2011	3	-0.0297***	-0.0279***	-0.0489***	0.0158*
		(0.0017)	(0.0063)	(0.0022)	(0.0085)
2011	4	-0.0315***	-0.0300***	-0.0512***	0.0164**
		(0.0018)	(0.0065)	(0.0022)	(0.0081)
R^2		0.288		0.446	
No of groups		102 968		102 968	
No. of obs.		1 733 332		1 733 332	

Notes: FE estimation of eq. (5). All explanatory variables and time dummies are included in the estimations but not shown in the table. Standard errors are reported in parentheses below the coefficient estimates, SE estimates are robust to disturbances that are heteroskedastic and autocorrelated. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level respectively.

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