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Household balance sheets and economic crisis

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Abstract

In this paper, the impact of an economic downturn on the household sector is studied. Household budgets can be negatively affected by declines in nominal wages and increases in unemployment. This effect is tested for the small, open, emerging economy using the estimated macro model. As a result of a lack of individual data on household finances, micro data are simulated. It is clearly shown by the conducted analysis that there is a significant additional decline in consumption related to an increase in household default rates and unemployment. It is found that potential household insolvencies have important implications for the financial system as well as for the macroeconomy.

Keywords

Aggregate consumption, credit cycle, household default, households' distress, credit risk modelling, micro simulations, insolvency.

JEL Classification: G28, G32, G33, G38

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1. Introduction

Household financial distress is addressed by numerous studies. In some, the main drivers of the insolvency risk are investigated and an attempt is made to link them to the macroeconomic environment, while in others the focus is on the effects of adverse macroeconomic scenarios on household consumption. It is notable that in only a few studies the household credit cycle is discussed as a whole. The limited research on this issue is largely related to insufficient household statistics on structured balance sheets and consumption.

A severe economic downturn has a negative effect on household balance sheets and can cause financial distress. The aim of this study is to assess the impact of the economic recession on households' 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 the government revenue and increase the need for social spending.

In the next section, a literature review is presented on household distress, insolvency triggers and the impact of adverse macroeconomic scenarios on a household's balance sheet. In section 3, the theoretical framework is discussed, focusing on the impact of an adverse macroeconomic scenario on the aggregate consumption. In section 4, a description of the data employed in the paper is provided. The empirical results are presented in section 5, and a summary and conclusion are provided in the final section.

2. Related Literature

The issue of household insolvency, with a focus specifically on its main drivers, is addressed by a number of studies. Additional incentives for creditors as well as regulators to deal with the issue are provided by the recent historic episode of financial turmoil and the subsequent economic recession. Three main streams of research can be identified. The first is focused on household default prediction, using a traditional insolvency framework. In the second, the spotlight falls 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 attention of the third is directed to the credit cycle and consumption.

The first group of studies is focused on household default prediction. In Peter and Peter's (2006) study, the main drivers of household default are investigated. To this end, a risk management model is developed for the Australian economy, using micro data from the Australian Bureau of Statistics. The choice of DeVaney and Lytton (1995) is to focus on household insolvency by applying a predictive model and using financial ratios to identify insolvent households. The implications for monitoring household solvencies are discussed and a response to insolvencies is presented. In Herrala and Kauko's (2007) study, a micro simulation model of household distress is presented. A logit analysis is used to estimate the extent to which a household's risk of being financially distressed depends on its 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. In Del-Rio and Young's (2005) study, the ways in which attitudes towards unsecured debt are related to household finances and other characteristics are examined, using a British Household Panel Survey. It is suggested by this analysis that the main causal factors of 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. It is also concluded that the increase in the levels of indebtedness of young people is the main factor driving the greater tendency to report debt-related problems.

The aim of the second research stream is to evaluate the impact of household defaults on the financial sector in adverse macroeconomic scenarios. In Kadeřábek et al.'s (2008) paper, household default probability is modelled as a function of macroeconomic variables, such as wages, unemployment and interest rates. An estimated model is further employed within the stress test framework by applying exogenous stress scenarios for the development of these indicators. It is pointed out by the authors that the stress sensitivity of default probability is mainly driven by the instalment-to-income ratio and loan maturity. Macroeconomic models for forecasting household default for the Czech and German economies are estimated by Jakubík and Schmieder (2008).

These models are employed to stress test banking portfolios and it is pointed out that macroeconomic indicators alone have limited use in explaining household defaults. Moreover, strong empirical support for a positive lagged relationship between rapid credit growth and loan losses is found by Jiménez and Saurina (2006). In their study, empirical evidence is provided of lax credit standards during boom periods, in terms of the screening of borrowers as well as collateral requirements and loan losses. A regulatory prudential tool is advocated 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 household stress test methodology of the Austrian central bank is described by Albacete and Fessler (2010). In their paper, the impacts of macroeconomic scenarios (changes in interest rates, the unemployment rate, asset prices and the exchange rate) on households' ability to pay their debts are assessed. The stress test methodologies of other central banks are presented, for example, by Holló and Papp (2007) for Hungary, Karasulu (2008) for Korea and Djoudad (2010) for Canada.

The focus of the third research group is on consumption and economic growth, employing credit cycle models. In Chang et al.'s (1997) study, a three-period model for optimal consumption is presented and empirically tested. It is suggested by the latter that many US consumers without sufficient levels of liquid assets may be acting rationally. The issues of consumption and solvency are combined by Elmer and Seeling (1998). A theoretical model is proposed for a single-family mortgage default and the events that could trigger defaults within this framework are investigated. An evaluation of the strengths and weaknesses of the real business cycle approach to the analysis of macroeconomic fluctuations is applied by McCallum (1988). In Tudela and Young's (2005) research, an overlapping generation model is used to explain rising household indebtedness. 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 are also investigated. Evidence of a positive effect of wealth on Italian households' consumption is found by Bassanetti and Zollino (2008), and the influence of income distribution in modelling aggregate consumption expenditure is analysed by Chakrabarty et al. (2006). For the Netherlands, the impact of financial capital losses relative to gains on household savings and consumption is investigated by Berben et al. (2006). It is suggested by their results that households react more strongly to capital losses than to capital gains. Thus, the failure to take this asymmetry into account could seriously influence the estimates of the marginal propensity to consume from wealth. A comprehensive survey of the literature dealing with wealth and asset price effects on economic activity is provided by Altisimo et al. (2005). The impacts of banking and currency crises on consumption in 19 OECD countries are estimated by Barrel et al. (2006). It is shown by their results 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 liberalization and the easing of liquidity constraints. It is implied by the high leverage in some countries 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 a certain time lag, but the impact is more persistent than in the corporate sector. As a consequence of an economic crisis, firms reduce their production to cope with the declining aggregate demand. To do so, they need to reduce the labour force or decrease the wages. However, the wages are usually *downwardly 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.

Household insolvency is investigated by Elmer and Seelig (1998) using a three-period pure exchange model with no taxes. This model can easily be extended to include any arbitrary number of periods (see Hirschleifer (1970) or Fama and Miller (1972) for further details). Within this framework, a key role is played by uncertainty about future income, interest rates and house prices and a household defaults if its borrowing from previous periods exceeds the home-owner equity. It is quite an expected result. If an individual cannot meet his obligation, he can still sell his 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 aids the understanding of the basic default trigger based on the shock to income. In practice, however, things are more complicated, as mortgages can have different maturities, which imply different annuities, and a mortgage is usually paid back in fixed monthly in-

stalments. Moreover, contrary to the assumed framework, the interest rates paid on deposits and loans might be substantially different. It is also necessary to calculate the disposable income as the income purged of living costs. Moreover, household distress is defined by Herrala and Kauko (2007) as a situation in which 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. The assumption is that households can temporarily sustain their consumption by taking on more debt or running down their stocks of liquid assets. Another source of change in household consumption might stem from assets price effects via the wealth channel. A comprehensive study by Maki and Palumbo (2001) provides important evidence in favour of the wealth effect on US consumer spending during the 1990s. The relationship between equity wealth and consumption within the consumption-based capital asset pricing model is analysed by a number of studies, e.g. Mankiw and Zeldes (1990), Attanasio et al. (1998) and Brav et al. (1999). It is found that the spending of stockholders is more highly correlated with stock market returns than that of non-stockholders, which supports a direct effect.

3.1 Impact of an Adverse Scenario on the 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 in a significant decline in household consumption, which has a negative effect on the aggregate economy. To estimate this impact, a simple Keynesian framework can be used (see e.g. Romer, 1996):

$$C = C_0 + cY, \tag{1}$$

where C denotes the aggregate consumption, C_0 autonomous consumption, c the marginal propensity to consume and Y the disposable income. An adverse macroeconomic scenario corresponding to declines in the gross domestic product and disposable income is also assumed. Then, a decline in consumption can be expressed as

$$\Delta C = c\Delta Y, \tag{2}$$

where Δ is the operator for a 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 the aggregate consumption. Hence, the decline in consumption calculated via formula (2) could be considerably underestimated due to the underestimation of the marginal propensity to consume.

To achieve a better estimation of the impact of a decline in disposable income on consumption, consumers can simply be divided into two groups – defaulted [proportion d] and non-defaulted [proportion $(1–d)$]. Then, the aggregate consumption can be expressed as a weighted average of Keynesian consumption functions for both groups of consumers, taking into consideration the different propensities to consume:

$$C = dC_d + (1-d)C_n, \tag{3}$$

where C_d denotes the consumption function of the defaulted and C_n the 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, it is assumed that consumers reduce their consumption proportionally to the decline in their disposable income, which corresponds to the decline in the GDP. If it is further assumed that the disposable income of the defaulted household group is equal to zero in the limit, then the consumption is equal to the autonomous consumption related to the essential living expense:

$$\begin{aligned} C &= dC_d + (1-d)C_n = d \cdot C_0 + (1-d)(C_0 + cY) \\ &= C_0 + (1-d)cY. \end{aligned} \tag{4}$$

In the case of an adverse macroeconomic scenario, the GDP or disposable income declines and the household insolvency rate increases. The aggregate consumption is influenced by both these effects and can be easily derived from formula (4).

$$\Delta C = c\left[(1-d)\Delta Y - \Delta d\,(1+\Delta)Y\right]. \tag{5}$$

We see from equation (5) that the second term in the formula cannot be omitted. Only the terms of the second order can be omitted. Hence, the term $Y\Delta d$ would still remain in the formula and the omission of the second term could cause a significant underestimation of the decrease in consumption.

If it is further taken into account that the marginal propensity to consume could significantly differ for the unemployed and the employed consumers, equation (4) for the aggregate consumption can be reformulated as

$$C = C_0 + (1-d)\left(uc_U Y + (1-u)c_E Y\right), \tag{6}$$

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 impact of an adverse macroeconomic scenario on the aggregate consumption, it is necessary to take into account, together with the change in GDP and the change in the household default rate, the change in the

unemployment rate, to calculate the effect on the aggregate consumption. Formally, after some derivation, formula (7) is obtained:

$$\begin{aligned}\Delta C = (1-d)[u(c_U - c_E) + c_E]\Delta Y + \\ +[(c_U - c_E)(\Delta u - d\Delta u - \Delta du - \Delta d\Delta u) - \\ -\Delta d c_E](1+\Delta)Y.\end{aligned} \qquad (7)$$

It can be seen from equation (7) that – in the absence of a significant difference between the marginal propensities to consume for unemployed and employed consumers – it resembles formula (5). It is revealed by formula (7) that, with a significant difference between the 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 the 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, it would be necessary to know more about the distribution of income, wealth and the debt burden across the population. Furthermore, an estimate of the necessary living expenses as well as information on interest rates on loans to households would be required. In this research, the transmission channels for the Czech Republic as a small, open and emerging economy are empirically tested. Unfortunately, only limited data are publicly available. Neither micro data nor sufficient information on the income distribution are available. Thus, a simplifying assumption is made to deal with this problem.

The Czech Statistical Office is the main data source for Czech household statistics. Apart from that, some additional statistics on the aggregate bases are provided by the Czech National Bank, such as household financial assets and banking and non-banking loans to households. Moreover, the average bank interest rates on consumption and housing loans to households 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 the 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 with that of households without a mortgage.

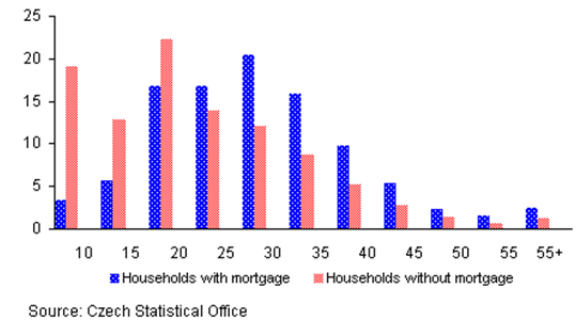

Figure 1 Household income distribution (Statistics of Family Accounts 2007, x axis: monthly household net income, CZK 1000; y axis: %)

Based on statistics from Fincentrum Hypoindex, the average value of mortgage loans rose over time from 2006 until the economic crisis emerged in 2009, but the rise was less than that in residential property prices. Slower growth is also found in nominal wages compared with changes in the residential property prices in the same period, reflecting the fact that owner-occupation has become less accessible to Czech households over time. Although the income situation was improving until 2008, it still did not compensate for the increase in residential property prices.[1]

Due to the lack of micro data on household balance sheets,[2] in this study, aggregate data from a bank credit registry are employed, as well as a one-factor model, to link the household insolvency to key macroeconomic variables (see the model specification e.g. in Hamerle et al. (2004), Jakubík (2007) and the Appendix).[3] These data include the total recent past-due

[1] At the end of 2008, banks started to tighten their 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 that started in 2008 is reflected in an increase in household sector credit risk.

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

[3] Econometric models that employ macroeconomic indicators to explain the household insolvency or default rate can be found in many research studies, e.g. Kadeřábek et al.

loans, which are used to proxy the credit default rate. The indicator for household credit risk is calculated based on new 3-month past-due loans. However, only the short time series for the household sector covering the period 3Q/2007–3Q/2009 is available. Although these data are available at a monthly frequency, for some macroeconomic variables, such as GDP growth, only quarterly data are available. In order to estimate the model on the basis of such a short time series, monthly data and linear interpolation are used for GDP growth and its components, such as consumption. The model is calibrated by maximizing a likelihood function (see the Appendix). In line with economic theory, macroeconomic variables are considered, which can drive household insolvency and the forecasts of which are published by the Czech National Bank. Automatic selection based on stepwise regression minimizing the residual sum of squares is used to find the combination of variables with the greatest prediction power and optimal time lag. Moreover, it is ensured that the coefficients have signs that are in line with economic theory. The final non-linear model obtained is able to explain the historic household default rate pattern relatively well. In addition, the non-linearity of the model was taken into account by investigating the pseudo-coefficients suggested by Estrella (1998), Cragg-Uhler (1970) and Veall-Zimmermann (1992), yielding values of close to one and thus supporting the quality of the model. A test on autocorrelation of the model was done by using the Q-statistics. Autocorrelation in the residuals is absent at the 5% confidence level. According to the results, the Czech household default rates can be explained by lagged real GDP growth, changes in the unemployment rate, lagged nominal wage growth and changes in interest rates (see equation (8) and Table 1, in which the lags are in quarters and ψ denotes the cumulative normal distribution function, and, for the model performance, Figure 2 of the Appendix – *The One-Factor Model with a Default Barrier Depending on the Macroeconomic Environment*).

$$df_t = \psi\left(\begin{array}{l} c + \beta_1 gdp_{t-4} + \beta_2\left(u - u_{t-1}\right) \\ +\beta_3 w_{t-1} + \beta_4\left(r_{t-3} - r_{t-4}\right) \end{array}\right). \qquad (8)$$

(2008), Rösch and Scheule (2007) and Jakubík et al. (2008). They typically employ as dependent variables macroeconomic indicators such as 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 macroeconomic indicators (see e.g. Pain, 2003). Moreover, in Trück and Rachev's (2005) study, the effects of changes in migration matrices on credit portfolio risk in terms of expected losses and value at risk are investigated.

Table 1 The macroeconomic model for the 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.

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

Nevertheless, a model based on individual data is usually able to explain household defaults better. Five groups of mortgage default determinants are identified by Peter and Peter (2006) that relate to the following: income, credit history, macroeconomics, borrower location and demographics. In their paper, it is 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.

4.1 Decrease in Nominal Wages

Given the sharp fall in economic activity related to the recent 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, in this paper, it is attempted 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 survey published by the Czech Statistical Office reveals 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, two variants of a typical indebted household are considered. 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, a three-member family with one child and monthly living costs of CZK 15,000 is assumed.[4] As micro data reflecting the current situation are not available, micro data simulation of the model household income is carried out, assuming a normal distribution with mean and standard deviations based on the available aggregate statistics.[5] Furthermore, it is assumed that each household is repaying a mortgage loan corresponding to 5 years of income with a maturity of 20 years, for which the household income is sufficient to cover monthly instalments and minimum living costs.[6] If the 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, 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 is additionally considered. The amount of the consumer loan is set so that the household is able to cover the monthly payment. If the 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, the impacts of a wage shock on hypothetical family budgets in relation to initial nominal incomes are tested. The household surplus, which is available for consumption, can be formulated as

$$S = Y - I - MC, \tag{9}$$

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

It is apparent from the results that if households with a mortgage had no other loans, the budgets of about 30% of them would go into deficit if the 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 facing difficulties in making loan repayments are extreme. For example, the assumption of constant living costs is very conservative, since households in reality can 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.

Alternatively, the macroeconomic forecast model (8) 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 it could be assumed that the results obtained by microsimulation would be much closer to reality. Despite the many simplifications and limitations, it is pointed out by the exercise in this paper that a potential decrease in nominal incomes can cause serious difficulties and 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. These 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.

The focus here is on the income aspects and household wealth is not considered in the analysis due to the limited data availability. However, the wealth effects are estimated to be stronger for households in

[4] For both variants, a family corresponding to the typical mortgage recipient in the Czech Republic is assumed. According to the 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. The 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.

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

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

the lowest income distribution (Altissimo et al., 2005). Due to the fact that the total debt burden of the Czech low-income households is relatively low, they should not contribute significantly to the potential rise in the non-performing loans of the Czech banking sector.

4.2 Impact on Aggregate Consumption

The period of economic crisis is manifested in increasing unemployment. It is reflected by an increase in the default rate on banking loans to households due to a deteriorating labour market situation and a decline in household disposable income. In a highly unfavourable scenario, this indicator could rise significantly. Using formula (7), the impact on aggregate consumption can be estimated for different negative changes in economic growth measured by the GDP. The proportion of defaulted households can be obtained as the product of the default rate and the share of households with a debt burden. Based on the available statistics, it is assumed 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. An empirical test of the MPC for households worried and not worried about their future job is carried out by Thomson et al. (2009) and points out that the MPC differs significantly for these two groups. If the change in consumption is further expressed as a ratio to GDP, equation (7) can be reformulated as formula (10):

$$\frac{\Delta C}{Y} = (1-dk)\left[u\left(c_U - c_E\right) + c_E\right]\frac{\Delta Y}{Y} + \left[\begin{matrix}\left(c_U - c_E\right)\left(\Delta u - dk\Delta u - \Delta dku - \Delta dk\Delta u\right)\\ -\Delta dkc_E\end{matrix}\right] \quad (10)$$
$$\left(1+\frac{\Delta Y}{Y}\right),$$

where parameter k corresponds to the share of consumers with some debt burden (k = 0.25) and d corresponds to the household default rate (it is assumed that d = 0.05, which corresponds to the default on the banking loan portfolio to households at the end of 2009). The value 0.9 is employed for the parameter c_E – the marginal propensity to consume for employed consumers – and 0.5 for the parameter c_U – the marginal propensity to consume for unemployed consumers.[7] In the following table, the change in aggregate consumption as a result of the change in the GDP growth rate, default rate and unemployment rate is illustrated.

Table 2 The change in consumption as a result of a change in the GDP growth rate, default rate and unemployment rate (in % 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

Table 2 shows that the impact on household consumption as a response to GDP decline can be amplified by an increase of the household default rate as well as an increase in the unemployment rate. For example a decline of the GDP growth rate by 4 percentage points can lead with a rise of the household default rate by 3 percentage points and an increase of the unemployment rate by 3 percentage points to a decrease of the household consumption by 5.2%.

Furthermore, the negative feedback effect on the aggregate consumption stemming from the adverse macroeconomic scenario can be calculated using the

[7] The marginal propensity to consume can be estimated using aggregate data. In Barry et al.'s (2000) study, the value of 0.8 is employed for the Czech economy. In Thomson et al.'s (2009) research, the MPC is estimated 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. An MPC of close to 0.9 is suggested by the Czech aggregated data. Hence, in this paper, this value is used for employed consumers. For unemployed consumers, this parameter is set at 0.5, in line with the study by Thomson et al. (2009), as the MPC for households worried about their future job should be the upper estimate for unemployed consumers. However, it does not mean that unemployed consumers spend only 50% of their income, as the autonomous consumption does not change.

second term in formula (10). In the following table, the size of this effect is illustrated for different rates of GDP growth, default rate and unemployment rate.

Table 3 The additional feedback effect on aggregate consumption (in % 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

It is suggested by these sensitivity analyses that the impact of the macroeconomic shock on the GDP is stronger than the impact of the original shock. For instance, with an increase of the uneployment rate by 2 percentage points and a rise of the household default rate by 1 procentage point, there is an additional effects of 2 procentage points of a decline in household consumption. However, within this simple theoretical framework, it is assumed that households do not expect the macroeconomic shock. Hence, they have not adjusted their consumption prior to the shock. Table 3 shows how important the additional consumption effects can be in the case of a significant increase in the household default and unemployment rates.

5. 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. Two basic mechanisms causing the increase in household insolvency were described in the analysis: 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 evaluated directly. However, with some simplifying assumptions, micro data were simulated and the impact of macroeconomic shocks on the household sector assessed. Alternatively, a simple Merton-type one-factor model can be utilized in the macroeconomic approach. It was suggested by the analysis of a potential slump in nominal wages during 2010 that in 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%, corresponding to roughly 7%–12% of the total Czech population.

The crucial second part of the empirical analysis deals with the estimation of aggregate consumption. The extent to which an unexpected increase in the household default and unemployment rates causes an additional decline in consumption, which is reflected in an economic slump, is shown by this relatively simple theoretical model. It is illustrated 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. It is shown by the analysis, based on the derived relationship for aggregate consumption, that for the Czech economy, for example, a 4 percentage point increase in the default rate and a 3 percentage point increase in the unemployment rate cause an additional decline in the GDP of roughly 2 percentage points. If this effect is not taken into account, the expected decline in economic growth can be significantly underestimated. The importance of the transmission channel via household balance sheets for the economy, which is not usually taken into account in macroeconomic and monetary policy models, is clearly shown by this study. Such an omission of feedback effects on household consumption may produce a bias in economic policy making.

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Appendix

The One-Factor Model with a Default Barrier Depending on the 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 and Schmieder (2008) for the version of the one-factor model with a default barrier depending on the 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:

$$R_{it} = \sqrt{\rho} F_t + \sqrt{1-\rho} U_{it}, \tag{11}$$

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 that 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 and 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,

$$P(Y_{it} = 1) = P(R_{it} < T), \tag{12}$$

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 the 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 modelled 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 (12), 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}:

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

$$= \psi\left(\beta_0 + \sum_{j=1}^{K} \beta_j x_{jt}\right). \tag{13}$$

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 (13) is given by formula (14).

$$p_i(f_t) = P\left(U_{it} < \frac{\beta_0 + \sum_{j=1}^{K}\beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}\right) = \Psi\left(\frac{\beta_0 + \sum_{j=1}^{K}\beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}\right). \quad (14)$$

If it is furthermore assumed that a homogeneous portfolio of economic agents exists in the economy, whose asset returns follow process (11); 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 (13) is as follows:

$$df_t = \psi\left(\beta_0 + \sum_{i=1}^{K}\beta_i x_i\right), \quad (15)$$

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 (15), 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 (14) and the number of economic agents N_t.

$$D(f_t) \approx Bi\left(N_t, p(f_t)\right). \quad (16)$$

The model is then calibrated by maximizing a likelihood function (17).

$$l(\beta_0,\ldots,\beta_N,\rho) = \sum_{t=1}^{T}\ln\left\{\int_{-\infty}^{+\infty}\left[\binom{n_t}{d_t}\Psi\left(\frac{\beta_0 + \sum_{j=1}^{N}\beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}\right)^{d_t}\left[1-\Psi\left(\frac{\beta_0 + \sum_{j=1}^{N}\beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}\right)\right]^{n_t-d_t}\right]\varphi(f_t)\,df_t\right\} \quad (17)$$

Performance of credit risk models for the Czech household sector

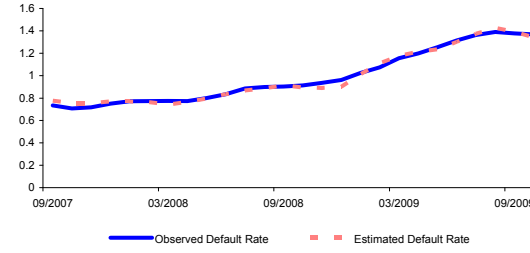

Figure 2 The credit risk model for the Czech household sector (3M default rate, in %)