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Household Balance Sheets and Economic Crisis

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IES Working Paper: 20/2011

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Bibliographic information:
Jakubík, P. (2011). " Household Balance Sheets and Economic Crisis" IES Working Paper 20/2011. IES FSV. Charles University.

This paper can be downloaded at: http://ies.fsv.cuni.cz

Household Balance Sheets and Economic Crisis

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June 2011

Abstract:
This paper studies the economic impact of the current global economic downturn on the household sector. Household budgets can be negatively affected by declines in nominal wages and increases in unemployment. We empirically test this effect for the small open emerging economy. As a result of a lack of individual data on household finances, micro data are simulated. Our analysis clearly shows that there is a significant additional decline in consumption related to an increase in household default rates and unemployment. We find that potential household insolvencies have important implications for the financial system as well as for the macroeconomy.

Keywords: credit cycle, households' distress, insolvency, household default, aggregate consumption

JEL: G28, G32, G33, G38

Acknowledgements:
The findings, interpretations and conclusions expressed in this paper are entirely those of the author and do not represent the views of any of the author's institutions. Financial support from the IES (Institutional Research Framework 2005-2010, MSM0021620841), The Grant Agency of Charles University (GAUK 2009/47509 –"Decomposition of securities' market prices into risk parameters" and The Czech Science Foundation (GACR 403/10/1235 Institutional Responses to Financial Market Failures) is gratefully acknowledged.

1. Introduction

There are numerous studies that address household financial distress. Some investigate the main drivers of the insolvency risk and try to link them to the macroeconomic environment while others focus on the effects of adverse macroeconomic scenarios on household consumption. Of note is that only a few studies discuss the household credit cycle as a whole. The lack of research on this issue is largely related to insufficient household statistics on structured balance sheets and consumption.

The ongoing economic crisis has a negative effect on household balance sheets and can cause financial distress. This paper aims to assess the impact of the economic recession on a household's finances by taking their debt burden into account and evaluating the negative feedback on the aggregate economy via reduced consumption. This is of particular importance from the government's perspective, as household insolvencies can significantly reduce government revenue and increase the need for social spending.

The next section contains a literature review on household distress, insolvency triggers and the impact of adverse macroeconomic scenarios on a household's balance sheet. Section 3 discusses the modelling framework and presents a model for a single household mortgage default. It also looks at the impact of an adverse macroeconomic scenario on aggregate consumption. Section 4 contains a description of the available data for the Czech economy. The empirical results are presented in section 5, and the final section summarises and concludes.

2. Related Literature

A number of studies address the issue of household insolvency and focus specifically on the main drivers. The recent financial turmoil and subsequent economic recession provide additional incentive for creditors as well as regulators to deal with the issue. Four main streams of research can be identified. The first looks at household default prediction, using a traditional insolvency framework. The second focuses on the impact of household defaults on the financial sector within a stress test framework for evaluating the potential negative effects of adverse macroeconomic scenarios. The third focuses on the optimal legal framework to deal with individual insolvencies. The fourth addresses the credit cycle and consumption.

The first group of studies focus on household default prediction. Peter and Peter (2006) investigate the main drivers of household default. To this end they developed a risk management model for the Australian economy, using micro data from the Australian Bureau of Statistics. DeVaney and Lytton (1995) chose to focus on household insolvency by applying a predictive model and using financial ratios to identify insolvent households. They discuss the implications for monitoring household solvencies and present a response to insolvencies. Herrala and Kauko (2007) present a micro simulation model of household distress. They use a logit analysis to estimate the extent to which a household's risk of being financially distressed depends on net income after tax and loan servicing costs. The impact of the assumed macroeconomic shocks on the net income is calculated at the household level. Their micro simulation model is used to simulate both the number of distressed households and their aggregate debt in various macroeconomic scenarios. Del-Rio and Young (2005) examine how attitudes towards unsecured debt are related to household finances and other characteristics, using a British Household Panel Survey. This analysis suggests that the main causal factors for problems relating to debt are the unsecured debt-income ratio, the level of mortgage income gearing, the level of households' financial wealth, and their health, ethnicity and

marital status. They also concluded that the increase in levels of indebtedness of young people was the main factor driving the greater tendency to report debt related problems.

The second research stream tries to evaluate the impact of household defaults on the financial sector under adverse macroeconomic scenarios. Kadeřábek, Slabý and Vodička (2008) modelled household default probability as a function of macroeconomic variables, such as wages, unemployment and interest rates. They further employed an estimated model within the stress test framework by applying exogenous stress scenarios for the development of these indicators. The authors pointed out that stress-sensitivity of default probability is mainly driven by the instalment-to-income ratio and loan maturity. Jakubík, Schmieder (2008) estimated macroeconomic models for forecasting household default for the Czech and German economies. They employed these models to stress test banking portfolios and pointed out that macroeconomic indicators alone have limited use in explaining household defaults. Moreover Jiménez, Saurina (2006) found strong empirical support for a positive lagged relationship between rapid credit growth and loan losses. Their study contains empirical evidence of lax credit standards during boom periods, in terms of screening of borrowers as well as collateral requirements and loan losses. They advocate a regulatory prudential tool based on a countercyclical, or forward-looking, loan loss provision that takes into account the credit risk profile of a bank's loan portfolios across the business cycle.

The third group of studies focuses on the optimal legal framework. Li and Sarte (2006) study the implications of US personal bankruptcy rules for resource allocation and welfare. They found that the complete elimination of bankruptcy provisions can cause a significant decline in output and welfare as it reduces capital formation and labour input. Feibelman (2009) pointed out that the deepening of consumer finances promotes growth and development in emerging markets. His research stressed the importance of consumer bankruptcy law as an effective form of regulation to address the problem of over-indebtedness. He calls for emerging economies to consider adopting a consumer bankruptcy system or modernizing their existing regimes.

The fourth research group focuses on consumption and economic growth, employing credit cycle models. Chang, Hanna, Fan (1997) presented and empirically tested a three-period model for optimal consumption. The latter suggests that many US consumers without sufficient levels of liquid assets may be acting rationally. Elmer and Seeling (1998) combine the issue of consumption and solvency. They proposed a theoretical model for a single family mortgage default and investigated events that could trigger defaults within this framework. McCallum (1988) applies an evaluation of strengths and weaknesses of the real business cycle approach to the analysis of macroeconomic fluctuations. Tudela, Young (2005) using an overlapping generation model to explain rising household indebtedness. They also investigate the impacts of various events, such as a fall in house prices, a fall in pension income, and an increase in interest rates, on household wealth, indebtedness and consumption. Evidence of a positive effect of wealth on Italian households' consumption was found by Bassanetti, Zollino (2008), and the influence of income distribution in modelling aggregate consumption expenditure was analysed by Chakrabarty, Schmalenbach and Jeffrey (2006). For the Netherlands, the impact of financial capital losses relative to gains on household savings and consumption is investigated by Berben, Bernoth and Mastrogiacimo (2006). Their results suggest that households react more strongly to capital losses than to capital gains. Thus, the failure to take this asymmetry into account could seriously influence estimates of marginal propensity to consume from wealth. Effects of banking and currency crises on consumption in 19 OECD countries are estimated by Barrel, Davis and Pomerantz (2006). Their results show that consumption plays an important role in the adjustment following a crisis and that the effects are not fully captured by the impact of crises on the standard consumption

determinants, i.e. income and wealth. Additional effects, attributable to factors such as time-varying confidence, uncertainty and credit rationing, are aggravated by high and rising leverage, despite financial liberalisation and easing of liquidity constraints. High leverage in some countries implies that banking crises could have a greater incidence than in the past.

3. Theoretical Framework

Households are usually affected by an adverse negative economic scenario with some time lag, but the impact is more persistent than in the corporate sector. As a consequence of an economic crisis, firms reduce production to cope with declining aggregate demand. To do so, they need to reduce the labour force or decrease wages. However, the wages are usually "downward sticky"; so that firms need to make employees redundant. Alternatively, they could reduce the variable part of salaries such as bonuses or other benefits. As employees become unemployed they also become dependent on social benefits. Moreover, if they are indebted they are not able to cover their current payments with their current income. Thus, if they are not able to find employment, the only solution is to use their savings. In the end this provides a temporary solution that postpones their insolvency.

Single-household Mortgage Default

To investigate household insolvency, we consider a three period pure exchange model with no taxes, as e.g. in Elmer and Seelig (1998). Individuals are endowed with initial income (y_0) and invest in real estate equity (p_0), financed by a fixed-rate mortgage (m_0) at time 0. It could further be assumed that rents earned from real estate equity are fully consumed in the period received and that periodic consumption (c_t) is the recorded net of these earnings. Unsecured borrowing (b_t) is a residual that smoothes out intertemporal consumption. However it can also be positive, and in such case it is interpreted as savings in the form of a deposit. Initial income, the value of investment in real estate equity and the interest rate (y_t, p_t, i_t) are known, but may differ from their future realised values. An individual chooses his optimal life cycle consumption pattern as follows:

$$\max U(c_0, c_1, c_2) \qquad (1)$$

S.T.

$$c_0 = y_0 - (p_0 - m_0) + b_0$$

$$c_1 = y_0 - m_0 i_0 - b_0 i_0 + b_1$$

$$c_2 = y_0 + (p_0 - m_0(1 + i_0)) - (b_0 + b_1)(1 + i_0)$$

$$c_0, c_1, c_2 > 0,$$

This model can easily be extended to include any arbitrary number of periods (see Fama and Miller (1972) or Hirschleifer (1970) for further details). Within this framework, a key role is played by uncertainty about future income, interest rates and house prices. An adverse change in these variables increases the possibility of exercising the option to refinance a mortgage (*R*) or default (*D*). The strategic option to default is chosen if the default transaction costs exceed a present value of interest savings in case of mortgage refinancing. If the refinance and strategic default options fall out of the money, then the period 0 debt remains and the revised choice (1) can be reformulated to a two-period optimization problem with debt constraints from prior commitments:

$$\max U(c_0, c_1, c_2) \quad (2)$$

S.T.

$$c_1 = y_1^{'} - m_0 i_0 - b_0 i_0 + b_1^{'}$$

$$c_2^{'} = y_1^{'} + (p_1^{'} - m_0(1+i_0)) - b_0(1+i_0) - b_1^{'}(1+i_1^{'})$$

$$c_1^{'}, c_2^{'} > 0,$$

We further focus on the situation of an adverse macroeconomic shock and its impact on household income. In our model framework, the consumer must at least cover the debt obligations in both periods. We further assume a shock to income $y_1^{'} \to 0+$ holding interest rate and house prices constant. Solvency in period 1 requires borrowing against period 2 wealth at least in the amount of $m_0 i_0 + b_0 i_0$, and thus a household defaults if

$$p_0 - m_0(1+i_0) - b_0(1+i_0) - (m_0 i_0 + b_0 i_0)(1+i_0) > 0$$

$$b_0(1+i_0)^2 > p_0 - m_0(1+i_0)^2 \quad (3)$$

that is, borrowing from previous periods exceeds homeowner equity. It is quite an expected result. If an individual cannot meet his obligation, he can still sell owned real estate in order to avoid default. However, he will default if the value of his equity does not cover his debt obligation.

This simple framework can help us to understand the basic default trigger based on the shock to income. But in practice things are more complicated, as mortgages can have different maturities, which implies different annuities, and a mortgage is usually paid back in fixed monthly instalments. We also need to calculate disposable income as income purged of living costs. Moreover, Herrala, Kauko (2007) define household distress as a situation where the increment in household surplus (income diluted by debt service payment), via the incurrence of new debt, is smaller than the minimum level of consumption. They assume that households can temporarily sustain consumption by taking more debt or running down their stocks of liquid assets.

Impact of Adverse Scenario on Aggregate Consumption

From the creditor's point of view, a precise estimation of future household default is one of the most challenging issues. On the other hand, the objective of financial regulators is to assess the future course of the economy and the potential threat to financial stability. Households' inability to meet their financial obligations results not only in higher default rates and losses for the financial sector but also as in a significant decline in household consumption, which has a negative effect on the aggregate economy. To estimate this impact we can use a simple Keynesian framework (see e.g. Romer (1996))

$$C = C_0 + cY, \quad (4)$$

where *C* denotes aggregate consumption, C_0 autonomous consumption, c marginal propensity to consume and *Y* disposable income. We further assume an adverse macroeconomic scenario corresponding to declines in gross domestic product and disposable income. Then a decline in consumption can be expressed as

$$\Delta C = c\Delta Y, \quad (5)$$

where Δ is the operator for change in level. However, in the case of a significant increase in household default rates, there is an additional feedback effect of household insolvency on aggregate consumption. Hence, the decline in consumption calculated via formula (5) can be

considerably underestimated due to the underestimation of the marginal propensity to consume.

To better estimate the impact of a decline in disposable income on consumption, we can simply divide consumers into two groups – defaulted [proportion d] and non-defaulted [(1-d)]. Then, aggregate consumption can be expressed as

$$C = dC_d + (1-d)C_n \tag{6}$$

where C_d denotes consumption of the defaulted and C_n non-defaulted households. Using this formula, the decline in consumption in response to the decline in disposable income or GDP can be derived. Using the Keynesian formula, we assume that consumers reduce their consumption proportionally to the decline in disposable income, which corresponds to the decline in GDP. If we further assume that disposable income of the defaulted household group is equal to zero in the limit, then their consumption is equal to the autonomous consumption related to the necessary living expense:

$$C = dC_d + (1-d)C_n = d * C_0 + (1-d)(C_0 + cY) = C_0 + (1-d)cY \tag{7}$$

In the case of an adverse macroeconomic scenario, GDP or disposable income declines and the household insolvency rate increases. Aggregate consumption is influenced by both these effects and can be easily derived from formula (7).

$$\Delta C = c[(1-d)\Delta Y - \Delta d(1+\Delta)Y)] \tag{8}$$

We see from equation (8) that for small changes in household insolvency, we can omit the second term in formula (8), but for significant changes, it can play an important role and the omission of the second term can cause a significant underestimation of the decrease in consumption.

If we further take into account that the marginal propensity to consume could significantly differ for the unemployed and employed consumers, we can reformulate equation (7) for the aggregate consumption as

$$C = C_0 + (1-d)(uc_U Y + (1-u)c_E Y) \tag{9}$$

where c_U and c_E are the marginal propensity to consume for the unemployed and employed consumers and u is the unemployment rate. In the case of an adverse macroeconomic scenario, we need to also take into account, together with the change in GDP and the change in household default rate, the change in the unemployment rate, to calculate the effect on aggregate consumption. Formally, after some derivation we obtain the formula (10).

$$\Delta C = (1-d)[u(c_U - c_E) + c_E]\Delta Y + [(c_U - c_E)(\Delta u - d\Delta u - \Delta du - \Delta d\Delta u) - \Delta dc_E](1+\Delta)Y \tag{10}$$

We see from equation (10) that - in the absence of a significant difference between marginal propensities to consume for unemployed and employed consumers - formula (10) resembles formula (8). Formula (10) reveals that, with a significant difference between marginal propensities to consume for unemployed and employed consumers, a change in the unemployment and default rates can have a marked impact on the change in aggregate consumption.

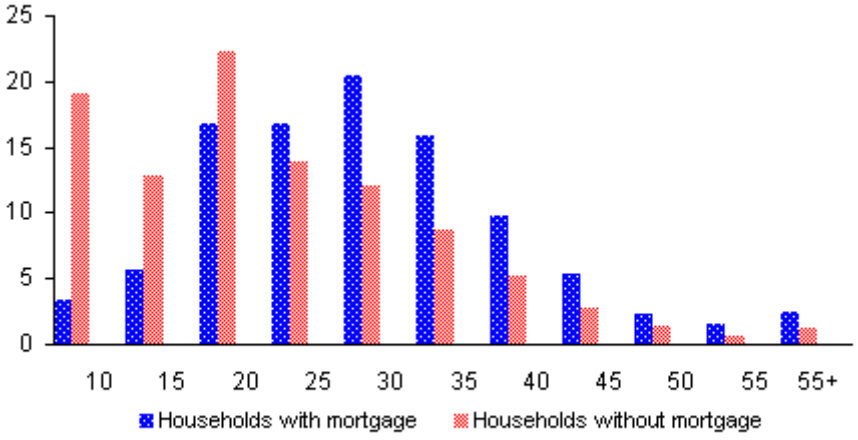
4. Available Data

The limiting factor in modelling household insolvencies is usually the availability of the appropriate data. To estimate the household default rate we would need to know more about the distribution of income and the debt burden across the population. Furthermore, we would need an estimate of the necessary living expenses as well as information on interest rates on loans to households. We empirically tested the transmission channels for the Czech Republic as a small open and emerging economy. Unfortunately, the relevant data are not available in this case.[1] We have neither micro data nor sufficient information on the income distribution. Thus we make a simplifying assumption to deal with this problem.

The Czech Statistical Office is the main data source for Czech household statistics. Apart from that, the Czech National Bank provides some additional statistics on the aggregate bases such as household financial assets, banking and non-banking loans to households. Moreover, the average bank interest rates on consumption and housing loans to household are published by the Czech National Bank. Some additional characteristics of the mortgage markets can be obtained from Fincentrum Hypoindex. However, micro data are available only from the Czech Statistical Office. These statistics are based on household surveys and include some characteristics of households. In connection with household insolvency, they provide information on household net income but not on characteristics of the debt burden except for binary (yes/no) information such as whether the given households have mortgages. Moreover, the debt burden related to consumer loans is not covered by these statistics. Another serious disadvantage is the relatively long lag; for example, the latest statistics are based on information collected in the year before the last complete year. This lack of appropriate statistics causes difficulties in making estimations.

The income distribution of households with and without mortgages reveals that the indebtedness of low income Czech households is relatively limited. The income distribution of households with a mortgage is positively skewed compared to that of households without a mortgage.

Chart 1: Household income distribution (Statistics of Family Accounts 2007)
(x axis: monthly household net income, CZK 1000; y axis: %)



Source: Czech Statistical Office

[1] The appropriate data can be obtained from credit registers or household surveys for some countries.

Based on statistics from Fincentrum Hypoindex, we see that since 2006 the average value of mortgage loans has been rising over time, but the rise is less than that in residential property prices (see Table 1). We also find slower growth in nominal wages compared to changes in residential property prices in the same period. This reflects the fact that owner-occupation is becoming less accessible to Czech households over time. Although the income situation had been improving until 2008, it still did not compensate for the increase in residential property prices.[2]

Table 1: Average mortgage loan

	2005	2006	2007	2008	03/2009
Average mortgage loan (end of period, in ths.CZK)	1412	1450	1707	1766	1802
Growth of average mortgage loan (in %)	11.4	2.7	17.7	3.5	2.0
Change in residential property prices (y-o-y, in %)	6.0	10.4	18.9	12.5	
Growth of average gross monthly nominal wage (y-o-y, in %)	5.3	6.5	7.3	8.5	-2.6
Consumer price Inflation (end of period, in %)	2.2	1.7	5.4	3.6	2.3

Source: Fincentrum Hypoindex

Note: 03/2009 correspond to quarterly change

5. Empirical Results

To evaluate the impact of the economic crisis on the household sector, we focus mainly on the income transmission channel that was most important for the Czech economy in the post-crisis period.

Due to the lack of micro data on household balance sheets[3], we employ aggregate data from a bank credit registry and a one factor model to link the household insolvency to key macroeconomic variables (see model specification e.g. in Jakubik (2007), Hamerle, Liebig, Scheule (2004) and Appendix).[4] These data include total recent past-due loans, which was used to proxy the credit default rate. The indicator for household credit risk was calculated based on new 3-month past-due loans. However, the only short time series for the household sector covered the period 3Q/2007-3Q/2009. Although these data were available at monthly frequency, for some macroeconomic variables, such as GDP growth, only quarterly data were available. In order to estimate the model on the basis of such a short time series, we used monthly data and linear interpolation for GDP growth and its components such as consumption. The model was calibrated by maximising a likelihood function (see Appendix). In line with economic theory, we considered macroeconomic variables which can drive household insolvency and whose forecasts are published by the Czech National Bank. Automatic selection based on stepwise regression minimising residual sum of squares was used to find the combination of variables with the greatest prediction power and optimal time lag. Moreover, we ensure that coefficients have signs in line with economic theory. Our final non-linear model is able to explain relatively well the historic household default rate pattern. According to our results, Czech household default rates can be explained by lagged real GDP

[2] At the end of 2008, banks started to tighten credit standards due to the ongoing economic recession. The increasing uncertainty about future income together with the resultant negative expectations of households caused a rapid slowdown in credit growth. Moreover, the economic decline which started in 2008 is reflected in an increase in household sector credit risk.

[3] Although we have information on the historical distribution of household net income, the rest of the statistics are available on the aggregate level only.

[4] Econometric models which employ macroeconomic indicators to explain household insolvency or default rate include e.g. Rösch, Scheule (2007), Kadeřábek, Slabý, Vodička (2007), Jakubík, Schmieder (2008) or Danmarks Nationalbank (2007). They employ as dependent variables indicators e.g. GDP, unemployment, wage growth, household income, interest rates, or indebtedness of the household sector. Some other studies directly link banks' provisions, which should ideally capture expected losses with an macroeconomic indicator (see e.g. Pain 2003). Moreover Trück, Rachev (2005) investigated the effects of changes in migration matrices on credit portfolio risk in terms of expected losses and value-at-risk.

growth, changes in the unemployment rate, lagged nominal wage growth and changes in interest rates (see equation (11) and Table 2, where the lags are in quarters and ψ denotes the cumulative normal distribution function, and, for model performance, Chart 2 of the Appendix, One-factor Model with Default Barrier Depending on Macroeconomic Environment).

$$df_t = \psi(c + \beta_1 gdp_{t-4} + \beta_2(u - u_{t-1}) + \beta_3 w_{t-1} + \beta_4(r_{t-3} - r_{t-4})) \quad (11)$$

Table 2: Macroeconomic model for Czech household sector

Description of variable corresponding to estimated coefficient	Notation	Estimate	Standard error	Pr>|t|
Constant	c	-2.127	0.015	<.0001
Real GDP growth (β_1)	gdp_{t-4}	-0.028	0.003	<.0001
Change in unemployment (β_2)	$u - u_{t-1}$	0.012	0.004	0.009
Nominal wage growth (β_3)	w_{t-1}	-0.012	0.001	<.0001
Change in interest rate (β_4)	$r_{t-3} - r_{t-4}$	0.034	0.007	0.0001

Note: The lag length is in quarters.

Our results showed that lagged real gross domestic product growth negatively affects default rates. Moreover, a decrease in lagged nominal wage growth, an increase in the unemployment rate and an increase in lagged interest rates each have positive effects on household insolvencies. Our model captures both the asset and liabilities side of households' balance sheet. While unemployment and nominal wages impact household income, interest rates influence household financial costs. Real GDP is used as a proxy for factors affecting disposable income not covered by the previously mentioned indicators. Household financial distress or default can be defined as a situation where a debtor is not able to service its outstanding debt. In such case, the household's disposable income is negative.

Nevertheless, the model based on individual data is usually able to better explain household defaults. Peter and Peter (2006) identify five groups of mortgage default determinants that relate to the following: income, credit history, macroeconomics, borrower location, and demographics. They pointed out that although the most important cause of mortgage default is a fall in household income, the other factors may also be important for future default estimation.

Decrease in Nominal Wages

Given the sharp fall in economic activity related to the economic crisis, the potential decrease in nominal wages (see Table 1) can be regarded as a relatively plausible scenario for the Czech economy. For this reason we try to identify a decrease in household nominal income that would cause a massive increase in loan defaults by households at the aggregate level and prompt a collapse of the mortgage market. Although individual data on household indebtedness are not available, the recently published survey of the Czech Statistical office revealed that about 10% of Czech households are repaying mortgage loans and roughly 20 % are repaying consumer credit. This means that a significant part of the population is involved and renders the issue an important one for analysis.

To quantify the effects of wage shocks, we consider two variants of a typical indebted household. In the first case, the household is only repaying a mortgage loan and in the second case it is repaying both a mortgage loan and a consumer loan. These are being repaid in

regular monthly instalments. In both cases we assume a three-member family with one child and monthly living costs of CZK 15,000.[5] As micro data reflecting the current situation are not available, we use micro data simulation to model household income, assuming a normal distribution with mean and standard deviations based on the available aggregate statistics.[6] Furthermore, we assume that each household is repaying a mortgage loan corresponding to 5 years of income with a maturity of 20 years, where household income is sufficient to cover monthly instalments and minimum living costs.[7] If household income is not adequate, the maturity is prolonged to a maximum of 30 years. If that is still not enough, the household is not granted a mortgage loan. The interest rate is assumed to correspond to the average rate on mortgages at the end of 2009.

In the second variant, we additionally consider the repayment of a consumer loan of up to CZK 100,000 with 5-year maturity and an interest rate corresponding to the average rate on such credit at the end of 2009. The amount of the consumer loan is set so that the household is able to cover the monthly payment. If household income is not sufficient to cover the monthly mortgage payment and essential living costs, a consumer loan is assumed not to be granted.

For both variants we test the impacts of a wage shock on hypothetical family budgets in relation to initial nominal incomes. We can formulate a household surplus, which is available for consumption, in line with model (1).

$$S = Y - I - MC\,, \qquad (12)$$

where S denotes the household surplus, Y household net income, I the loan instalment that household is committed to and MC household's essential living costs. We define household distress as a situation where the household surplus is close to zero and the household is only able to cover the essential living costs. In contrast to Herrala and Kauko (2007) we do not take into account a pledgeable amount of wealth, as its distribution among households with a mortgage is not available. And, contrary to Elmer and Seelig (1998), we simplify the analysis by ignoring homeowner equity. In calculating household net income, we take account of the Czech tax code.

The results show that if households with a mortgage had no other loan, the budgets of about 30% of them would go into deficit if nominal wages declined by more than 10%. If this group of households also had a consumer loan of CZK 100,000, around 50% of them would be hit. However, the estimates of the proportion of households with difficulty in making loan repayments are extreme. For example, the assumption of constant living costs is very conservative, since households can in reality cut their living costs to some extent if needed. Moreover, a large proportion of households can cope with a potentially bad situation by selling their assets (bank deposits, life insurance, private pension schemes, building saving schemes) or are insured against the inability to repay debts.

[5] For both variants we assume a family corresponding to the typical mortgage recipient in the Czech Republic. According to CZSO data, this is most often a household with two economically active members and one child. The main breadwinner is a 39-year-old man with a secondary education. His partner is a 33-year-old employee or housewife with a secondary or basic education. Essential living costs can be estimated on the basis of the household budget statistics on expenditures on food, clothing, housing, health, transport and restaurants. These expenditures can alternatively be estimated as the sum of the minimum subsistence amount and normal housing expenses, as stipulated in a government order of 16 December 2008. In both cases, the estimated amount is about CZK 15,000.

[6] We are aware of the non-normality of household income (see Chart 1). However, with a host of other simplifications and assuming only households with mortgages, this should not significantly bias our results.

[7] This reflects common banking practice for the mortgage granting process in the Czech Republic.

Alternatively, the macroeconomic forecast model (9) can be employed. It suggests a much more modest impact of the shock. However, the macro model usually cannot deal well with the extreme scenario, so we could assume that the results obtained by micro-simulation would be much closer to reality. Despite a lot of simplifications and limitations, our exercise points out that a potential decrease in nominal incomes can cause serious difficulties and cause distress to a significant number of households with debt burdens. This could happen as a result of a shorter working week or cutbacks in variable wage components. In such a situation, the number of insolvencies would rise sharply and the quality of bank loan portfolios would fall. This would lead to a decline in residential property prices due to the sale of collateral. A decrease in the value of collateral (or a fall in the LTV ratio) would increase the risk to which banks are exposed. Moreover, a significant increase in household insolvencies would also have a negative social impact.

Impact on Aggregate Consumption

The current economic crisis is manifested in increasing unemployment. According to the CNB (2010) baseline scenario, the default rate on banking loans to households should increase by roughly 2 percentage.points during 2010 due to a deteriorating labour market situation and a decline in household disposable income. In a highly unfavourable scenario this indicator could rise by as much as 5 percentage points. Using formula (10), we can estimate the impact on aggregate consumption for different negative changes in economic growth measured by GDP. The proportion of defaulted households can be obtained as the product of default rate and share of household with debt burden. According to a survey by the Czech Statistical Office, 20% of households are repaying mortgage loans and 10% consumer loans. We do not know how many households with mortgage loans are also repaying consumer credit at the same time. We assume that 25% of Czech households have some debt burden. According to some studies, the marginal propensity to consume (MPC) can differ for unemployed and employed consumers. Thomson, Chung and McKibbin (2009) empirically tested MPC for households worried and not worried about their future job and pointed out that MPC significantly differs for these two groups. If we further express change in consumption as a ratio to GDP, we can reformulate equation (10) in formula (13).

$$\frac{\Delta C}{Y} = (1 - dk)[u(c_U - c_E) + c_E]\frac{\Delta Y}{Y} + [(c_U - c_E)(\Delta u - dk\Delta u - \Delta dku - \Delta dk\Delta u) - \Delta dkc_E](1 + \frac{\Delta Y}{Y}) \quad (13)$$

where parameter k corresponds to the share of consumers with some debt burden (k = 0.25) and d corresponds to household default rate (we assume d = 0.5, which corresponds to default on banking loan portfolio to households at the end of 2009). We employ the value 0.9 for the parameter c_E - marginal propensity to consume for employed consumers and 0.5 for the parameter c_U - marginal propensity to consume for unemployed consumers.[8] The following

[8] The marginal propensity to consume can be estimated using aggregate data. Barry, Bradley, Kejak and Vavra (2000) employed the value of 0.8 for the Czech economy. Thomson, Chung and McKibbin (2009) estimated MPC for households worried about their future job at close to 0.9 and for households not worried about their future job at close to 0.5. The Czech aggregated data suggest an MPC of close to 0.9. Hence we used this value for employed consumers. For unemployed consumers, we set this parameter at 0.5, in line with the study of Thomson, Chung and McKibbin (2009), as MPC for households worried about their future job should be the upper estimate for unemployed consumers.

tables illustrate the change in aggregate consumption as a result of change in the GDP growth rate, default rate and unemployment rate

Table 3: Change in consumption as a result of a change in GDP growth rate, default rate and unemployment rate (% of GDP)

Δu = 1%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-1.47	-1.69	-1.91	-2.13	-2.36
	-2	-2.32	-2.54	-2.76	-2.98	-3.20
	-3	-3.17	-3.38	-3.60	-3.82	-4.04
	-4	-4.02	-4.23	-4.45	-4.66	-4.88
	-5	-4.87	-5.08	-5.29	-5.50	-5.72
	-6	-5.71	-5.93	-6.14	-6.35	-6.56
	-7	-6.56	-6.77	-6.98	-7.19	-7.40

Δu = 2%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-1.86	-2.08	-2.30	-2.52	-2.74
	-2	-2.71	-2.92	-3.14	-3.36	-3.58
	-3	-3.55	-3.77	-3.98	-4.20	-4.42
	-4	-4.40	-4.61	-4.82	-5.04	-5.25
	-5	-5.24	-5.45	-5.66	-5.88	-6.09
	-6	-6.09	-6.30	-6.51	-6.72	-6.92
	-7	-6.93	-7.14	-7.35	-7.55	-7.76

Δu = 3%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-2.25	-2.47	-2.69	-2.91	-3.13
	-2	-3.09	-3.31	-3.53	-3.75	-3.96
	-3	-3.93	-4.15	-4.36	-4.58	-4.80
	-4	-4.78	-4.99	-5.20	-5.41	-5.63
	-5	-5.62	-5.83	-6.04	-6.25	-6.46
	-6	-6.46	-6.67	-6.87	-7.08	-7.29
	-7	-7.30	-7.51	-7.71	-7.92	-8.12

Δu = 4%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-2.64	-2.86	-3.08	-3.30	-3.52
	-2	-3.48	-3.70	-3.91	-4.13	-4.35
	-3	-4.32	-4.53	-4.75	-4.96	-5.17
	-4	-5.15	-5.37	-5.58	-5.79	-6.00
	-5	-5.99	-6.20	-6.41	-6.62	-6.83
	-6	-6.83	-7.04	-7.24	-7.45	-7.66
	-7	-7.67	-7.87	-8.08	-8.28	-8.49

Furthermore, the negative feedback effect on the aggregate consumption stemming from the adverse macroeconomic scenario can be calculated using the second term in the formula (13).

The following tables illustrate the size of this effect for different rates of GDP growth, default rate and unemployment rate.

Table 4: Additional feedback effect on aggregate consumption (% of GDP)

Δu = 1%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-0.61	-0.84	-1.06	-1.28	-1.50
	-2	-0.61	-0.83	-1.05	-1.27	-1.49
	-3	-0.60	-0.82	-1.04	-1.25	-1.47
	-4	-0.60	-0.81	-1.03	-1.24	-1.46
	-5	-0.59	-0.80	-1.01	-1.23	-1.44
	-6	-0.58	-0.79	-1.00	-1.21	-1.43
	-7	-0.58	-0.78	-0.99	-1.20	-1.41

Δu = 2%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-1.00	-1.23	-1.45	-1.67	-1.89
	-2	-0.99	-1.21	-1.43	-1.65	-1.87
	-3	-0.98	-1.20	-1.42	-1.63	-1.85
	-4	-0.97	-1.19	-1.40	-1.62	-1.83
	-5	-0.96	-1.18	-1.39	-1.60	-1.81
	-6	-0.95	-1.16	-1.37	-1.58	-1.79
	-7	-0.94	-1.15	-1.36	-1.57	-1.77

Δu = 3%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-1.40	-1.62	-1.84	-2.06	-2.28
	-2	-1.38	-1.60	-1.82	-2.03	-2.25
	-3	-1.37	-1.58	-1.80	-2.01	-2.23
	-4	-1.35	-1.57	-1.78	-1.99	-2.21
	-5	-1.34	-1.55	-1.76	-1.97	-2.18
	-6	-1.33	-1.53	-1.74	-1.95	-2.16
	-7	-1.31	-1.52	-1.72	-1.93	-2.14

Δu = 4%		Change in household default rate (in percentage points)				
		1	2	3	4	5
Change in GDP (in %)	-1	-1.79	-2.01	-2.22	-2.44	-2.66
	-2	-1.77	-1.99	-2.20	-2.42	-2.64
	-3	-1.75	-1.97	-2.18	-2.39	-2.61
	-4	-1.73	-1.94	-2.16	-2.37	-2.58
	-5	-1.71	-1.92	-2.13	-2.34	-2.55
	-6	-1.70	-1.90	-2.11	-2.32	-2.53
	-7	-1.68	-1.88	-2.09	-2.30	-2.50

These sensitivity analyses suggest that the impact of the macroeconomic shock on GDP was stronger than the impact of the original shock. However, within our simple theoretical framework, we assume that households do not expect the macroeconomic shock. Hence, they

have not adjusted their consumption prior to the shock. Table 4 shows how important the additional consumption effects can be in the case of a significant increase in the household default and unemployment rates.

6. Conclusion

The economic downturn arguably makes it less likely that households will be able to repay their loans. Household budgets can be negatively affected by declines in nominal wages and increases in unemployment. This effect was empirically tested for the Czech economy. Our analysis describes two basic mechanisms causing the increase in household insolvency: a decline in nominal wages and an increase in unemployment. As a result of a lack of micro data on Czech household finances, the extent of their financial distress due to adverse macroeconomic shocks cannot be directly evaluated. However, with some simplifying assumptions, micro data were simulated and the impact of macroeconomic shocks on the household sector assessed. Alternatively, the macroeconomic approach utilizes a simple Merton-type one-factor model. Our analysis of a potential slump in nominal wages during 2010 suggested that under the extreme scenario the budgets of about 30% – 50% of households with debt burdens would be in deficit if their nominal incomes were to decrease by more than 10%. This corresponds to roughly 7% - 12% of the total Czech population.

The crucial second part of the empirical analysis deals with the estimation of aggregate consumption. Our relatively simple theoretical model showed the extent to which an unexpected increase in the household default and unemployment rates cause an additional decline in consumption, which is reflected in an economic slump. We illustrate that the impact of the change in unemployment on the size of that effect positively depends on the difference between the marginal propensities to consume for employed and unemployed consumers. Our analysis, based on the derived relationship for aggregate consumption, showed that for the Czech economy e.g. a 4 percentage point increase in the default rate and a 3 percentage point increase in unemployment rate cause an additional decline in GDP of roughly 2 percentage points. If we do not take this effect into account, the expected decline in economic growth can be significantly underestimated. The study clearly shows the importance of the transmission channel via household balance sheets for the economy, which is usually not taken into account in macroeconomic and monetary policy models. Such omission of feedback effects on household consumption may produce a bias in economic policy making.

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Appendix

One-factor Model with Default Barrier Depending on Macroeconomic Environment

The one-factor model is one of the variants of the latent factor model which belongs to the class of Merton structural models (see e.g. Jakubík (2007) or Jakubík, Schmieder (2008) for the version of the one-factor model with default barrier depending on macroeconomic environment). A random variable with a standard normal distribution is assumed for the standardized logarithmic asset returns of economic agent *i* at time *t*:

$$R_{it} = \sqrt{\rho} F_t + \sqrt{1-\rho} U_{it} \tag{4}$$

where R_{it} denotes the logarithmic asset return for economic agent *i* in an economy at time *t*, and F_t corresponds to the logarithmic asset return of the economy at time *t*, which is assumed to be a random variable with a standard normal distribution. This variable represents the part of the asset return which is not specific to the economic agent and can thus denote general economic conditions. U_{it} denotes the economic agent-specific asset return, which is again assumed to be random with a standard normal distribution. The two random variables are assumed to be serially independent. The portion of risk that is systematic is defined by ρ_i, the correlation of the economic agent's asset return with the systematic factor F_t.

Given these assumptions, the logarithmic asset return of economic agent *i* at time *t* is also standard normally distributed. The model is based on the Merton model, according to which a default occurs if the return on an economic agent's assets falls below a certain barrier *T*, the default threshold. Formally,

$$P(Y_{it} = 1) = P(R_{it} < T), \tag{5}$$

where *Y* denotes a binary random variable with two potential states, borrower *i* defaults (1), or does not default (0), at time *t* and *T* is the default threshold.

In order to model aggregate credit risk by means of different macroeconomic indicators, it is further assumed – unlike in the case of Gordy's Basel II one-factor-model (Gordy, 2003) – that the value of the default threshold *T* depends on the economic cycle. This is modeled by taking a linear combination of macroeconomic variables (x_{jt}) to represent the value of the default threshold *T*.

The final form of the macroeconomic one-factor credit risk model used in this study is shown in equation (6), where Ψ denotes the distribution function of the standard normal distribution that represents the impact of a change in the macroeconomic indicators, β_0 is a constant and β_j are the coefficients of the macroeconomic variables, x_{jt}:

$$p_{it} = P(R_{it} < T) = P(\sqrt{\rho} F_t + \sqrt{1-\rho} U_{it} < \beta_0 + \sum_{j=1}^{K} \beta_j x_{jt}) = \Psi(\beta_0 + \sum_{j=1}^{K} \beta_j x_{jt}) \tag{6}$$

The default probability conditional on the realization F_t of a random unobservable factor representing the state of the economy at time t corresponding to the default probability (6) is given by formula (7).

$$p_i(f_t) = P(U_{it} < \frac{\beta_0 + \sum_{j=1}^{K} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}) = \Psi\left(\frac{\beta_0 + \sum_{j=1}^{K} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}} \right) \quad (7)$$

If we furthermore assume a homogeneous portfolio of economic agents in the economy whose asset returns follow process (4), the default rate in the economy is – based on the law of large numbers – equivalent to the economic agent's default probabilities. Accordingly, the model may then be applied to homogeneous sub-sectors of the economy such as the corporate sector and the household sector.

Accordingly, the specification of the model resulting from (6) is as follows:

$$df_t = \psi(\beta_0 + \sum_{i=1}^{K} \beta_i x_i) \quad (8)$$

where df_t denotes the dependent variable of the model (i.e. the default rate of the corporate or household sector), β is the coefficient vector, x is the vector of the macroeconomic variables and β_0 is a constant.

In order to estimate model (8), a relationship with a conditional number of defaults of economic agents depending on the realization of random variable F, the latent factor f_t is used. This number is, under the given assumptions, again random and has a binomial distribution with conditional probability $p_i(f_t)$ given by equation (7) and the number of economic agents N_t.

$$D(f_t) \approx Bi(N_t, p(f_t)) \quad (9)$$

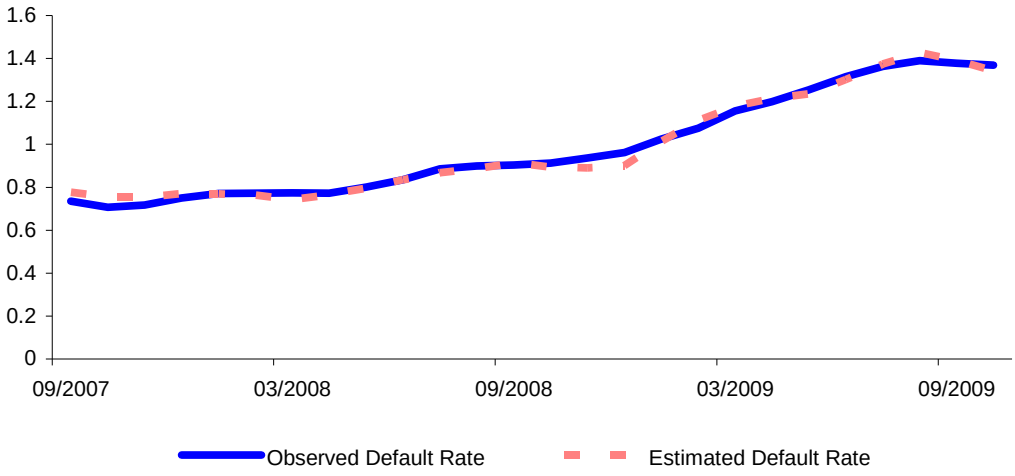
The model is then calibrated by maximising a likelihood function (10).

$$l(\beta_0,...,\beta_N,\rho) = \sum_{t=1}^{T} \ln\left\{ \int_{-\infty}^{+\infty} \binom{n_t}{d_t} \Psi\left(\frac{\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}} \right)^{d_t} \left[1 - \Psi\left(\frac{\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}} \right) \right]^{n_t - d_t} \phi(f_t) df_t \right\}$$

(10)

Performance of credit risk models for Czech household sector

Chart 1: Credit Risk Model for Czech Household Sector
(3M-default Rate, in %)



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